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KENYA NATIONAL HUMAN DEVELOPMENT REPORT

2013

CLIMATE CHANGE AND HUMAN DEVELOPMENT



HARNESSING EMERGING OPPORTUNITIES



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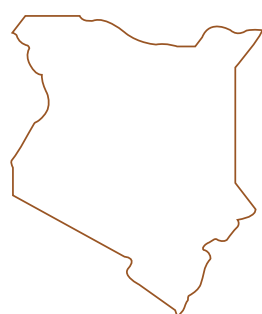
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KENYA HUMAN DEVELOPMENT REPORT 2013
Climate Change and Human Development:
Harnessing Emerging Opportunities

MINISTRY OF STATE FOR DEVOLUTION AND PLANNING

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP)

DECEMBER, 2013



Kenya

AT A GLANCE

	PERIOD	VALUE
ECONOMIC INDICATORS		
GDP at Current Market Prices (USD 'Millions)	2012	40,471.9
Growth of GDP at Constant prices (%)	2012	4.6
GDP per capita (USD) constant	2012	466
GDP per capita (USD) current	2012	995.6
Unemployment rate (%)	2005/06	12.7
Inflation rate (%)	2013	9.4
Informal sector share of employment (%)	2012	82.5

SOCIO-DEMOGRAPHIC INDICATORS		
Population Statistics		
Population (projection in millions)	2012	41.4
Annual Population Growth Rate (%)	2012	2.7
Age dependency Ratio (per 100)	2012	81.85
Fertility rate (%)	2009	4.6
Population Density (per Km ²)	2012	73.84

Health		
Life Expectancy at Birth (years)	2011	60.37
Under 5 Child Mortality (per 1000)	2012	74
Infant Mortality (per 1000)	2011	48.7
Maternal mortality (per 100,000)	2012	488
Medical personnel ¹ (per 100,000)	2011	267
Number of Health Institutions	2012	8,375

Education		
Gross Enrollment Rate of Primary (%)	2012	115.5
Gross Enrollment Rate of Secondary (%)	2012	49.3
Ratio of Girls to Boys in Primary Education (%)	2012	97.8
Adult Literacy Rate (%) Male to Female	2012	1914.8

	PERIOD	VALUE
Environment		
Population with Access to piped water (%)	2009	27.9
Population with Access to improved unimproved springs, wells or boreholes piped water (%)	2009	37.2
Population with Access to water from unsafe sources (%)	2009	29
Population with Access to Acceptable Sanitation (%)	2011	29.4
Proportion of Population Relying on Traditional Fuels for Energy	2011	19.71

Geography		
Total Geographic area of Kenya (Km ²)	2011	580,370
Land Area (Km ²)	2011	569,140
Water Mass (Km ²)	2011	11,230
Arable Land (%)	2011	9.66
ASAL (%)	2011	82
Land under forest cover (%)	2011	6.07

Infrastructure		
Bitumen Road coverage (%)	2010	14.3
Population with access of weather road within 2km (%)	2011	30
Railway lines coverage (Km)	2012	2,704
Installed Electricity (MW)	2012	1,606.1
Share of household accessing grid electricity (%)	2012	20
Population with Mobile subscription (per 100)	2012	71
Population accessing internet (per 100)	2012	32
Kenya's share of total Air-flight in SSA (%)	2010	10.6
Total Port Freight (million TNS)	2011	19.95

Sources: KIHBS, Statistical Abstract 2012, Economic Survey 2013, MTP II, KC&PD, WORD BANK DATA.

1. Comprise of Doctors, Dentists, Pharmacists, Pharm technologists, BSC Nursing, Registered Nurses, Enrolled Nurses, Clinical Officers, Public Health Officers and Public Health Technicians.



FOREWORD

Climate change is globally acknowledged as one of the most significant development challenges facing humanity. There is increasing evidence that climate change is directly affecting the social, economic and human development of countries. Combating climate change therefore has become one of the key global development priorities. The effects of climate change and related disasters have the potential to adversely impact the majority of Kenyans given that about 75% of the population depends directly on land and natural resources for their livelihoods. In recent years, there has been increased attention to climate change due to its impacts on the lives of Kenyans. This has been mainly due to an increase in intensity and frequency of extreme climate events such as severe droughts and flooding. These extreme events have had negative socio-economic impacts on almost all sectors in the Kenyan society such as health, agriculture, livestock, environment, hydropower generation, and tourism. The seriousness of the problem has made it imperative for policy makers to begin to mainstream climate change in development policies and strategies. This is the motivating factor for a national human development report (NHDR) on climate change. This is the 7th NHDR produced for Kenya on the theme: "Climate Change and Human Development: Harnessing Emerging Opportunities".

The report seeks to: a) review existing evidence of the impacts of climate change on human development through key sectors; b) present current adaptation and mitigation efforts in place; and c) identify opportunities that could be harnessed from the adverse impacts of climate change. The main objective of this report is therefore to integrate the current efforts and any new requisite interventions into a coherent framework for action, with the goal of reaching a more resilient and sustainable development path.

Climate change vulnerability depends on the scale of the hazard or the degree of change of climate variability (such as temperature, precipitation, sea level rise, and frequency and intensity of extreme weather events), which determines the degree of exposure; population density, which determines the number of people exposed; location, which determines sensitivity to the hazard; and the economy's reliance on climate-sensitive natural resources, wealth and development, which determine its ability to cope with or adapt to the perturbations on the one hand, and the amount of infrastructure exposed to risk, on the other.

This report shows that the human development aspirations of Kenyans cannot be achieved through a business-as-usual approach. Among the essential unusual approaches are clear understanding of the nature and magnitude of the challenge posed by climate variability; the resilience and adaptive capacity of the country; policies and other measures required to build the resilience and adaptive capacity to the required levels; and ways and means of effective integration of these efforts within the overall development planning framework.

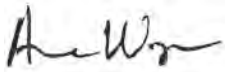
It has become evident that women are more vulnerable to climate change than men, primarily because they constitute the majority of the world's poor, and also because they are more dependent on natural resources which are susceptible to the effects of climate change for their livelihood. In addition to unequal access to resources and decision-making processes, limited mobility places women in rural areas in a position where they are disproportionately affected by climate change. Furthermore, they face social, economic, and political barriers that limit their coping capacity. It is therefore important to identify gender-sensitive strategies to respond to the environmental and humanitarian crises caused by climate change.

There are, however, opportunities associated with climate change. One of them is improved technologies to reduce vulnerability and build resilience in key sectors such as water, agriculture, and human settlements, and the other, access to funds from new financing mechanisms that support mitigation and adaptation action plans. But to harness them, Kenya needs to incorporate gender perspectives into its national policies, action plans, and other measures on sustainable development and climate change, through carrying out systematic gender analysis, collecting and utilizing sex-disaggregated data, establishing gender-sensitive benchmarks and indicators, and developing practical tools to support increased attention to gender perspectives.

The analysis and recommendations in this report focus on a specific challenge that, if not dealt with in a timely and effective manner, is expected to hinder the efforts the country has made so far towards the achievement of human development. The report has shown that changing climate patterns, resulting from global CO₂ emissions, are already producing harmful impacts on the Kenyan economy, society, and environment. Productive sectors, such as agriculture and tourism, are suffering significant losses from uncertain weather patterns, with direct consequences for the well-being of the population. Health challenges, for example, are worsened by the effects of rising temperatures on the incidence of certain diseases such as malaria. Access to water, energy, and basic conditions for human development is seriously threatened by the progressive depletion of ecosystems as well as the impacts of extreme weather events on infrastructure.

It is also important to note that climate change is a trans-boundary issue that requires international cooperation on different levels of governance: multilateral, bilateral, global, regional, and sub-regional. Policies and strategies, especially those on the management of natural resources, should be coordinated beyond the borders of Kenya, through the creation of international action plans and treaties, as well as informal partnerships and collaboration.

The impacts of climate change on human development cannot be stopped by single institutional mandates or geographic boundaries. In order to effectively address these risks and explore potential opportunities, collaboration amongst all relevant stakeholders is needed. Accurate information and reliable communication networks are key to ensuring that there is constant awareness of complementarities and synergies in order to increase cooperation and maximize results toward the achievement of sustainable and resilient human development. There is need to establish clear and workable frameworks, including regulation where necessary, in order to rebalance the risk and / or reward mechanism for addressing climate change challenges.



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Eng. Peter O. Mangiti
Principal Secretary, Ministry of Devolution and Planning

EXECUTIVE SUMMARY

The Context

Since independence, Kenya has been progressing towards the realization of human development. The national economy has expanded throughout the years, and significant progress has been achieved in reducing gender-based differences, supporting the development of the most vulnerable segments of the population, improving access to health and sanitation services, promoting a more equitable access to resources, protecting human rights, and valuing individual goals and objectives. Consequently, the 2012 Human Development Index (HDI) estimate for Kenya is now 0.522, an improvement from the previous year's score of 0.509. This score is higher than the average for Sub-Saharan Africa.

Despite this progress, many challenges still stand in the way of more equitable and sustainable human development. This has seen the gap between Kenya's HDI and global averages worsen since the 1980s. The focus of this National Human Development Report (Kenya Human Development Report, 2013) is on a specific challenge which, if not effectively, aggressively and consistently dealt with, will make things worse. That challenge is climate variability and change.

Changing climate patterns, resulting from global CO₂ emissions, are already producing harmful impacts on the Kenyan economy, society, and environment. Economic sectors such as agriculture and tourism are suffering significant losses from uncertain weather patterns, with direct consequences on the well-being of the population. Health challenges are being exacerbated by the effects of rising temperatures on the incidence

of certain diseases, such as malaria. Access to water, energy, and basic conditions for human development is seriously threatened by the progressive depletion of ecosystems, as well as the impacts of extreme weather on delivery infrastructure.

Kenya is actively implementing strategies and actions to respond to current and projected climatic changes. In 2010 for example, the National Climate Change Response Strategy (NCCRS) was developed and some of its recommendations have already been implemented. In addition, the National Climate Change Action Plan (NCCAP) 2013-2017 and Mitigation Action Plan (NAMA) were also developed. Legislation to establish a Climate Change Authority with the responsibility of spearheading the implementation of the adaptation and mitigation plans has also been drafted.

Climate change adaptation is fundamental for the realization of human development in Kenya. This report sought to review existing evidence of the impacts of climate variability and change on human development through key sectors, current adaptation and mitigation efforts, and to identify opportunities that could be harnessed from climate change. The main objective of this review was to integrate the current efforts and any new requisite interventions into a coherent framework for action, with the goal of reaching a more resilient and sustainable development path.

Main Messages

The main messages of the report are summarised in the table below:

Table 1: Summary of report's main messages

Issue or sector	Main messages
Human Development and Climate Change in Kenya	<ol style="list-style-type: none"> 1. There are significant spatial disparities in human development indices in the country. 2. Women are more vulnerable to the effects of climate change than men, primarily because they constitute the majority of the world's poor, and are more dependent on natural resources that are threatened by climate change for their livelihood. Furthermore, they face social, economic, and political barriers which limit their coping capacity. 3. County level data shows that human development in Kenya is negatively correlated to climate change vulnerability.
Agriculture and Food Security	<ol style="list-style-type: none"> 1. The agriculture sector (including crops, livestock, fisheries and forestry) is very sensitive to climate variability and change. This sector also affects climate through emissions of GHGs, especially the livestock sub-sector, which emits more than 90 per cent of all emissions from agriculture. 2. The negative impacts of climate change are discernible through food insecurity and widespread poverty particularly in Sub-Saharan Africa. 3. In Kenya, the adverse impacts are mainly caused by rising temperatures, erratic rainfall patterns, and extreme weather events which lead to frequent droughts and floods.

Issue or sector	Main messages
Tourism	<p data-bbox="539 271 1414 360">4. Climate change offers some opportunities though, especially in the form of adaptation and mitigation actions which help to build resilience, enhance food security and livelihoods, and at the same time, pursue a low carbon development pathway.</p> <hr/> <p data-bbox="539 443 1414 775">1. The tourism sector is important for human development because of its potential to reduce poverty and create employment. It has been identified as one of the critical sectors for poverty alleviation in Kenya's Vision 2030.</p> <p data-bbox="539 546 1414 607">2. The tourism sector is a significant contributor to climate change. It contributes about 5-14% of the total global CO₂ emissions.</p> <p data-bbox="539 613 1414 674">3. Empirical research on the impact of climate variability and change on the tourism sector in Kenya is lacking.</p> <p data-bbox="539 680 1414 775">4. Climate change provides an opportunity for the Government to enact legislation that supports mitigation and adaptation interventions in the sector, which would yield the added advantage of realizing sustainable tourism.</p>
Human Health	<p data-bbox="539 860 1414 920">1. Climate change is real and has affected and continues to affect some human health outcomes, which impact negatively on human development.</p> <p data-bbox="539 927 1414 1021">2. Kenya is vulnerable to climate-induced diseases such as malaria, whose geographic distribution is shifting as a result of changing weather patterns, thereby exposing some regions to unprecedented health risks. This is compounded by weak public health infrastructure and high poverty levels.</p> <p data-bbox="539 1028 1414 1088">3. Efforts being made in the health sector are confronted by paucity of financial, physical, and human resources.</p>
Water and Sanitation	<p data-bbox="539 1173 1414 1267">1. Water is a basic commodity for sustaining life yet it is undelivered to a majority of Kenyans. It is estimated that 41% of the country's population (17% of the urban population and 48% of the rural population) still does not have access to an improved water supply.</p> <p data-bbox="539 1274 1414 1402">2. Even worse, 69% of the population (73% of the urban population and 68% of the rural population) does not have access to improved sanitation services. Poor sanitation services translate to high incidence of water-borne diseases, which costs Kenya about USD 324 million (approximately, 0.9% of GDP) annually.</p> <p data-bbox="539 1408 1414 1581">3. The country lacks an effective system to establish water supply and sanitation coverage, making it very difficult to track the Millennium Development Goals (MDGs) or national targets. However, efforts are being made to find a solution through improved data systems such as MajiData, which focuses on the poor urban areas, and the Water Service Board's Investment Tool (WaSBIT), which compiles data at a sub-location level and is currently being piloted in the country.</p> <p data-bbox="539 1588 1414 1671">4. Unless urgent, innovative and effective measures are taken to address it, climate variability and change threatens to turn an already bad situation of water and sanitation challenges into a monumental crisis.</p> <p data-bbox="539 1677 1414 1715">5. Climate change has created good investment opportunities in the water and sanitation sector.</p>
Infrastructure	<p data-bbox="539 1800 1414 1861">1. Infrastructure quantity and quality are key determinants of human development by spurring economic growth, reducing poverty, and empowering people to make choices.</p> <p data-bbox="539 1868 1414 1890">2. Infrastructure is also a key determinant of a country's vulnerability to climate change.</p> <p data-bbox="539 1897 1414 2051">3. While there is notable progress in roads and ICT, there are major infrastructure deficits in Kenya, especially in the electricity and transportation sectors. Inadequate supply and high cost of electricity, and inefficient and expensive port and related logistics services, feature as the main impediments to the county's competitiveness. About 25% of the country's infrastructure assets require rehabilitation.</p>

Issue or sector	Main messages
	<ol style="list-style-type: none"> 4. There are wide disparities with respect to infrastructure services in the country (along regional, income, and gender lines, among others). 5. Infrastructure is one of the sectors that are highly impacted by and vulnerable to climate variability and change. 6. The main climate change impacts, vulnerability, and risk to the country's infrastructure come from flooding, and the effects of it, which range from destruction of different types of physical infrastructure, to siltation of dams, and the resultant reduction of water storage and hydroelectricity generation capacity. The replacement cost of infrastructure damaged during the 1997-1998 El-Niño floods, for example, was estimated at Kshs 62 billion (US\$ 777 million). 7. The impacts, vulnerability, and risks vary across various cleavages, especially regional or location with arid and semi-arid lands ASAL areas; the Coast, Nyanza and Western provinces, and generally in low lying areas; people living in urban slums; and people living along steep slopes facing the greatest risk to drought and/or floods. 8. Kenya has already made significant progress towards adaptation to and mitigation of climate change or example, the development of national adaptation and mitigation strategies, and the initiation of the process of establishing a Climate Change Authority through an Act of Parliament, as well as increasing investment and reliance on green or clean energy, among others. 9. Obstacles to adaptation and mitigation efforts in the Kenyan infrastructure sector mainly revolve around technology challenges such as awareness, cost, and poor quality enforcement; data challenges; and lack of credit to access the technology. 10. The increasing global attention to climate change and Kenya's richness in renewable resources, especially green energy resources, present a considerable opportunity for the country to tap into the international financial resources and expertise to develop unique technologies for adapting to or mitigating climate change, and to create employment opportunities.
<p>Integration of Human Development and Climate Change into Development Planning.</p>	<ol style="list-style-type: none"> 1. Integration and mainstreaming of climate change adaptation into core development policies, strategies, and plans requires the adoption of an Integrated Policymaking approach (IP), which takes into consideration economic, social, and environmental variables that influence the achievement of policy objectives. 2. Climate change policy work should consider the three layers of policy development (structure, scenarios, and policies). Clear and reliable indicators for policy formulation and evaluation should also be established, along with clear responsibilities. 3. Adequate planning (physical, socio-economic, etc.) needs to be undertaken on a continual basis in order to address the impacts of climate change. Such planning should be undertaken not in isolation, but in the wider context of sustainable development. 4. A multi-stakeholder approach should be employed to ensure coordination of all actors in climate change mitigation and adaptation. Such involvement and participation should occur on an appropriately coordinated basis which minimises duplication of effort and conflict, and which ensures efficient use of resources and the creation of positive synergies. 5. Given the impacts of climate change on human development, which directly impacts sustainable development, national human and institutional capacity should be developed in all aspects of climate change research, response, planning, and implementation. 6. Funding is necessary to improve climate resilience and support human development. Efforts should be made to procure and allocate financial and other resources, as is appropriate and feasible, to ensure that climate change is addressed in the required manner.

Opportunities to address climate change and improve human development

It is estimated that Kenya will need about US \$1-2 billion per year by 2030 to address current and future climate change effects (Mutai and Ochola, 2009). Unless effective mitigation and adaptation mechanisms are urgently instituted, the combined effect of 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.

In 2010, Kenya developed a National Climate Change Response Strategy (NCCRS), which identifies agriculture, tourism, infrastructure, health, and natural resources as being the most vulnerable areas to climate change (MENR, 2010). The NCCRS identifies a number of priority adaptation actions by sector. On November 22nd 2012, Kenya validated the Climate Change Action Plan to operationalise the NCCRS. This is a step further towards addressing climate change concerns in the country.

While the National Climate Change Response Strategy (NCCRS) was finalized in 2010 and the National Adaptation Plan validated in 2012, there is need to go further and formulate a national policy on climate change and enact a climate change law. The goal of establishing this policy would be to find a strategy to balance funding responsibilities and sharing benefits with all actors of society and the economy, while providing support to low income and disadvantaged families.

In order to incorporate climate change concerns into national development policies, the Government of Kenya should:

- Foster the development of strategies, plans, and processes to avoid, minimise, or adapt to the negative impacts of climate change on key assets of Kenya, which include damage to human settlements and infrastructure.
- Integrate and mainstream climate change adaptation into core development policies, strategies, and plans.
- Procure and allocate financial and other resources, as appropriate and feasible, to ensure that climate change is addressed in the manner required.
- Endeavour to, to the extent possible and necessary, among other aspects, develop national human and institutional capacity in all aspects of climate change research, response, and planning.

Based on this general strategic approach, sectoral strategies should be implemented to transform green economy opportunities into real actions. Towards this end, five main strategies were selected and evaluated, as presented in the table below. The dimensions of human development are presented in rows, with specific indicators selected for health, knowledge (education), and income. The five main strategies are presented in columns. The table shows the impact that each strategy would have on the indicators of human development, with the goal being to evaluate possible synergies to be created across interventions and sectors.

Table 2: Summary of selected sectoral policy impacts on climate change response and human development indicators

Dimension of Human Development	Indicator	1. Land-use Policy	2. Ecosystem Restoration	3. Health Care Policy	4. Community-led total sanitation Policy	5. Tourism attractiveness
Health	Mortality rate (infant and maternity)	↔	↔	↓	↓	↔
	Access to healthcare	↔	↔	↑	↔	↔
	Access to clean water	↑	↑	↔	↑	↑
	Access to adequate sanitation	↑	↔	↔	↑	↔
	Electricity availability	↔	↔	↔	↔	↔
Knowledge (education)	Formal years schooling	↔	↑	↑	↑	↔
	On the job training	↑	↑	↔	↑	↑
Income	Gross National Income	↑	↑	↑	↑	↑
	Employment	↑	↑	↑	↔	↑
	Productivity (e.g. agricultural yield)	↑	↑	↑	↑	↔
	Ownership of assets	↑	↔	↔	↔	↑

Key: ↑ Increase ↓ Decrease ↔ No Obvious Change

Table 3: Proposed sectoral policy priorities

Sector	Proposed Policy Priorities
Agriculture and Food Security	<ol style="list-style-type: none"> 1. The National Land Commission needs to articulate a comprehensive land use policy, which mainstreams climate variability and change, as it affects agriculture and food security. 2. The role of the national and county governments in addressing climate variability and change should be clarified. 3. The policy on strategic food reserves needs to be reviewed.
Tourism	<ol style="list-style-type: none"> 1. The government should harmonize various policies and laws (e.g. those relating to wildlife conservation and management, protection of endangered species; wildlife cropping; wildlife hunting; land ownership, land-use, etc.) in order to minimize areas of conflict in the wake of climate change. 2. There should be controlled land use changes as tourism is a very sensitive sector. 3. There is need for empirical and localized research on the impact of climate change on the tourism sector.
Human Health	<ol style="list-style-type: none"> 1. A workable human resources policy should be formulated in order to address the chronic staffing problem in public health facilities. 2. Climate change adaptation and mitigation policies should be implemented in sectors which affect human health such as water and sanitation, food security, energy, and transport.
Water and Sanitation	<ol style="list-style-type: none"> 1. Promotion of environmental education in Kenya's education curriculum. 2. Promotion of safe hygiene practices including household water treatment, safe storage (HWTS), and hand-washing with soap, to enhance the health benefit of improved sanitation. 3. Rapid acceleration of sanitation coverage through Community-Led Total Sanitation (CLTS) in rural areas.
Infrastructure	<ol style="list-style-type: none"> 1. Restoration of ecosystems such as forests and river basins, tree planting, and other conservation measures. 2. Review of infrastructure policies and laws to incorporate climate change and adaptation. 3. Harnessing emerging opportunities by tasking a specific department in the government to pursue the opportunities. 4. Entrenchment of adaptation and mitigation planning via research on impacts, vulnerability & risks; and improvement of data collection and packaging including resource assessments such as wind speeds.

Conclusions

"The basic objective of development is to create an enabling environment for people to live long, healthy, and creative lives. This may appear to be a simple truth. But it is often forgotten in the immediate concern with the accumulation of commodities and financial wealth" (HDR, 1990). Climate change adaptation reinforces this message, giving priority to the impact of climate change on the wellbeing of individuals, and focusing on reducing their vulnerability to such impacts. Individuals should thus be the protagonists of climate change response actions. Local leaders should be included in national development planning, especially with regard to disaster risk management and climate change adaptation.

The impacts of climate change on human development in Kenya cannot be stopped by single institutional mandates or geographic boundaries. In order to effectively address these risks and explore potential opportunities, collaboration among all relevant stakeholders is needed. Climate change impacts, vulnerability, adaptive capacity, and barriers to adaptation are location-specific and change over time, but the processes needed for adaptation that support all affected parties are similar. This requires having the right information and creating strong communication networks to ensure that there is constant awareness of complementarities and synergies, in order to increase cooperation and maximize results in the achievement of sustainable and resilient human development.

TABLE OF CONTENTS

Kenya at a glance.....	ii
Foreword.....	iii
Acknowledgements.....	v
Executive Summary.....	vi
Table of Contents.....	xi
List of Tables.....	xiv
List of Figures.....	xv
List of Maps and Boxes.....	xvi
List of Abbreviations.....	xvi
Key Concepts.....	xviii

CHAPTER ONE: SETTING THE STAGE

1.1 Introduction and Background.....	1
1.1.1 Climate, variability and change.....	1
1.1.2 Kenya's contribution to climate change.....	2
1.1.3 Uncertainty: Compounding the challenge.....	3
1.2 Rationale and Structure of Report.....	3
1.2.1 Rationale.....	3
1.2.2 Conceptual framework and methodology.....	4
1.2.3 Structure of report.....	5

CHAPTER TWO: HUMAN DEVELOPMENT IN KENYA: STATUS AND IMPACT OF CLIMATE CHANGE

2.0 Introduction.....	6
2.1.1 Aim of the chapter.....	6
2.1.2 Review of past Human Development Reports of Kenya.....	6
2.2 Human Development in Kenya.....	11
2.2.1 Human Development Index (HDI).....	11
2.2.2 Inequality Human Development Index (IHDI).....	11
2.2.3 Gender Inequality Index (GII).....	13
2.2.4 Multidimensional Poverty Index (MPI).....	15
2.2.5 Climate Change Vulnerability Index.....	15
2.3 Climate Change and Human Development in Africa.....	16
2.3.1 The need for gender sensitive responses to the effects of climate change.....	16
2.3.2 Correlation Between Climate Change Vulnerability and Human Development in Kenya.....	18
2.4 Harnessing Opportunities.....	18
2.5 Conclusions.....	19

CHAPTER THREE: AGRICULTURE AND FOOD SECURITY

3.1 Introduction.....	20
3.1.1 Climate variability and change and food security.....	21
3.1.2 Importance of agriculture in Kenya.....	21
3.2 Climate Change, Impacts, Vulnerability and Risks.....	27
3.2.1 Agricultural production.....	27
3.2.2 Livestock production.....	28
3.2.3 Fisheries.....	30
3.2.4 Forestry.....	30
3.3 Adaptation to Climate Change.....	31
3.3.1 The food and agriculture sector.....	31
3.3.2 Adaptation goals and interventions.....	31
3.4 Mitigation of Climate Change.....	33
3.4.1 Mitigation in agriculture.....	34
3.4.3 Mitigation in forestry.....	34
3.5 Managing Challenges and Embracing Opportunities.....	35
3.5.1 Opportunities to be derived from national efforts.....	35
3.5.2 Opportunities to be derived from international cooperation.....	35
3.6 Conclusion.....	36

CHAPTER FOUR: TOURISM SECTOR

4.1	Introduction	37
4.2	Emissions from Global Tourism: Status and Trends.....	37
4.3	Tourism and Human Development.....	37
4.4	Link between Tourism and Human Development.....	38
4.5	Climate Change and Tourism.....	38
4.6	Contribution of Tourism Sector to Kenya's Economy.....	39
4.7	Climate Variability and Change Impacts on Tourism Sector in Kenya.....	40
4.7.1	Wildlife-human conflicts.....	40
4.7.3	Emerging wildlife disease outbreaks.....	42
4.7.4	High Vulnerability of the low lying coastal region, a major tourism region.....	42
4.8	The Link between Climate Variability and Change Impacts on the Tourism Sector and Human Development.....	44
4.9	Adaptation and Mitigation to Climate Change in Kenya's Tourism Sector.....	45
4.10	Opportunities That Could Be Harnessed.....	45
4.11	Conclusion	47

CHAPTER FIVE: HUMAN HEALTH

5.1	Introduction	48
5.2	Climate Change, Health and Human Development.....	49
5.3	The State of Human Health in Kenya.....	50
5.4	Vulnerability to Climate-induced Health Risks.....	52
5.5	Adaptation to and Mitigation against Climate Change Health Risks.....	54
5.6	Managing Challenges and Embracing Opportunities.....	56
5.7	Conclusion	56

CHAPTER SIX: WATER AND SANITATION

6.1	Introduction	57
6.2	Human Development, Water and Sanitation: Understanding the Links.....	57
6.2.1	Health effects.....	58
6.2.2	Effects on education.....	58
6.2.3	Effects on income and consumption.....	59
6.2.4	Gender and social inclusion effects.....	60
6.3	Vulnerability and Risks in Water and Sanitation Sectors.....	60
6.4	Situational Analysis	60
6.5	Water Resources in Kenya	64
6.6	Adjusted Human Water Security (HWS) Threat Indicator	65
6.7	Drinking Water and Sanitation	67
6.8	Kenya's Vision 2030 for Water and Sanitation	67
6.9	Water, Climate Change and Human Development in Kenya.....	68
6.10	Adaptation Strategies in Water and Sanitation Sector.....	71
6.11	Harnessing Opportunities in the Water and Sanitation Sector.....	72

CHAPTER SEVEN: INFRASTRUCTURE SECTOR

7.1	Introduction and Sector Overview	73
7.1.1	The transport sector.....	76
7.1.2	Information Communication Technology (ICT) sector.....	80
7.1.3	Energy sector	81
7.2	Equity and Infrastructure in Kenya.....	86
7.2.1	Location/regional disparities.....	86
7.2.2	Income disparities.....	89
7.2.3	Gender disparities.....	89
7.3	Impact of Climate Change on Infrastructure in Kenya.....	90
7.3.1	Main drivers.....	90
7.3.2	Equity considerations	94
7.4	Adaptation and Mitigation Efforts.....	94
7.4.1	Obstacles to adaptation and mitigation	97

7.5	Harnessing Emerging Opportunities	99
7.6	Conclusion and Policy Recommendations	101
7.6.1	Conclusion.....	101
7.6.2	Policy recommendations	102
7.6.3	Improved management of climate change impacts, vulnerabilities and risks	102
7.6.4	Exploiting green energy potential.....	103
7.6.5	Enhancing infrastructure role of providing adaptation avenues to productive sectors	104
7.6.6	Harnessing emerging opportunities	104

CHAPTER EIGHT: INTEGRATION OF HUMAN DEVELOPMENT AND CLIMATE CHANGE IN DEVELOPMENT PLANNING

8.1	Introduction	105
8.2	Climate Change Adaptation and Mitigation in the Context of National Planning.....	106
8.2.1	Incorporating climate change into national development planning	108
8.2.2	Introduction to Integrated Policymaking (IP)	109
8.3	Strategic and Policy Directives.....	109
8.3.1	Enabling conditions.....	113
8.3.2	A systemic analysis of policy and strategic options in Kenya	115
8.4	Responsibilities and Suggested Institutional Arrangements.....	123
8.5	Conclusions	124

CHAPTER NINE: CONCLUSION AND RECOMMENDATIONS

9.1	Overview of the Human Development Trends, Past Challenges.....	125
9.2	Presentation of Human Development Goals and Future Challenges Related to Climate Change	126
9.3	Overview of Opportunities to Address Climate Change and Improve Human Development.....	126
9.3.1	National policy perspective	126
9.3.2	Sectoral opportunities	127
9.4	Concluding statement	128

References	129
Appendices	138

LIST OF TABLES

Table 1.1: Climate change in Kenya	2
Table 2.1a: Link between the first KNHDR and public policy/legislative agenda	6
Table 2.1b: Link between the second KNHDR and public policy/legislative agenda.....	8
Table 2.1c: Link between the third KNHDR and public policy/legislative agenda	9
Table 2.1d: Link between the fourth KNHDR and public policy/legislative agenda	9
Table 2.1e: Link between the fifth KNHDR and public policy/legislative agenda.....	10
Table 2.1f: Link between the sixth KNHDR and public policy/legislative agenda.....	10
Table 2.2a: Comparison of Kenyan, global and Sub-Saharan Africa HDIs	11
Table 2.2b: Correlation between CCI and HDI, IHDI and GII	18
Table 3.1: Food balance sheet indicators, 2006-2010.....	22
Table 3.2: Tea production and yields, 2007-2011	26
Table 3.3: Emissions from agriculture, 2000-2030 (MtCO ₂ e).....	27
Table 3.4: Episodes of drought and floods in Kenya, 1975-2011	28
Table 3.5: Forest cover in Kenya by type, 1990-2010.....	30
Table 4.1: Estimated emissions from global tourism, 2005.....	38
Table 4.2: A SWOT analysis for the tourist sector in Kenya.....	40
Table 4.3: Climate-related disasters in Mombasa City, Kenya	43
Table 6.1: Vulnerability assessment in the water sector	61
Table 6.2a: Projected increase in mean annual rainfall and potential evapotranspiration	64
Table 6.2b: Estimated renewable water, surface water and ground recharge using SHER model	64
Table 6.2c: Renewable surface water estimates per catchment.....	64
Table 6.2d: Safe yield of ground water per catchment.....	64
Table 6.2e: Water demand by various sub-sectors.....	64
Table 6.2f: Water demand by catchment and sub-sector by the target year 2030.....	64
Table 6.3: Trend in water and sanitation access in urban and rural Kenya, 1990-2010	67
Table 7.1: Infrastructure sector targets and priorities, 2008-2012	74
Table 7.2: Role of energy access in the achievement of MDGs.....	82
Table 7.3: Kenya's energy resources.....	83
Table 7.4: Impact of climate change on infrastructure in Kenya	91
Table 7.5: Adaptation and mitigation efforts and potential in Kenya's infrastructure sector.....	95
Table 7.6: Costs and benefits of investing in green transport – global evidence.....	97
Table 7.7: Obstacles to adaptation and mitigation in Kenya's infrastructure sector	97
Table 7.8: Green transport technologies.....	100
Table 8.1: Sectoral objectives, climate change impacts and actions in existing policy and strategy documents	110
Table 8.2: Examples of policy options that the government of Kenya could adopt to create the enabling conditions for a transition to climate resilient human development.....	114
Table 8.3: Integrated analysis of the impacts of agriculture productivity interventions on human development indicators.....	117
Table 8.4: Integrated analysis of ecosystem restoration impacts on infrastructure preservation and human development indicators.....	118
Table 8.5: Integrated analysis of health care policy impacts on climate change response and human development indicators.....	119
Table 8.6: Integrated analysis of Community-Led Total Sanitation (CLTS) impacts on climate change response and human development indicators	120

Table 8.7: Integrated analysis of tourism attractiveness preservation policy impacts on climate change response and human development indicators.....	121
Table 8.8: Summary of selected sectoral policies impacts on climate change response and human development indicators	122

LIST OF FIGURES

Figure 1.1: Kenya's GDP per capita since 1960s, US dollars.....	2
Figure 1.2: CO ₂ emissions, metric tons per capita.....	3
Figure 1.3: Mean CO ₂ emissions 2001-2010 for selected countries (million metric tons).....	3
Figure 1.4a: Current and future drivers of human development	4
Figure 1.4b: Focus of KHDR 2013	4
Figure 3.1a: Area (ha-millions) under maize, 2003-2011	23
Figure 3.1b: Maize production (million bags), 2003-2011	23
Figure 3.1c: Maize yields (bags per ha), 2003-2011	24
Figure 3.2a: Wheat production, 2003-2011	24
Figure 3.2b: Wheat yield (ha): 2003-2011	25
Figure 3.3a: Beans production (million bags), 2007-2011	25
Figure 3.3b: Beans yields (bags/ha), 2007-2011	26
Figure 4.1: Climate change impacts on tourism and implications on human development	44
Figure 5.1: Pathways by which climate change affects human health.....	50
Figure 5.2: Life expectancy: Male-female and average, both sexes.....	51
Figure 5.3: Infant mortality (male, female and both sexes)	51
Figure 5.4: Malaria transmission rates per thousand people.....	53
Figure 5.5: Differentials in malaria prevalence, Kenya, 2010.....	53
Figure 6.1: Linkages between selected human development dimensions, water and sanitation.....	58
Figure 6.2: Effects of water and sanitation interventions on health	59
Figure 6.3: Consumption and income effects	59
Figure 6.4: Kenya sanitation coverage.....	62
Figure 6.5: Economic impacts of unimproved sanitation in Kenya	62
Figure 6.6: Cost per capita of unimproved sanitation	63
Figure 6.7: Freshwater stress and scarcity in selected African countries by the year 2025.....	65
Figure 6.8: Human water security threat for Kenya.....	66
Figure 7.1: Number of motor vehicles and passenger cars, Kenya versus world	78
Figure 7.2: Intensity of energy use in the roads sector	78
Figure 7.3: Internet users (per 100 people).....	80
Figure 7.4: Mobile cellular subscriptions (per 100 people).....	81
Figure 7.5: Alternative and nuclear energy (% of total energy)	83
Figure 7.6: Sources of electricity production in Kenya (% of total)	84
Figure 7.7: Sources of electricity in Kenya, %, 2011 and 2030.....	85
Figure 7.8: Population (%) with access to electricity, 2009	85
Figure 7.9: Electric power transmission and distribution losses (% of output)	86
Figure 7.10: Source of energy for household lighting at County level (%).....	87
Figure 7.11: Type of walls used for housing by county (%).....	87
Figure 7.12: Type of roofing used for housing by County (%).....	88
Figure 7.13: Road Type by County (%).....	88
Figure 7.14: Access to Mobile Telephone and Internet Services (%), by Region.....	89
Figure 7.15: Gender disparity in literacy rates, by County	90
Figure 8.1: The three main layers for carrying out integrated policy formulation and evaluation.....	109
Figure 8.2 Simplified causal diagram indicating the cross-sectoral relations existing among society, economy and the environment.....	116

LIST OF MAPS AND BOXES

LIST OF MAPS

Map 2.1:	Spatial distribution of HDI for all Counties in Kenya	12
Map 2.2:	Spatial distribution of IHDI for all Counties in Kenya	13
Map 2.3:	Spatial distribution of GII for all Counties in Kenya.....	14
Map 2.4:	Spatial distribution of CCVI in Kenya, 2012	15

LIST OF BOXES

Box 2.1:	Kenya National Human Development Reports and Thematic Areas.....	7
Box 3.1:	Agriculture at a crossroads	21
Box 3.2:	Drought interventions.....	29
Box 3.3:	Conservation Agriculture Improves Yields.....	32
Box 3.4:	Crop diversification reduces hunger and boosts food security.....	33
Box 3.5:	Farmer climate coping strategies in Western Kenya	33
Box 4.1:	Water competition worsening farmer-wildlife conflict in Kenya	41
Box 4.2:	Climate change devastating wildlife in Kenya	42
Box 5.1:	Climate change and determinants of health: Facts and figures	49
Box 5.2:	Health consequences of El Niño-induced floods in 1997/1998	52
Box 5.3:	Development choices to enhance health and address climate change.....	55
Box 6.1:	Girls, Sanitation and Education	59
Box 6.2:	Climate change water crisis impacts hospital maternal care.....	68
Box 6.3:	Water shortages in Kenya responsible for growing thefts and conflicts	69
Box 7.1:	Kenya opens its first Railway Station in more than 80 years!.....	80
Box 7.2:	Kenya's largest wind power project underway	84

LIST OF ABBREVIATIONS

AAP	Africa Adaptation Programme	HDI	Human Development Index
AKST	Agricultural Knowledge, Science and Technology	HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
ALLPRO	ASAL-based Livestock and Rural Livestock Support Programme	HPI	Human Poverty Index
ASALS	Arid and Semi-Arid Lands	HWS	Human Water Security
AU	African Union	IAAKST	International Assessment of Agriculture Knowledge Science and Technology for Development
BRT	Bus Rapid Transit	IDRC	International Development Research Centre
CAF	Cancun Adaptation Framework	IEA	International Energy Agency
CBD	Central Business District	IFAD	International Fund for Agricultural Development
CCAA	Climate Change Adaptation in Africa	IGAD	Intergovernmental Authority on Development
CCFS	Climate Change and Food Security Framework	IHDI	Inequality Human Development Index
CCRS	Climate Change Response Strategy	ILO	International Labour Organisation
CDM	Clean Development Mechanism	ILRI	International Livestock Research Institute
CFLs	Compact Fluorescent Lamps	IPCC	Intergovernmental Panel on Climate Change
CIF	Climate Investment Fund	IRENA	International Renewable Energy Agency
CO ₂	Carbon Dioxide	ISO/IEC	International Organization for Standardization /International Electrotechnical Commission
CoK	Constitution of Kenya	ITCZ	Inter Tropical Convergence Zone
COMESA	Common Market for Eastern and Southern Africa	ITNs	Insecticide Treated Nets
CP-EDE	Country Programme Framework for Ending Drought Emergencies	JMP	Jomo Kenyatta International Airport Joint Monitoring Programme
CTF	Clean Technology Fund	KACCAL	Kenya Adaptation to Climate Change in Arid and Semi-arid Lands
CTI	Climate Index for Tourism	KDHS	Kenya Demographic and Health Survey
DFID	Department for International Development	KEFRI	Kenya Forestry Research Institute
DPs	Development Partners	KEMRI	Kenya Medical Research Institute
DRC	Democratic Republic of Congo	KEPSA	Kenya Private Sector Alliance
DRR	Disaster Risk Reduction	KFS	Kenya Forestry Service
EAC	East African Community	KHDR	Kenya Human Development Report
EEA	European Environment Agency	KLDP	Kenya Livestock Development Programme
ENSO	El-Niño/Southern Oscillation	KMIS	Kenya Malaria Indicator Survey
FAO	Food and Agriculture Organisation	KNBS	Kenya National Bureau of Statistics
FEWS	Famine Early Warning System	KNHDR	Kenya National Human Development Report
GDI	Gender Development Index	KRDP	Kenya Rural Development Programme
GDP	Gross Domestic Product	KSH	Kenya Shillings
GEF	Global Environment Facility	LAPSET	Lamu Port – Southern Sudan – Ethiopia Transport
GHG	Greenhouse Gases		
GII	Gender Inequality Index		
HABS	Harmful Algal Blooms		

LDCF	Least Developed Countries Fund	UNEP	United Nations Environment Programme
LPG	Liquefied Petroleum Gas	UNFCCC	United Nations Framework Convention on Climate Change
LRT	Light Rail Transit	UNICEF	United Nations Children’s Fund
LTWP	Lake Turkana Wind Power Project	UNWTO	United Nations World Tourism Organization
MDGs	Millennium Development Goals	WFP	World Food Programme
MENR	Ministry of Environment and Natural Resources	WFS	World Food Summit
MICS	Multiple Indicator Cluster Survey	WHO	World Health Organisation
MLND	Maize Lethal Necrosis Disease	WMO	World Meteorological Organization
MDP	Ministry of Devolution and Planning	WMS	Welfare Monitoring Surveys
MOPHS	Ministry of Public Health and Sanitation	WRMA	Water Resources Management Authority
MOSSP	Ministry of State for Special Programmes	WRUAs	Water Resources User Associations
MoWI	Ministry of Water and Irrigation		
MPI	Multidimensional Poverty Index		
MSP	Multi-Stakeholder Processes		
MTP	Medium Term Plan		
NAdP	National Adaptation Action Plan		
NAMA	National Mitigation Action Plan		
NCCI	National Climate Change Index		
NCCAP	National Climate Change Action Plan		
NCCRS	National Climate Change Response Strategy		
NCCS	National Climate Change Secretariat		
NDDCF	National Drought and Disaster Contingency Fund		
NDMA	National Drought Management Authority		
NEMA	National Environment Management Authority		
NET	National Environment Tribunal		
NWP	Nairobi Work Programme		
ODA	Official Development Assistance		
PES	Payments for Ecosystem Services		
PM&ER	Planning, Monitoring and Evaluation Report		
SCCF	Special Climate Change Fund		
SEI	Stockholm Environment Institute		
SEM	Sustainable Ecosystem Management		
SRAs	Strategic Response Areas		
SSA	Sub-Saharan Africa		
SWAp	Sector Wide Approach		
TCI	Tourism Climate Index		
UNCCA	United Nations Common Country Assessments		
UNCTAD	United Nations Conference on Trade and Development		
UNDAF	United Nations Development Assistance Framework		
UNDP	United Nations Development Program		

KEY CONCEPTS

The concepts defined below are central to this report:

- **Human Development** – Human development is both a goal and a process of empowering people to lead the lives they value by expanding their capabilities, freedoms, and choices (UNDP, 2009c). Principles of human development are equity within and across groups, efficiency in the use of resources, empowerment in terms of provision of resources and opportunities for people to participate in the development process, sustainability (of environmental, social, economic and political policies), and inclusiveness (UNDP, 2009c).
- **Climate Change** – Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2007d).
- **Climate Variability** – 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. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability) (IPCC, 2007d).
- **Extreme Weather Event** – An extreme weather event is an event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th per centile of the observed probability density function (IPCC, 2007d).
- **Greenhouse Gas (GHG)** – Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H₂O), carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄) and ozone (O₃) are the primary greenhouse gases in the Earth's atmosphere (IPCC, 2007d).
- **Vulnerability to Climate Change** – Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability 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 (IPCC, 2007e).
- **Impact of Climate Change** – This refers to effects of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts:
 - Potential impacts: all impacts that may occur given a projected change in climate, without considering adaptation.
 - Residual impacts: the impacts of climate change that would occur after adaptation (IPCC, 2007e).
- **Risk** – Risk is the combination of the probability (likelihood) of an event and its consequences (ISO/IEC, 2002).
- **Adaptation** – Adaptation refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation (IPCC, 2007e).
- **Mitigation** – Mitigation refers to a human intervention to reduce the sources or enhance the sinks of greenhouse gases (IPCC, 2007d).
- **Resilience** – Resilience is the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change (IPCC, 2007e).
- **Exposure** – Exposure is the nature and degree to which a system is exposed to significant climatic variations (IPCC, 2001).
- **Sensitivity** – This is the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli (IPCC, 2001).
- **Adaptive Capacity** – Adaptive Capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC, 2001).

1

SETTING THE STAGE

“... climate change is already eroding decades of hard-won development gains, thus the need for concerted and coherent efforts in urgently tackling this development challenge.”

– UNECA/AU Commission (2010, p. 1).

1.1 Introduction and Background

1.1.1 Climate Variability and Change

“Serikali tafadhali, niko saidi mbaya kabisa. Kama unawezako kunisaidia, nisaidie. Pahali pakuenda leo hakuna, hata pahali ya kulalisha watoto. Niko tu bila kitu, hata manguo zangu zimeenda yote; hata watoto yangu sijui wengine ziko wapi.”¹

This is a heart rending cry in poor Kiswahili from Jane Anyango, a mother of 6, from the flood prone Kano Plains of Kisumu County in Western Kenya. Jane is a perennial flood victim. As she makes this cry, she is waist deep in the floods. Her plea is to the government for assistance, as the floods have left her in a desperate state: homeless, helpless, and with the whereabouts of some of her children unknown. Every year, she is captured on television making this same cry. She cannot move out of the area because of its high fertility.

Jane Anyango and millions like her, have become the unforgettable images of climate variability and change in Kenya. Indeed, it has been estimated that the cumulative impacts of climate change over the next two to three decades have the potential to reverse much of the progress made in advancement of human development, the attainment of the Millennium Development Goals (MDGs), and Kenya Vision 2030. The impact is manifested mainly through reduced agricultural productivity, heightened water insecurity, increased exposure to coastal flooding and extreme weather events, collapse of ecosystems, and increased health risks (UNDP, 2007). The annual cost of climate change could be as much as 2.6-3.0% of Kenya’s Gross Domestic Product (GDP) by 2030 or US\$ 1-2 billion per year (UNDP, 2007; SEI, 2009).



In a recent study (Diffenbaugh et al., 2007), Kenya’s vulnerability was estimated at 0.5 on National Climate Change Index (NCCI), out of the worst possible score of 1.0.² The seemingly moderate scores notwithstanding, the country’s vulnerability is evident from increasing average surface temperatures in many areas of the country: rainfall that is increasing in some regions and decreasing in others; increasing rainfall variability over time and space; and serious and recurrent episodes of drought and flooding that are already having devastating consequences on the economy, society, and environment.

Between 2003 and 2007, for example, the country suffered one of the most devastating droughts estimated to have led to the loss of 70% of the livestock. Moreover, the 1998-2000 drought is estimated to have cost the country at least 16% of GDP in each of the years 1998/1999 and 1999/2000 (World Bank, 2004), while the 2008-2011 one led to a 2.8% annual slowdown in economic growth, thereby costing the country Kshs 968.6 billion (US\$ 12.1 billion) (GoK, 2012).

The 1997-98 El Niño floods are estimated to have cost the country 11% of GDP, including damage to transport and water infrastructure valued at Kshs 62 billion (US\$ 777 million) and Kshs 3.6 billion (US\$ 45 million), respectively (World Bank, 2004). Moreover, the country experienced one of its worst El Niños in 2007-08 with unprecedented destruction of infrastructure (Shisanya and Khayesi, 2007).

Climate change is also associated with a significant increase in the probability of conflict due to resource scarcity effects (Burke et al., 2009;

1. Jane Anyango as captured by Citizen TV Kenya on 21 March 2013. Available at www.youtube.com/watch?v=zm8t1K8Hr18&noredirect=1, accessed on 23 June 2013.

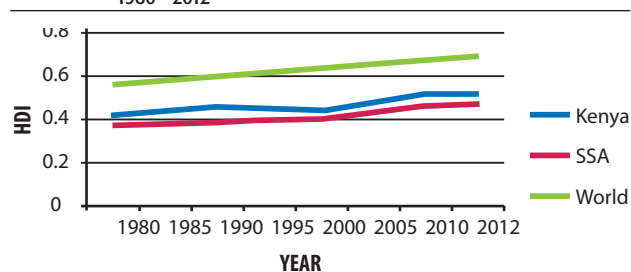
2. The score improved to 0.2 when this bio-physical index was aggregated with a population index, and to 0.3 when the index was aggregated with population, poverty index, and wealth density (Diffenbaugh et al., 2007).

Hsiang et al., 2011). Indeed, Burke et al. (2009) have suggested that a 10°C increase in temperature could represent a 49% increase in the incidence of civil war. Conflicts associated with resource scarcity, especially pasture and water among pastoralist communities, are increasingly common in Kenya. Moreover, recent stakeholder consultations have revealed that both human-human and human-wildlife conflicts are potential effects of climate change in most counties of the country (LTS International & Acclimatise, 2012).

With the gap between the global and Kenya's Human Development Index (HDI) worsening since the 1980s (Fig. 1.1), these adverse effects of climate variability and change cannot be more unwelcome. There is the real risk of the already slow improvement of human development in the country over the last 3 decades remaining slow, as shown by the flat HDI trend between 1980 and 2012, or even declining.

Climate is an important natural resource in Kenya, since a wide range of

Figure 1.1: Trend of Kenya's HDI relative to SSA and World averages 1980 - 2012



Source: UNDP, Human Development Reports, 2010 and 2013

socio-economic development activities depend on it. The country's climate varies over time and from one region to the other. It is driven by factors such as varying topography and the small scale circulation patterns it generates, the large scale circulation patterns generated by the Inter Tropical Convergence Zone (ITCZ), key global systems such as sea surface

temperature fields in the surrounding Indian and Atlantic oceans, El-Niño/Southern Oscillation (ENSO) and La-Niña phenomena driven by sea surface temperature field in the Pacific Ocean, winds, and cyclones (LTS International, 2012).

Climate variability and change is attributed to unsustainable human activities. It refers to the increasing variability in climate and the projected incremental changes in air and sea temperatures, precipitation and sea level, together with changes in the frequency and severity of extreme events. Table 1.1 provides a snapshot of tentative climate change projections for Kenya.

1.1.2 Kenya's contribution to climate change

Climate variability and change presents a major challenge in Kenya as in many parts of the world. The most vulnerable countries (most of which are also the poorest) and the poorest communities within them are the least contributors to the problem. However, poor countries are the most vulnerable to various shocks owing to their low level of development and their relatively higher dependence on climate sensitive means of livelihood. Mendelsohn et al. (2006) argue that the main reason poor countries are highly vulnerable to climate change, in terms of potential loss of their Gross Domestic Product (GDP), is the current climate. Further increase in temperature for countries with a mean annual temperature of 15°C is expected to reduce economic growth (Mendelsohn et al., 2006; Nordhaus, 2006). Indeed, besides sea level rise, the current temperature is a good generic indicator of a country's sensitivity to climate change (Füssel, 2009). Poor people within countries often live in fragile ecosystems or areas rendered vulnerable by lack of or inadequate public investment, in crowded slum settlements bereft of even the most basic infrastructure and social services. In addition, they face the greatest food insecurity risk, and lack the health and education facilities and infrastructure required to cope with shocks. Climate change amplifies these vulnerabilities and multiplies the threats (United Nations, 2009; Munasinghe, 2010; Bruckner, 2012). Kenya is one of the least contributors to climate variability and change,

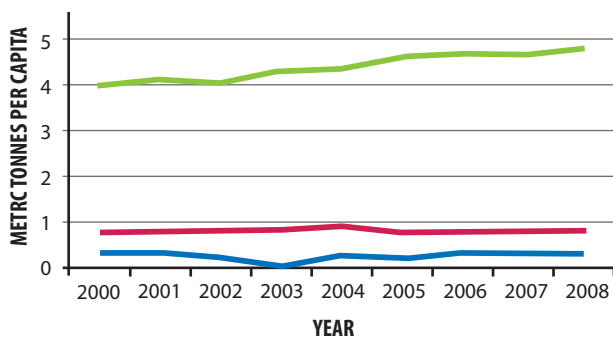
Table 1.1: Climate change in Kenya

Climate change indicator	Current and projected change	Source
Mean Annual Precipitation	1-13% increase by the 2090s or 0.2-0.4% annual increase	ILRI, 2010
Mean Annual Temperature	10C increase since the 1960s, and thus increase in the number of hot days and nights. Projected 1 - 2.80C increase by the 2060s and 1.3 - 4.50C by the 2090s.	McSweeney et al., 2009
Floods	Increase in frequency	Various: World Bank (2005, 2006); UNESCO (2006); SEI (2009); LTS International (2012)
Droughts	Increase in the frequency and intensity. Between 1993 and 2010, Kenya had declared 6 drought-induced national disasters.	IDRC & DFID, 2010

Source: Various

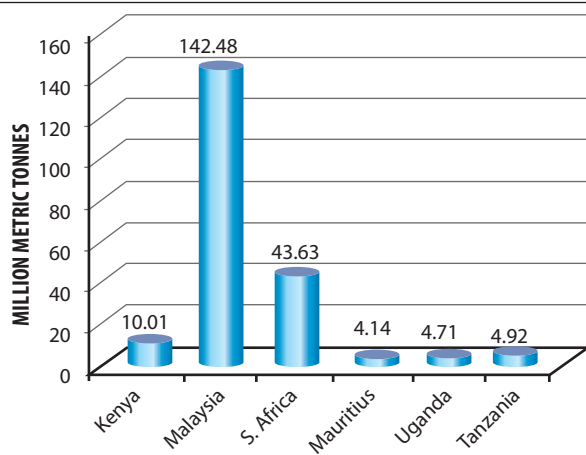
even relative to the average Sub-Saharan African country (Figs. 1.2 & 1.3). Kenya is, however, one of the highly vulnerability countries to climate

Figure 1.2: CO₂ emissions, metric tons per capita



Source: World Bank Open Source Data, accessed in November 2012.

Figure 1.3: Mean CO₂ emissions 2001-2010 for selected countries (million metric tons)



Source: Data from Wheeler (2012).

change. About 90 per cent of all disasters in the country, for instance, are mainly attributed to drought and flooding (LTS International, 2012). In this country, like elsewhere, vulnerability depends on the magnitude of the hazard or the degree of change of climate variables (such as temperature, precipitation, sea level rise, and frequency and intensity of extreme weather events) which determines the degree of exposure; population density, which determines the number of people exposed; location, which determines sensitivity to the hazard; the economy's reliance on climate-sensitive natural resources; and wealth and development, which determine its ability to cope with or adapt to the perturbations on the one hand, and the amount of infrastructure exposed to risk, on the other.

1.1.3 Uncertainty: Compounding the challenge

The impacts already being experienced in the country, and the country's high vulnerability to risks associated with current climate variability and future climate change, make judicious management of climate change through innovative adaptation and mitigation measures imperative. Regrettably, limited knowledge on climate variability and change is a serious

impediment.

There are serious weaknesses regarding knowledge on climate change in Kenya (LTS International & Acclimatise, 2012). Firstly, rainfall projections are inconsistent. While some models and scenarios suggest increases in total precipitation, others predict decreases (Osbaahr & Viner, 2006). Secondly, understanding of climate change variability is inadequate and the performance of existing GCM models in predicting ENSO episodes is particularly poor (LTS International & Acclimatise, 2012). Thirdly, investment in seasonal forecasts and downscaled model climate projections is inadequate (Zwaagstraet al., 2010; Maeda et al., 2010). Fourthly, accurate and long term data on sea level rise is limited (Kebede et al., 2009).

1.2 Rationale and Structure of Report

The seventh Kenya Human Development Report (KHDR, 2013) explores the important link between climate variability and change, and sustainable human development in the country. This report provides information how climate variability and change impacts sectors of the economy which are key to sustainable human development. It also provides information on the adaptation and mitigation measures being implemented or considered and their impact on human development.

1.2.1 Rationale

Considerable effort has been made in Kenya towards effective responses to the challenge posed by current climate variability and future climate change. This effort includes the development of: a National Climate Change Response Strategy (NCCRS) in 2010, and the implementation of some of its recommendations; National Climate Change Action Plan (NCCAP) 2013-2017, and National Mitigation Action Plan (NAMA); and drafting of legislation establishing a Climate Change Authority with the responsibility of spearheading the implementation of the adaptation and mitigation plans. Moreover, there is a sizeable amount of literature on various aspects of climate variability and change in Kenya in refereed and grey sources. However, climate change impacts, vulnerabilities and risks in the country, and specifically, the implications of these, adaptation measures, and mitigation efforts on sustainable human development, have not been well documented. This gap is glaring in light of the country's continuing effort to achieve sustainable human development.

Human development aspirations of Kenyans, as captured in Kenya Vision 2030, Millennium Development Goals (MDGs), and the Constitution of Kenya (2010), cannot be achieved through a business-as-usual approach. This has not worked well since the country attained independence in 1963. Among the essential unusual approaches has to be a clear understanding of the nature and magnitude of the challenge posed by climate variability and change; the resilience and adaptive capacity of the country; the policies and other measures required to build the resilience and adaptive capacity to the required levels; and ways and means of effective integration of these efforts within the overall development planning framework. Indeed, the NCCRS recommends a nationwide assessment of how climate variability and change could affect human population, infrastructure, the environment, the economy and society as a whole.

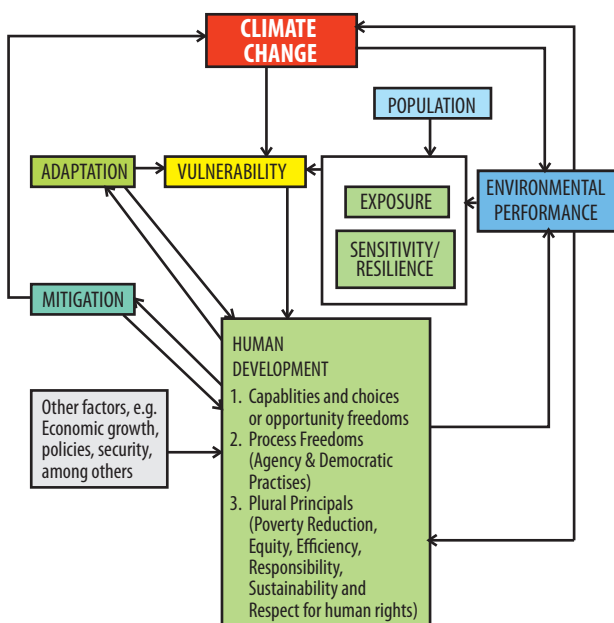
1.2.2 Conceptual framework and methodology

Human development is the central objective of governments all over the world. In Kenya, this has been pursued since independence with modest achievement. Human development is determined by many factors, key among them being economic growth, education, health, and increasingly, environmental quality and climate change (Fig. 1.4a). While there is considerable understanding of what drives human development already, it is important to pay attention to its threats in the future.

The focus of this report is this future: the relationship between climate variability and change, and human development. The relationship is bi-directional and determined by environmental performance, mitigation efforts and adaptation activities (Fig. 1.4a). The impact of climate variability and change on human development depends on exposure or intensity of the climate change as may be reflected on the magnitude and frequency of shocks, sensitivity of the system to impact damage or system vulnerability, and resilience of the system or its ability to withstand the impacts and recover from them (Munasinghe, 1999). The population has the choice of adapting to climate change or mitigating climate change, which in the long term has implications for the overall human development.

This report:(i) identifies climate variability and change impacts, vulnerabilities, and risks in the sectors of the Kenyan economy that are most important to human development; (ii) the adaptation and mitigation policies and other measures that have been implemented or are being considered; (iii) assesses how both of these affect or may affect various aspects or dimensions of human development (Fig. 1.4b), including the presence of any opportunities that may be harnessed; and (iv) considers ways and means of integrating adaptation and mitigation policies and other measures into overall development planning.

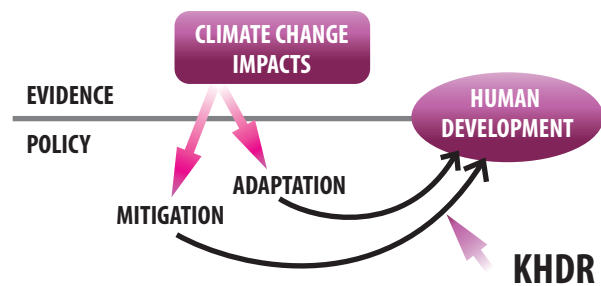
Figure 1.4a Current and future drivers of human development



Source: Authors' own conceptualization

Climate change impacts, vulnerabilities, and risks are identified from available literature. This entailed looking at data on actual and projected levels of specific climate change variables such as temperature rise, change in precipitation, and increase in the intensity and frequency of extreme events such as drought, flooding, and strong winds. Empirical evidence of the degree of exposure to these climate change variables, the numbers of people affected (and other costs of) during different episodes associated with climate variability and change was also used. Where evidence was available, moreover, the report considered the factors responsible for such impacts, vulnerabilities and risks. Such factors include geographical location, past human development levels, population density, environmental health, and adaptation and mitigation policies and interventions.

Figure 1.4b Focus of KHDR 2013



Source: Authors' own conceptualization

This report attempts to understand the specific aspects or dimensions of human development and how they are each impacted or threatened by climate change. Each climate change variable affects people: their capabilities, freedoms, and choices, including their abilities to lead long and healthy lives, to be knowledgeable, to have a decent standard of living, and to participate in community life with dignity and self-respect. The report further presents empirical evidence of various impacts, vulnerabilities, and risks on the basis of demographics (gender, age, income, head of household status, education level, ethnicity, location, physical/mental ability, current versus future generations, migrant versus non-migrant, and urban slum versus non-slum categorizations etc.). Other human development aspects that are considered include empowerment and participation, efficiency, sustainability, human security, human rights, local values, religious beliefs, and intellectual traditions.

In addition, the report identifies adaptation and mitigation efforts being made or being considered in different sectors, examines the strategies being used by the vulnerable groups to cope with climate variability and change, as well as how both these types of responses are impacting or may impact on different aspects of human development.

The report is based on an extensive literature search from both refereed and grey sources, and quantitative and qualitative data analysis especially for the estimation of various human development and climate change indices.

Preparation of the report was steered by a steering committee and involved the input and oversight of an Inter-Institutional technical committee. The technical committee held various meetings with other auditors at different stages of the report preparation. Moreover, a core

committee drawn from the larger technical committee calculated the human development indices. Members of the core team had received training on this earlier on.

1.2.3 Structure of report

The remainder of this report comprises of eight chapters. **Chapter Two** reviews the state of human development in Kenya and the impact, vulnerability, and risks of climate change. Specifically, the chapter reviews the past human development reports in the country and how they have been used for public policy; traces the trend of human development in the country through the lens of several indices; and presents county level human development figures for 2012 using various indices, before assessing the impacts of climate variability and change on human development in the country at the macro level. The chapter then reviews the priority adaptation measures adopted in the country, and explores opportunities emerging from climate change, before drawing conclusions and making some policy recommendations.

Chapters Three to Seven present analysis of climate change impacts, vulnerabilities, and risks for the following key sectors of the Kenyan economy: Agriculture, Tourism, Health, Water and Sanitation, and Infrastructure. Each of the chapters provides a sector overview touching on, among others, the sector's economic contribution and its relation to human development; contribution of the sector to GHG emissions; assessment of climate change impacts, vulnerabilities, and risks in the sector, both current and projected, and the related consequences for human development; a review of the current adaptation and mitigation initiatives in the sector; opportunities emerging from climate change and variability; and finally makes conclusions and policy recommendations.

Chapter Eight considers ways of effectively integrating adaptation and mitigation interventions with overall development planning in the country.

Chapter Nine presents a synthesis of conclusions and recommendations made in the preceding chapters of the report.



2 HUMAN DEVELOPMENT: STATUS AND IMPACT OF CLIMATE CHANGE

Key messages

1. Kenya National Human Development reports continue to inform government policy interventions and legal framework.
2. There are significant spatial disparities in Human Development Indices in Kenya.
3. Women are more vulnerable to the effects of climate change than men – primarily as they constitute the majority of the world’s poor and are more dependent, for their livelihood, on natural resources that are threatened by climate change. Furthermore, they face social, economic, and political barriers that limit their coping capacity.
4. County level data shows that human development in Kenya is negatively correlated to climate change vulnerability.



2.1 Introduction

2.1.1 Aim of the Chapter

This chapter has four aims. The first is to review past Kenya National Human Development Reports and assess whether these have had any link with Government policy interventions and legal framework. Secondly, the chapter presents estimates of various human development indices and climate change vulnerability index, at disaggregated levels, and assesses whether these are strongly correlated. Thirdly, it describes the link between climate change and human development from a macro level gender perspective. Fourthly, it examines opportunities presented by climate change in Kenya.

2.1.2 Review of past Human Development Reports of Kenya

Kenya’s 1st National Human Development Report (KNHDR) was published in 1999. Since then, five KNHDRs have been published each focusing on a specific dimension of human development (Box 2.1). While it is difficult to directly attribute public policy and legislative reforms to the KNHDRs, these reports may have informed both public policy and the legislative agenda (Tables 2.1a - f).

Table 2.1a Link between the first KNHDR and public policy/legislative agenda

Policy/Legal framework	Year published/enacted	Details
Kenya Vision 2030	Launched 2007	The vision rests on three pillars: economic, political, and social. It spells out long-term objectives for government programmes and provides the overarching guidelines for the design and implementation of these programmes.
Constitution of Kenya Act	Enacted 2010	Constitution provides for affirmative action with respect to elective and appointive Government bodies; equity before the law through a strengthened bill of rights; ensuring women have legal access to and control over property including land; outlaws harmful cultural practices.
Criminal Law Amendment Act	Published April 2000 and enacted	Removes the inconsistencies between penalties for sexual offences against minors and women. It includes a section to protect the identity of a victim while giving evidence of abuse.

Policy/Legal framework	Year published/enacted	Details
Equity Bill	Published 2002	Aims at eliminating all forms of social and economic discrimination and promotes equity of access and opportunity for all persons. It also outlaws all forms of sexual harassment in the private and public sectors.
Affirmative Action Bill	Published October 2000	Seeks to improve representation for marginalized groups in society including women and people with disabilities.
Domestic Violence (Family Protection) Bill	Published 2001	Aims to protect victims of domestic violence and gives courts power to remove abusive partners from the family home. However, nowhere in this bill is physical abuse considered to be assault and nowhere is marital rape considered possible. Police are given wide discriminatory powers in bringing charges against perpetrators.
National Commission on development processes. Gender and Development Act	Enacted 2002	Established a Commission to ensure gender mainstreaming in national

Source: www.kenyalaw.org and Johnston, Seth-Smith and Beacham (2003)

Box 2.1: Kenya National Human Development Reports (KNHDRs) and Thematic Areas

1st Kenya National Human Development Report (1999): The main themes of this first report were gender and poverty. Each of the two groups, the poor and women, constitute half of the total population of Kenya. Their limited participation in the mainstream of Kenya's development is of serious concern for the groups themselves on the one hand and for the country on the other. Full participation and contribution of these groups is crucial for Kenya to achieve sustainable development. This report recommended that it was upon the people of Kenya, their institutions and Government to discuss and agree upon a pragmatic and progressive path that leads to popular participation, poverty reduction and gender equality, increased economic prosperity, and sustainable development.

2nd Kenya National Human Development Report (2001): The second report addressed Social and Economic Disparities. This was necessitated by the decline in economic performance and the associated increase in poverty, unemployment, and the widening social and economic inequalities prevailing in the country during that period. Key recommendations that emerged from this report were that future policy challenges for human development in Kenya should entail expanding human capabilities and access to opportunities in economic, social, and political aspects of life.

3rd Kenya National Human Development Report (2003): The third report focused on participatory governance. Lack of good, effective, and participatory governance was noted as one of the main causes of underdevelopment in Kenya. Corruption, inefficient management of public resources, and the reluctance or failure to involve the poor in the development process, are some of the manifestations of this problem. Apathy and disregard for projects meant for the poor had also contributed to lack of social, economic, and political development in the country. It is against this background that the report explored the theme of participatory governance for human development. This report concluded that human development requires participatory governance that creates and strengthens institutions for effective participation in the development process. It requires good governance to ensure efficient economic management and distribution of resources to the majority of the population, decentralisation of power and service delivery, wider participation in decision making and implementation of policies, as well as transparency and accountability in the mobilisation, allocation, and management of resources.

4th Kenya National Human Development Report (2005): The fourth report focused on human development outcomes of industrialization. Its theme, "Linking Industrialisation with Human Development in Kenya", was inspired by the recognition that industrialization offers unique opportunities for development, and that Kenya's overall human development may well be shaped by the path of industrialization the country pursues. The report explored the state of industrialization and its consequences on human development in Kenya. It noted that a close relationship exists between industrialisation and human well-being in Kenya, in that industrialisation has had significant bearings on human development indicators. These indicators are related to wage, employment, incomes, improved livelihoods, skill formation, entrepreneurship, gender parity, and links with agriculture and other sectors.

5th Kenya National Human Development Report (2006): The theme “Human Security and Human Development” was chosen as an area of focus for a number of reasons. Firstly, without human security, Kenya cannot attain the Millennium Development Goals. The circumstances that lead to or reinforce human insecurity are often the same conditions that diminish a country’s prospects for improving human development and reducing poverty. Secondly, Kenya continues to experience frequent and severe disasters and diseases, among other challenges, further diverting Kenya off its optimal development path. The report concluded that human security is all-embracing and remains relevant in addressing a myriad of issues, including: achieving a prosperous and economically just society that ensures equal distribution of national wealth, ensuring sufficiency in food to a level that guarantees decent life and access to basic education for all, guaranteeing social security and essential health care, ensuring freedom from personal and community harm for all Kenyans, guaranteeing environmental and political security, and pursuing partnerships for prosperity.

6th Kenya National Human Development Report (2009): This report reinforced policy debate on various issues affecting youth development. These include the link between youth development and the broader concept of human development, the potential of a youth bulge, and the introduction of a measure for youth development in Kenya. The report explored the potential and challenges of youth development, and discussed investment in youth social development through education and health. In addition, the report considered the relationships between youth economic productivity and youth well-being. The report recommended an asset approach to youth development issues in Kenya. Youth should be engaged with Government and in all aspects of society, setting the stage for continued participation throughout adulthood.

Table 2.1b: Link between the second KNHDR and public policy/legislative agenda.

Policy/Legal framework	Year published/enacted	Details
Kenya Vision 2030	Launched 2007	The vision rests on three pillars: economic, political, and social. It spells out long-term objectives for government programmes and provides the overarching guidelines for the design and implementation of the programmes. Central to this effort has been a reconsideration of the appropriate way for the state to engage in development policy, and which models of development to emulate.
Constitution of Kenya Act	Enacted 2010	The constitution provides for affirmative action with respect to elective and appointive Government bodies, equity before the law through a strengthened bill of rights, ensuring women have legal access to and control over property-including land, and it also outlaws harmful cultural practices.
The National Health Sector Strategic Plan (2005-2010)	Published 2005	This is a compulsory social medical scheme that offers in and outpatient cover. It targets households, governments, formally and now, informally employed individuals. Since contributions to the scheme are based on the members’ ability to pay, the introduction of NHIF was viewed as a positive step in re-distribution of health benefits to the population.
National Health Insurance Fund (NHIF) Act	Enacted in 2004	
Constituency Development Fund (CDF)	Enacted in 2003	This is a compulsory social medical scheme that offers in and outpatient cover. It targets households, governments, formally and now, informally employed individuals. Since contributions to the scheme are based on the members’ ability to pay, the introduction of NHIF was viewed as a positive step in re-distribution of health benefits to the population.

Source: Keriga and Bujra (2009).

Table 2.1c: Link between the second KNHDR and public policy/legislative agenda.

Policy/Legal framework	Year published/enacted	Details
Constitution of Kenya	2010	The objects of the devolution of government are: (a) to promote democratic and accountable exercise of power; (b) to foster national unity by recognizing diversity; (c) to give powers of self-governance to the people and enhance the participation of the people in the exercise of State powers, and in making decisions that affect them; (d) to recognize the right of communities to manage their own affairs and to further their development.
Constituency Development Fund (CDF) Act	2003	The CDF Act provides for communities to participate in development through its various committees. The CDF Committee (CDFC) members are selected by the local MP, although a framework detailing the categories of representation is legally provided for. The other is the Project Implementation Committee which is made up of local stakeholders.
Social Budgeting Framework (SBF)	2007	The framework was developed by the Ministry of State for Planning, National Development and Vision 2030 (MSPNDV). All sectors with the responsibility to plan, budget, implement, report, and account for public investment in the social pillar of the Vision 2030 are required to adopt the guidelines. MSPNDV envisions that with the constitutional reform, the guidelines will undergo modifications. SBF is a good model because it adopts a Human Rights-Based Approach to improved effectiveness of budgetary policies and choices. However, it is premised on a strong centralized government with notable input from the provincial administration. It therefore needs to be radically modified to make it applicable to the new constitutional dispensation.

Source: Omolo(2011)

Table 2.1d: Link between the fourth KNHDR and public policy/legislative agenda

Policy/Legal framework	Year published/enacted	Details
Kenya Vision 2030	Launched 2007	Vision 2030 aims at making Kenya a newly-industrializing middle-income country capable of providing a high quality of life for all its citizens by the year 2030. Kenya's competitive advantage lies in agro-industrial exports. For superior performance of the manufacturing sector, one strategy includes strengthening of Small and Micro Enterprises (SMEs) to become the key industries of tomorrow. This can be accomplished by improving their productivity and innovation by increasing investment in research and development, and development of SME Parks (at least 5 of them).
Sessional Paper No. 2 of 2005: Development of Micro and Small Enterprises for Wealth and Employment Creation for Poverty Reduction	2005	This policy paper was intended to form the basis for enactment of the SME Act. The new SME Act ³ would give direction to, among others, key issues such as the legal and regulatory environment, markets and marketing, business linkages, the tax regime, skills and technology, and financial services.

Sources: Syekei and Opjiah (2012)

3. The legislation has since been enacted and the MSEs Authority established to coordinate MSME issues.

Table 2.1e: Link between the fifth KNHDR and public policy/legislative agenda

Policy/Legal framework	Year published/enacted	Details
Constitution of Kenya Act	2010	Kenya's new Constitution addresses human security concerns and, if well implemented, will propel the nation towards the future envisioned in Kenya's Vision 2030. The goals and objectives of Vision 2030 are encapsulated in the new constitution and their achievement will advance the human security agenda. Responsibility for success belongs to all and there is need for attitudinal change which will allow the development of a culture that values constitutionalism and the rule of law. Simultaneous implementation of the various facets of the constitution is essential. To comprehensively deal with the root causes of conflict, the implementation of the human security provisions in the new constitution should be consistent and complete
Kenya National Dialogue and Reconciliation Act	2008	The Specific chapters in the new constitution address human security concerns and some key provisions that were highlighted in the discussions are: (a) devolution and representation, (b) governance, (c) equity and (d) land.

Source: Institute for Security Studies (2012)

Table 2.1f: Link between the sixth KNHDR and public policy/legislative agenda

Policy/Legal framework	Year published/enacted	Details
<i>Kazi Kwa Vijana</i> (Work for Youth)	2009	It was aimed at the employment of youth in rural and urban areas in labour intensive public works projects, focusing on smaller projects that can be implemented rapidly. Examples are road maintenance sub-projects, small-scale water supply and sanitation, water harvesting, afforestation, and waste collection.
Youth Enterprise Development Fund	2009	Was established to increase access to capital for young entrepreneurs and to provide business development services, facilitate linkages in supply chains, create market opportunities locally and abroad for products and services of youth enterprises, and facilitate infrastructure to support growth of youth businesses. However, for a young person to qualify for a project loan, he or she must finance 20% of the project's cost. This requirement may encourage youth to begin to save so that they can qualify for a loan.
Kenya Vision 2030	2007	It outlines specific policies and interventions aimed at developing and exploiting the potential of the youth. The interventions include: (i) Formulation of the National Youth Policy (ii) Establishment of Youth Enterprise Development Fund (iii) Revitalization of Youth Polytechnics (iv) Establishment of Youth Empowerment Centres in all constituencies (v) Establishment of an International Academy of Sports (vi) Revision of Education and Training curricula at all levels of learning (vii) Implementation of the <i>Kazi Kwa Vijana</i> programme as a temporary measure for youth-targeted employment creation.

Source: ISS (Institute for Security Studies)(2012): National Human Development Reports and Public/Legislative Agenda in Kenya.

2.2 Human Development in Kenya

Progress in human development in Kenya has traditionally been expressed through various indices, namely Human Development Index (HDI), Human Poverty Index (HPI), Human Gender Development Index (GDI), Gender Inequality Index (GII) and, more recently, the Multidimensional Poverty Index (MPI).⁴

2.2.1 Human Development Index (HDI)

Each year since 1990, the Human Development Report publishes the Human Development Index (HDI), which was introduced as an alternative to conventional measures of national development such as level of income and rate of economic growth (Appendix 2.1). The HDI represents a push for a broader definition of well-being, and provides a composite measure of three basic dimensions of human development: health, education, and income. The HDI estimate for Kenya in 2012 was estimated at 0.520. Map 2.1 shows the spatial distribution of HDI values for all counties in Kenya for the year 2012. Of the 47 counties in Kenya, 20 (43%) of them have

HDI estimates above the national estimate, while 27 (57%) have measures lower than the national average, indicating a disparity of human development within the country. Nairobi County has the highest HDI of 0.641, followed by Kajiado with 0.591, and Mombasa 0.548. Counties that fall under Arid and Semi-Arid lands exhibit low HDI values. Kenya's HDI is lower than the global average but higher than the Sub-Saharan Africa average (Table 2.2).

Kenya's HDI has experienced only modest growth since 1980, from 0.420 to 0.520 in 2012 (UNDP, 2013). Kenya has been ranked lowly in a UN global survey on well-being and quality of life beyond annual economic growth rates. The Human Development Index survey by the United Nations Development Programme ranked Kenya at 145th out of 187 nations. However, in the 2013 HDI report titled *"The Rise of the South: Human Progress in a Diverse World"*, Kenya performed better than her neighbours Uganda (position 161), Tanzania (152), and Ethiopia (173). Rwanda and Burundi were ranked 167th and 178th respectively. This shows that between 1980 and 2012, Kenya's HDI rose by 0.9 per cent annually from 0.424 to 0.520.

Table 2.2a: Comparison of Kenyan, global, and sub-Saharan Africa HDIs

YEAR	1980	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
GLOBAL	0.558	0.576	0.594	0.613	0.634	0.660	0.664	0.670	0.674	0.676	0.679	0.682	0.694
KENYA	0.420	0.438	0.456	0.450	0.443	0.467	0.474	0.486	0.493	0.499	0.505	0.509	0.519 0.520*
SSA	0.365	0.374	0.383	0.395	0.401	0.431	0.438	0.445	0.451	0.456	0.460	0.463	0.475

Source: Various UNDP Publications; *Kenya National Bureau of Statistics

The report further states that sub-Saharan Africa's HDI rose from 0.0366 in 1980 to 0.475 in 2012, placing Kenya above the regional average. There are, nevertheless, impediments to Kenya's HDI, key among them extreme poverty, which is the proportion of the population living under \$1 per day. 30 per cent of Kenya's population is poor. As a result, education, gender equality, HIV/AIDS reduction, environmental stewardship, and maternal health all lack positive movement forward. When free primary education was introduced in 2003, first time school enrolment rose to 1.5 million children, which resulted to very large class sizes. However, these schools are vastly underfunded and therefore lack vital teaching and learning materials, as well as enough teaching staff.

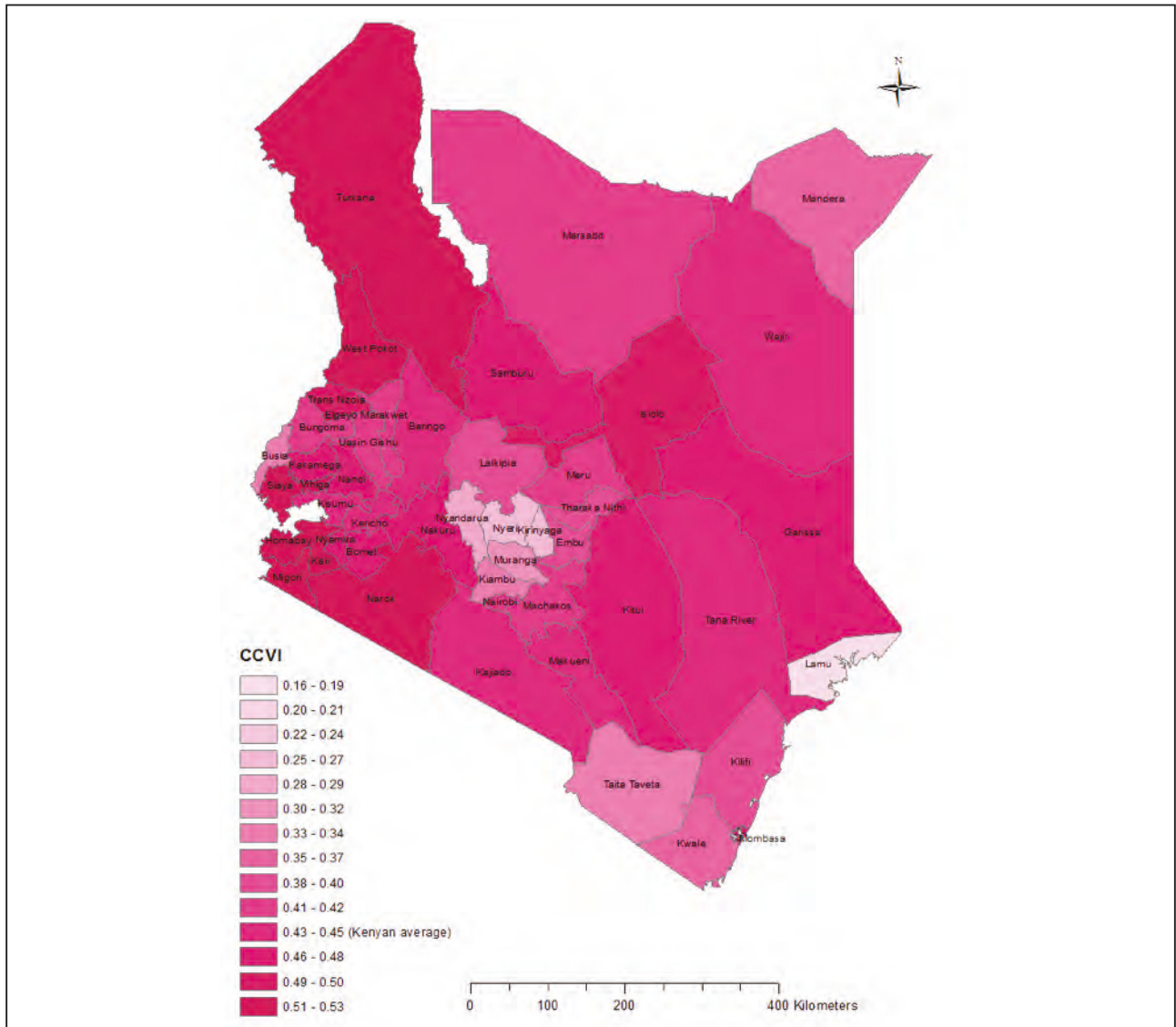
Child mortality rose from 9 per cent in 1990 to 11.5 percent in 2003, while infant mortality increased to 1.7 per cent in the same time frame. The impacts of climate change manifested in forms of severe flooding and shifting environmental conditions combined with a growing population, present a major threat to Kenya's natural habitats and its unique species of plants and animals. These challenges are further aggravated by continued governance challenges in the form of corruption.

2.2.2 Inequality Human Development Index (IHDI)

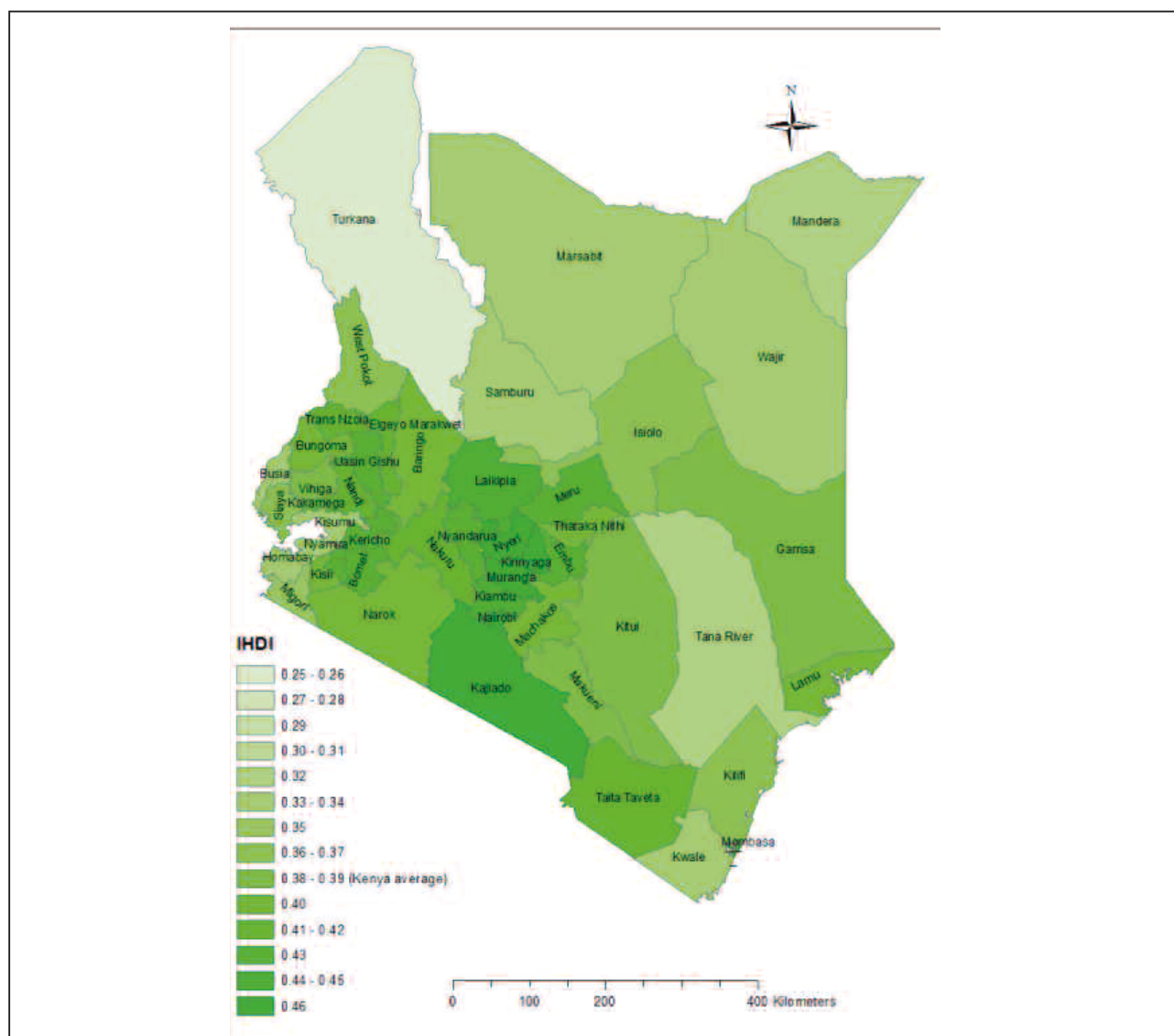
The IHDI takes into account not only the average achievements of a country with respect to health, education, and income, but also how those achievements are distributed among its citizens by "discounting" each dimension's average value according to its level of inequality (Appendix 2.1). The IHDI value for Kenya in 2012 was 0.344, compared to a HDI of 0.519 (UNDP, 2013). Map 2.2 shows the spatial distribution of IHDI for all Counties in Kenya, and exhibits a similar pattern to the HDI. Ideally, the IHDI equals the HDI when there is no inequality across people but is less than the HDI as inequality rises. In this sense, the IHDI is the actual level of human development (accounting for this inequality), while the HDI can be viewed as an index of "potential" human development (or the maximum level of HDI) that could be achieved if there was no inequality. Explanations to poor IHDI performance in Kenya include inequalities in human development, life expectancy, education attainment, income per capita, and gender, among others.

4. See Appendix 2.1 for a brief description of these indices.

Map 2.1: Spatial distribution of HDI for all Counties in Kenya, 2012.



Source: Generated from KNBS data

Map 2.2: Spatial distribution of IHD for all Counties in Kenya, 2012.

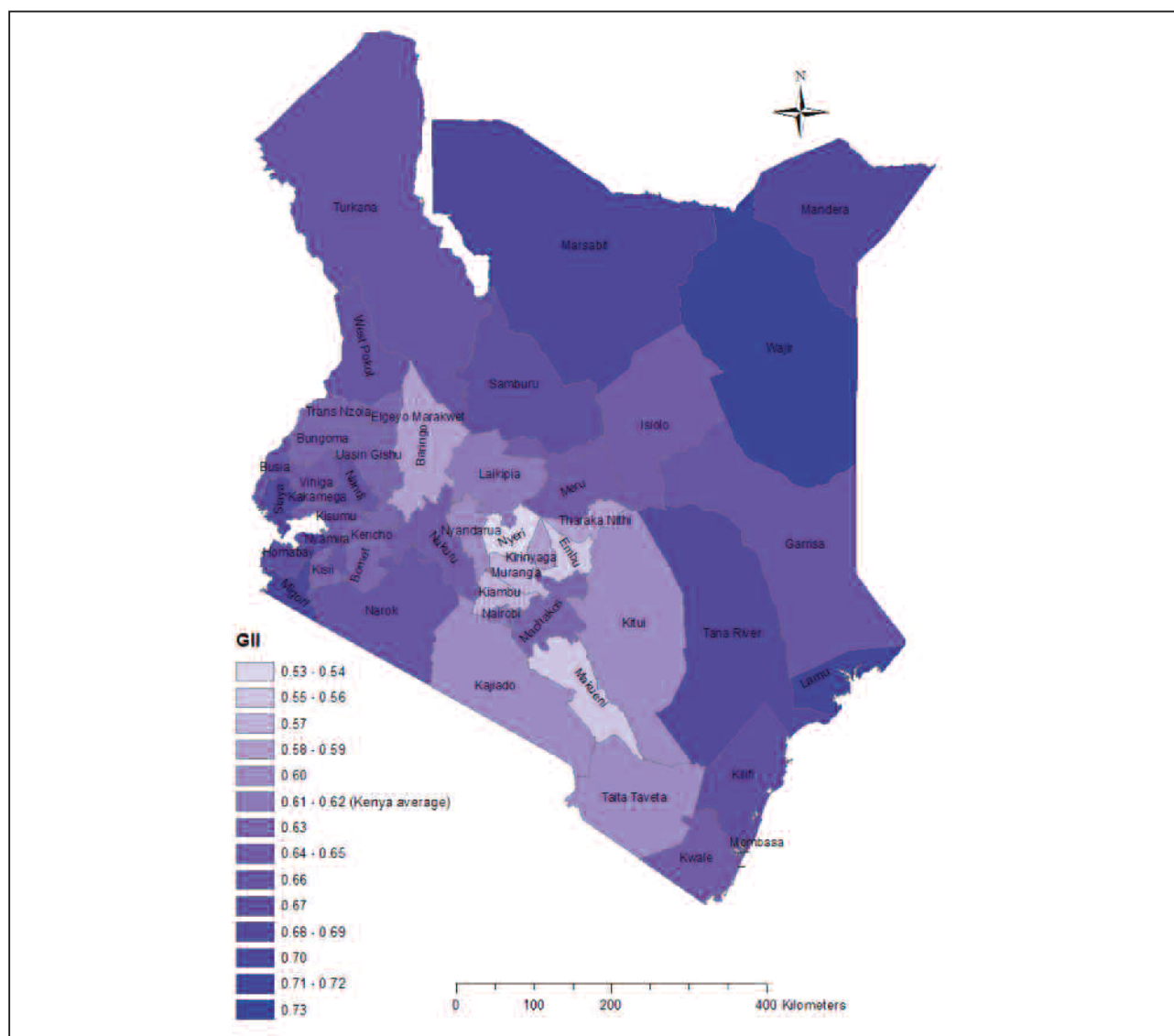
Source: Generated from KNBS data

2.2.3 Gender Inequality Index (GII)

The GII is a composite measure reflecting inequality in achievements between women and men in three dimensions: reproductive health, empowerment, and the labour market. It varies between zero (when women and men fare equally) and one (when one of the genders fares poorly compared to the other in all dimensions). The health dimension is measured by two indicators: maternal mortality ratio and the adolescent fertility rate. The empowerment dimension is also measured by two indicators: the share of parliamentary seats held by each sex and by secondary and higher education attainment levels. The labour dimension is measured by women's participation in the work force. The GII is designed to reveal the extent to which national achievements in these aspects of human development are eroded by gender inequality, and to provide empirical foundations for policy analysis and advocacy efforts (Appendix 2.1). Kenya's GII for 2012 is estimated at 0.622. Map 2.3 shows the spatial distribution of GII for all Counties in Kenya. High GII values dominate the Counties located in the Arid and Semi-Arid Lands.

The Institute of Economic Affairs' (IEA) report on the socio-economic status of women in Kenya shows that the country has made minimal strides in the quest to bridge the inequality gap. However, this state of affairs is not solely blamed on women, but on the prevailing political system. A report titled *Profile of Women's Socio-Economic Status in Kenya* shows low education levels among women in comparison to men. On primary school participation, the overall enrolment rate of boys is higher than that of their female counterparts. In addition, North Eastern Province still lags far behind compared to the other provinces in Kenya by recording the lowest figures for enrolment of girls in school. The figure stands at 27.6% followed by Nairobi at 40.1%.

The rate of women's secondary school enrolment is lower than that of men. This is because female students face the challenges of early marriage and some parents prefer to educate their sons over daughters. The trend continues into institutions of higher learning, where again, the number of female students at university level is much lower than their male counterparts. This situation depicts the low progression of female students across education levels.

Map 2.3: Spatial distribution of GII for all Counties in Kenya, 2012.

Source: Generated from KNBS data

In the labour force, women constitute 30% of the overall wage employment. The highest percentage is recorded in the education sector (45%) while the lowest is in the building and construction industry (7%), manufacturing (18%), and electricity and water (18%). More women tend to venture into the *small and micro enterprises* (SMEs), accounting for 54% of the total enterprises in the country. They dominate wholesale and retail businesses, rural manufacturing, and urban agriculture sectors. Men are well represented in such sectors as urban manufacturing, transport, financial, and social services. The report also points out that the representation of both men and women in decision making processes is critical for effective implementation of policies that affect the general

population. In spite of this, a negligible proportion of women representatives is in senior and middle level policy formulation and implementation processes.

The same report identifies the challenges of dealing with domestic violence as being more to do with attitudinal or cultural perceptions than policy. While it may be argued that the key issue related to persistence of gender violence is the rate of economic dependence of women on men, it is also worth noting that due to cultural reasons, even economically independent women persevere domestic violence and therefore allow it to persist. Domestic violence has locked out potential opportunities for women who cannot develop themselves because they are afraid of their husbands' attitude and reactions.

... it is also worth noting that due to cultural reasons, even economically independent women persevere domestic violence and therefore allow it to persist.

Enhancing gender equality is critical for any country's development. There has, encouragingly, been an increase in women's participation in government decision-making at various levels, including ministerial and administrative, particularly after the promulgation of the Kenyan

Constitution in 2010. Despite the fact that women represent 51% of the Kenyan population, their representation in post primary education, wage employment, enterprise ownership, and decision making process is limited. They are adversely affected by such factors as traditional and social practices, poverty and domestic violence, among other challenges. Improving women's profiles in all sectors and reducing gender disparities will not only benefit women but also men, children, the poor, and the rich. This will also enhance women's empowerment and contribute to sustainable economic growth, reduce poverty, and social injustices. The national budget could also be tailored to address gender issues in order to reduce gender inequalities.

2.2.4 Multidimensional Poverty Index (MPI)

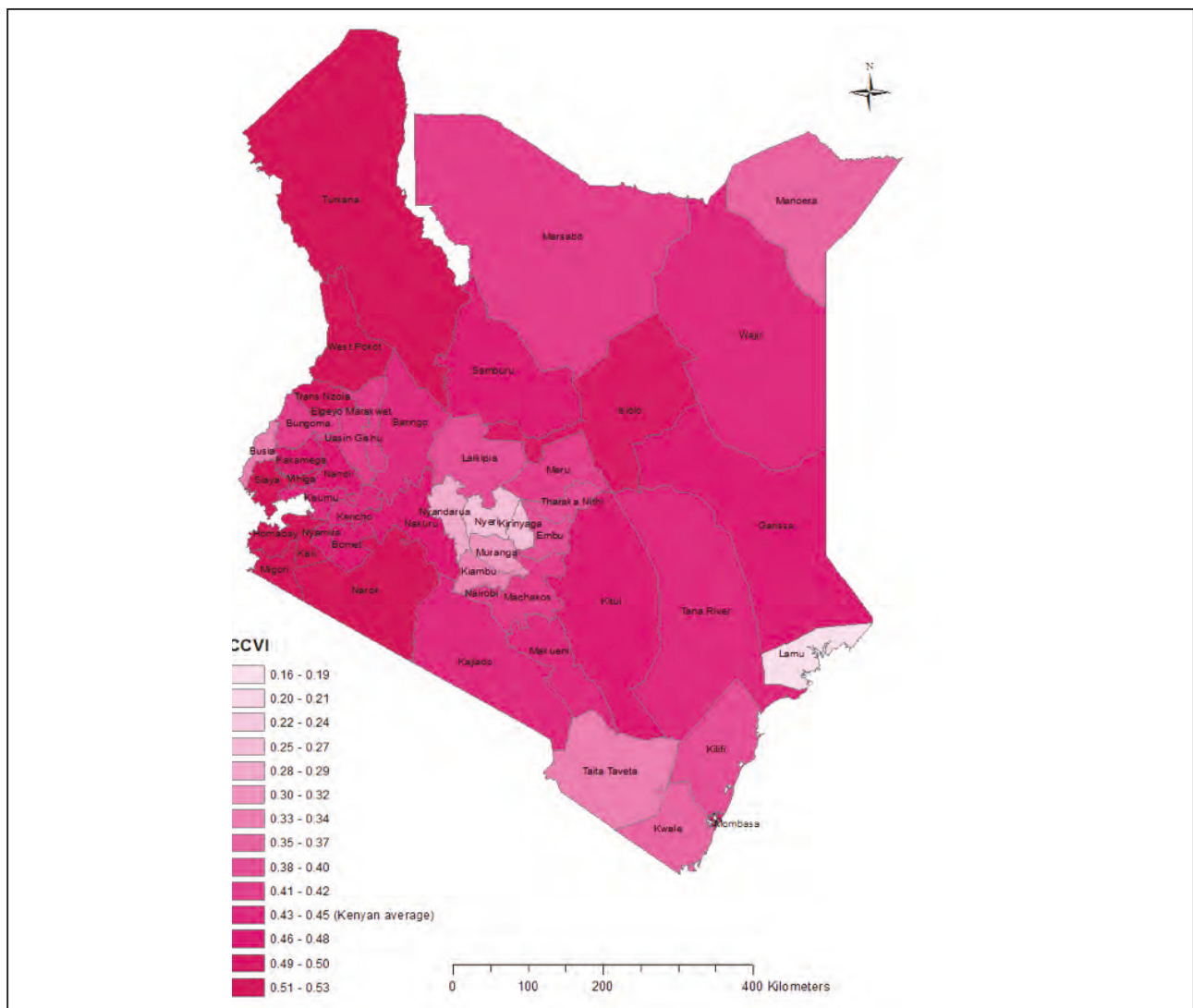
The MPI is a new measure designed to portray the many deprivations faced by the most severely disadvantaged. The MPI reflects both the incidence of multidimensional deprivation, and its intensity, that is, the number of deprivations people experience at the same time. It can be used to create a comprehensive picture of people living in poverty, and permits comparisons both across countries, regions and the world, and within

countries by ethnic group, urban or rural location, as well as other key household and community characteristics. The MPI builds on recent advances in theory and data to present the first global measure of its kind, and offers a valuable complement to income-based poverty measures. The national MPI value for Kenya in 2012 was estimated at 0.229, compared to Ghana's 0.144, Nigeria's 0.310, Malawi's 0.334, and Rwanda's 0.350 (UNDP, 2013). The major impediment to MPI is lack of accurate data sets to compute population in multidimensional poverty (intensity of deprivation), population vulnerable to poverty, population in severe poverty, and contribution of deprivation to overall poverty.

2.2.5 Climate Change Vulnerability Index

This is the first time that this index is being calculated for Kenya and at the County level. Equal weights were allocated to the variables. Vulnerability index was constructed as a function of exposure to climate variability and natural disasters, sensitivity to the impacts of that exposure, and capacity to adapt to on-going and future climatic changes. Map 2.4 shows the spatial distribution of this index across the counties of Kenya. For details, see Appendix 2.2.

Map 2.4: Spatial distribution of CCVI in Kenya, 2012



Source: Generated from KNBS data and Kenya Meteorological Department



2.3 Climate Change and Human Development in Africa

In sub-Saharan Africa, the region with the gravest inequalities as measured in the HDI, the poor, and especially women, will continue to be the most affected by such risks. They rely on natural resources for their livelihoods, have to cope with environmental hazards such as air and water pollution, and poor sanitation, and are more likely to be affected by extreme weather events. Detrimental effects of climate change can be felt in the short-term through natural hazards, such as landslides, floods and hurricanes; and in the long-term, through more gradual degradation of the environment. The adverse effects of these events are already felt in many areas, including in relation to, *inter alia*, agriculture and food security; biodiversity and ecosystems; water resources; human health; human settlements and migration patterns; and energy, transport, and industry.

In many of these contexts, women are more vulnerable to the effects of climate change than men—primarily as they constitute the majority of the world's poor and are more dependent for their livelihood on natural resources that are threatened by climate change. Furthermore, they face social, economic and political barriers that limit their coping capacity. Women and men in rural areas in developing countries are especially vulnerable when they are highly dependent on local natural resources for their livelihood. Those charged with the responsibility to secure water, food, and fuel for cooking and heating face the greatest challenges. Secondly, when coupled with unequal access to resources and to decision-making processes, limited mobility places women in rural areas in a position where they are disproportionately affected by climate change. It is thus important

to identify gender-sensitive strategies to respond to the environmental and humanitarian crises caused by climate change. It is important to remember, however, that women are not only vulnerable to climate change but they are also effective actors or agents of change in relation to both mitigation and adaptation. Women often have a strong body of knowledge and expertise that can be used in climate change mitigation, disaster reduction, and adaptation strategies. Furthermore, women's responsibilities in households and communities, as stewards of natural and household resources, position them well to contribute to livelihood strategies adapted to changing environmental realities.⁵

2.3.1 The need for gender sensitive responses to the effects of climate change

Women, agriculture, and food security in the context of climate change

Climate change has serious ramifications in four dimensions of food security: food availability, food accessibility, food utilization, and food systems stability. Women farmers currently account for 45-80 per cent of all food production in developing countries, depending on the region. About two-thirds of the female labour force in developing countries, and more than 90 per cent in many African countries, are engaged in agricultural work.⁶ In the context of climate change, traditional food sources are becoming more unpredictable and scarce. Women face loss of income as well as harvests—often their sole sources of food and income. Related increases in food prices make food more inaccessible to poor people, in particular to women and girls whose health has been found to decline more than male health in times of food shortages. Furthermore, women are often excluded from decision-making on access to and the use of land and resources critical to their livelihoods.⁷ For these reasons, it is important that the rights of rural women are ensured in regards to food security, non-discriminatory access to resources, and equitable participation in decision-making processes.

Women, gender equality, and biodiversity in the context of climate change

According to the Millennium Ecosystem Assessment, climate change is likely to become the dominant driver for the loss of biodiversity by the end of the century. Biodiversity plays an important role in climate change adaptation and mitigation. For example, in contexts where deforestation is responsible for an average of 20% of human-induced carbon dioxide emissions, the conservation of natural habitats can reduce the amount of carbon dioxide released into the atmosphere.⁸ Additionally, the conservation of mangroves and drought-resistant crops can reduce the impacts of climate change such as flooding and famine. In the rural areas of Africa and Asia, women and men are highly dependent on biomass such as wood, agricultural crops, wastes, and forest resources for their energy and livelihoods. However, in the face of climate change, the ability of

5. 52nd session of the Commission on the Status of women (2008) "Gender perspectives on climate change," Issues paper for interactive expert panel on Emerging issues, trends and new approaches to issues affecting the situation of women or inequality between and men.

6. FAO. Women and Food security. FAO FOCUS. <http://www.fao.org/FOCUS/E/Women/Sustain-e.htm>

7. Ibid

8. Ecosystems and Human Well-being: Biodiversity Synthesis. Millennium Ecosystems Assessment. 2005

women and men to obtain these indispensable resources is reduced.⁹ It is important to note that the declining biodiversity does not solely impact the material welfare and livelihoods of people. It also cripples access to security, resiliency, social relations, health, and freedom of choices and actions.¹⁰ The majority of the biodiversity decline has a disproportionate impact primarily on poor people in developing countries. To give a few examples, declining fish populations have major implications for artisanal fishers and communities that depend on fish. Moreover, in many parts of the world, deforestation has meant that wood – the most widely used solid fuel – is located further away from the places where people live. In poor communities in most developing countries, women and girls are responsible for collecting traditional fuels, a physically draining task that can take from 2 to 20 or more hours per week. As a result, women have less time to fulfil their domestic responsibilities, earn money, engage in politics or other public activities, learn to read or acquire other skills, or simply rest. Girls are sometimes kept home from school to help gather fuel, perpetuating the cycle of disempowerment. Moreover, when environmental degradation forces them to search farther afield for resources, women and girls become more vulnerable to injuries from carrying heavy loads for long distances,¹¹ and also face an increased risk of sexual harassment and assault.

Biodiversity also comes in the form of the wealth of knowledge on the environment that indigenous people and communities possess. Indigenous knowledge comprises: an understanding of indigenous foods, medicinal plants and domestic animals; symbiotic relations with ecosystems; an awareness of the structure of ecosystems and the functionality of specific species; and the geographic ranges of said species.¹² In order to further preserve biodiversity and limit its degradation, indigenous people can and should play a leading role in the global response to climate change. This should be particularly emphasized with regard to indigenous women who play a vital role as stewards of natural resources.¹³ A greater inclusion of

indigenous communities and indigenous women further validates the significance of their knowledge.

Women, gender equality, and water resources in the context of climate change

Climate change has significant impacts on fresh water sources, by affecting the availability of water used for domestic and productive tasks. The consequences of the increased frequency in floods and droughts are far reaching, particularly for vulnerable groups, including women who are responsible for water management at the household level.¹⁴ All over the developing world, women and girls bear the burden of fetching water for their families and therefore spend significant amounts of time daily hauling water from distant sources. The water from distant sources is rarely enough to meet the needs of the household and is often contaminated, and women and girls pay the heaviest price for poor sanitation.¹⁵ For example, in cases where the arsenic contamination of groundwater is prominent, increased flood levels intensify the rate of exposure among rural people and other socio-economically disadvantaged groups.¹⁶ The resulting health problems include: lesions, skin hardening, dark spots on hands and feet, swollen limbs, and numbness.¹⁷ Arsenic exposure also manifests itself in the form of skin lesions which usually attract negative social repercussions for arsenic-poisoning (arsenicosis) victims. The situation is particularly worse for women who can be shunned, excluded, and stigmatized- based on physical appearance. This also impacts the ability of single women to get married, and in many cases, unmarried women are more vulnerable to poverty and social exclusion.¹⁸ Given the changing climate, inadequate access to water and poor water quality does not only affect women, their responsibilities as primary givers, and the health of their families, it also impacts agricultural production and the care of livestock, as well as increases the overall amount of labour that is expended to collect, store, protect, and distribute water.

Climate change has significant impacts on fresh water sources, by affecting the availability of water used for domestic and productive tasks.



9. Lambrou, Y. et al. (2006). Energy and Gender in Rural Sustainable Development. FAO. Rome.

10. Ecosystems and Human Well-being: Biodiversity Synthesis. Millennium Ecosystems Assessment. 2005

11. UNDP. Sustainable Energy Services: The Gender Dimension.

12. Resources Guide on Gender and Climate Change. http://www.content.undp.org/go/cms-service/download/asset/?asset_id=1854911

13. Permanent Forum on Indigenous Issues Seventh session (2008). Issue paper on indigenous peoples and climate change. (E/C.19/2008/CRP.27). New York

14. UN Chief Executives Board (CEB). 2007. Coordinated UN System Action in Climate Change. United Nations.

http://www.uneca.org/eca_programmes/sdd/events/climate/CEB-climate.pdf

15. UNICEF. Arsenic Mitigation in Bangladesh. Rep. UNICEF. Web. <http://www.unicef.org/bangladesh/Arsenic.pdf>

16. Khan, M.M.H., and et al. "Magnitude of Arsenic Toxicity in Tube-Well Drinking Water in Bangladesh and its Adverse Effects on Human Health Including Cancer." Asian Pacific Journal of Cancer Prevention 4(9)2003. Web. http://www.apocp.org/cancer_download/Vol4_No1/MMH%20khan.pdf

17. UNICEF. Arsenic Mitigation in Bangladesh. Rep. UNICEF. Web. <http://www.unicef.org/bangladesh/Arsenic.pdf>

18. Ibid

Women, gender equality, and health in the context of climate change

In terms of health, some potential climate change scenarios include: increased morbidity and mortality due to heat waves, floods, storms, fires and droughts. What's more, the risk of contracting serious illnesses is aggravated by environmental hazards caused by climate change. In addition to the reference provided above of climate impacting women's health through water scarcity and water contamination, an abundance of evidence links the evolution and distribution of infectious diseases to climate and weather. This entails a greater incidence of infectious diseases such as cholera, malaria, and dengue fever, due to the extension of risk seasons and wider geographic distribution of disease vectors.¹⁹ Whilst climate defines the geographical distribution of infectious diseases, weather influences the timing and severity of epidemics. Diseases transmitted by mosquitoes, for example, are particularly sensitive to variations in climate. Warmth accelerates the biting rate of mosquitoes and speeds up the maturation process of the parasites they carry. Sub-Saharan Africa is already home to the most efficient mosquito species and to the most severe forms of malaria. Rising temperatures are likely to accelerate the lifecycle of the malaria parasite and to spread malaria to new areas.²⁰ Furthermore, floods - increasing consistently with climate change - may also increase the prevalence of water-related diseases, especially water and vector-borne diseases, which affect millions of poor people each year. In addition, an increase in prevalence of diseases will likely aggravate women's care-giving of family and community members who are ill. These diseases include malaria, onchocerciasis, schistosomiasis and diarrhoea.

2.3.2 Correlation Between Climate Change Vulnerability and Human Development in Kenya

While there are numerous sectoral examples of the impact of climate variability and change on human development, there is scant evidence at the aggregate level. In this report, correlation analysis between the climate change vulnerability index (CCVI) and the three indices of human development for which county figures have been estimated (HDI, IHDI and GII) was conducted. The results indicate a negative statistically significant relation between CCVI and each of the human development indices. However, the correlation is weak (Table 2.3). This, of course, should only be viewed as tentative in light of the data challenges encountered in

Table 2.2b: Correlation between CCVI and HDI, IHDI and GII

	CCVI
	P- Values
HDI	- 0.199
IHDI	- 0.242
GI	- 0.118

Source: Authors' calculation

the estimation of the various indices at the county level. More research is urgently required in this area.

2.4 Harnessing Opportunities

Studies show that global warming and extreme weather conditions may have calamitous human rights consequences for millions of people. Global warming is one of the leading causes and greatest contributors to world hunger, malnutrition, exposure to disease, and declining access to water. Moreover it poses limitations to adequate housing, spurring the loss of livelihoods as a result of permanent displacement. Climate change affects the economic and social rights of countless individuals; this includes their rights to food, health and shelter. As climate change will inevitably continue to affect humanity, it presents itself as an opportunity for countries like Kenya to prioritize safeguarding the human rights of people whose lives are most adversely affected.

Four areas have been identified as critical building blocks in response to climate change: mitigation, adaptation, technology transfer and financing. The first two blocks are linked to manifestations of climate change; and the latter two are linked to the means for achieving development goals. Mitigation involves a process of curbing greenhouse gas emissions from human activities, for example emissions from fossil fuels as well as deforestation, with a view to stabilizing greenhouse gas concentration at a safe level. Adaptation involves a range of activities to reduce vulnerability and build resilience in key sectors, such as water, agriculture and human settlements. An opportunity presents itself for Kenya to embrace new and improved technologies and both local and external financing mechanisms at all levels to address climate change. Mitigation and adaptation efforts should systematically and effectively address gender-specific impacts of climate change in the areas of, *inter alia*, food security, agriculture and fisheries; biodiversity; water; health; human rights; and peace and security. Financing mechanisms must be flexible enough to reflect women's priorities and needs. The active participation of women in the development of funding criteria and allocation of resources for climate change initiatives is critical, particularly at local levels. Gender analysis of all budget lines and financial instruments for climate change is needed to ensure gender-sensitive investments in programmes for adaptation, mitigation, technology transfer and capacity building. Technological developments related to climate change should take into account women's specific priorities, needs and roles, and make full use of their knowledge and expertise, including indigenous knowledge and traditional practices. Women's involvement in the development of new technologies can ensure that they are user-friendly, affordable, effective and sustainable. Gender inequalities in access to resources which include credit, extension services, information, and technology, must be taken into account in developing activities designed to curb climate change. Women should also have equal access to training, credit, and skills-development programmes to ensure their full participation in climate change initiatives. Governments should thus be encouraged to incorporate gender perspectives into their national policies, action plans, and other measures on sustainable development and climate change,

19. Resources Guide on Gender and Climate Change. http://www.content.undp.org/go/cms-service/download/asset/?asset_id=1854911

20. Dr. Margaret Chan. Director General of the World Health Organization (2007). "Climate Change and Health: Preparing for Unprecedented Challenges", Keynote statement at the U.S. National Institute of Health, Maryland, USA

through carrying out systematic gender analysis; collecting and utilizing sex-disaggregated data; establishing gender-sensitive benchmarks and indicators; and developing practical tools to support increased attention to gender perspectives.

The consultation and participation of women in climate change initiatives must be ensured, and the role of women's groups and networks strengthened. Currently, women are underrepresented in the decision-making process on environmental governance. They should be equally represented in decision-making structures to allow them to contribute their unique and valuable perspectives and expertise on climate change. Women can make substantive contributions through their knowledge and experience on issues related to the management of natural resources. For example, women in leadership positions – at national, local, and community levels - have made a visible difference in natural disaster responses, both in emergency rescue and evacuation efforts and in post-disaster reconstruction, as well as in the management of essential natural resources, such as fresh water.

2.5 Conclusions

Previous Human Development reports have influenced public policy and legislative agenda and thus the series should be continued but with a rigorous way of monitoring and evaluating use and impact. Kenya has been improving human development progressively, as demonstrated by the indices, but at an inadequate rate. Climate variability and change is already having a devastating impact on human development in Kenya, with floods and droughts particularly leading to costs as high as 16% of GDP in some years, loss of lives, conflicts and violent confrontations, etc. There is a correlation between climate change vulnerability index and the various human development indices. While the country has made considerable progress in the fight against climate change (NCCRS, Action Plan, NDMA, etc), national climate change policy and legislation are still outstanding. In addition, more effort and resources should be made available for adaptation. There are opportunities associated with climate change for example, improved technologies to reduce vulnerability and building resilience in key sectors, such as water, agriculture, and human settlements; and possibilities of accessing funds from new financing mechanisms that support mitigation and adaptation action plans. But to harness these opportunities, Kenya needs to incorporate gender perspectives into its national policies, action plans, and other measures on sustainable development and climate change, through carrying out systematic gender analysis; collecting and utilizing sex-disaggregated data; establishing gender-sensitive benchmarks and indicators; and developing practical tools to support increased attention to gender perspectives.

3 AGRICULTURE AND FOOD SECURITY

Key messages

1. The agriculture sector, including crops, livestock, fisheries, and forestry is very sensitive to climate variability and change. It also affects climate through emissions of GHG especially the livestock sub-sector which emits more than 90 per cent of all emissions from agriculture.
2. Due to the importance of agriculture as the main source of food and livelihoods for the majority of people in poor developing countries, the negative impacts of climate change are discernible through food insecurity and widespread poverty particularly in Sub-Sahara Africa.
3. In Kenya, the agriculture sector is one of the economic sectors which is most vulnerable to climate change mainly caused by rising temperatures, erratic rainfall patterns, and extreme weather events, which lead to frequent droughts and floods. These challenges need to be addressed through alignment of climate change policy with the Vision 2030 strategy which aims to achieve a commercially oriented agricultural sector. This will lead to food security and also be an impetus for a high level of economic growth.
4. The agriculture sector in Kenya needs to undergo considerable transformation in order to overcome the challenges of food security and climate change. Higher institutional capacity and financial support is needed to make the transition to a commercially viable sector.
5. In addition to challenges posed by climate change to a predominately rain-fed agriculture in Kenya, climate change also offers some opportunities to adopt measures and practices that reduce climate vulnerability through deliberate adaptation and mitigating actions. These help to build resilience, enhance food security and livelihoods, and at the same time pursue a low carbon development pathway.



3.1 Introduction

The agriculture sector is important for food security in two ways: firstly, it provides the food people eat, and secondly, it provides the primary source of livelihood to 36 per cent of the world's workforce. In sub-Saharan Africa, two-thirds of the working population still makes their living from agriculture (ILO, 2007). According to FAO, food security has four dimensions: food availability, food accessibility, food utilization, and food system stability. The definition of food security used in this report is the one adopted during the World Food Summit (WFS) held in November 1996, namely " Food security exists when all people at all times have physical or economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO,1996).

While climate variability and change affects all the four dimensions of food security at the global and national levels, food accessibility, especially at the household and individual levels, is the most susceptible. The African continent is the most food insecure area in the world with an estimated 240 million food insecure people, out of whom about 10 million²¹ are in Kenya (mainly found in ASAL areas which cover 83 per cent of the country's land area). According to a joint report by FAO, WFP, and IFAD on the state of food insecurity in the world, globally almost 870 million people were undernourished between 2010 and 2012 with 850 million being from low-income developing countries (FAO,2012). From a human development perspective, food insecurity leads to hunger, low educational standards, poverty, and poor health.

3.1.1 Climate variability and change and food security

Agriculture and the related forestry and fisheries sub-sectors are sensitive to climate and their performance will be affected by climate variability and change directly and indirectly. Agriculture and fisheries are the main sources of food and any positive or negative effects of climate variability and change on them will impact on food security. Generally, impacts are expected to be positive in the temperate regions and negative in the tropical ones (FAO, 2008). In the former regions, it is likely that more food will be produced while the opposite will be the case especially in sub-Saharan Africa.

The Climate Change and Food Security Framework (CCFS) developed by FAO shows how climate change affects food security in various direct and indirect ways (FAO, 2008). The framework considers the following climate variables:

- Carbon dioxide (CO₂) fertilization effect of greenhouse gas concentration;
- Increasing mean, maximum and minimum temperatures;
- Gradual change in precipitation;
- Increase in the frequency of extreme weather events such as floods and droughts; and

- Greater seasonal weather variability.

Appendix tables 3.1a-3.1e show how the above listed climate variables affect food security outcomes for the four components, namely food availability, accessibility, utilization, and food system stability. It is noticeable, for example, that more frequent and intense weather events have immediate effects not only on food production but also on the food distribution infrastructure, food emergencies and livelihoods. On the other hand, gradual changes in mean temperatures and rainfall have fewer immediate impacts.

At the global level, climate change will adversely affect those people who are already vulnerable and food insecure. Most of those people are to be found in Sub-Saharan Africa and South and East Asia where droughts and variability of rainfall will result in reduced agricultural production of the staple food crops such as maize and rice.

With the advent of climate change and in the face of a growing global population, the International Assessment of Agriculture Knowledge Science and Technology for Development (IAAKST) calls for a fundamental shift if the sustainability and development objectives of agriculture are to be achieved (Box 3.1).

Box 3.1: Agriculture at a crossroads

The key message of the Assessment of Agricultural Knowledge, Science and Technology for Development, published in 2009 is: "The way the world grows its food will have to change radically to better serve the poor and hungry if the world is to cope with a growing population and climate change while avoiding social breakdown and environmental collapse." The Assessment calls for a fundamental shift in agricultural knowledge, science and technology (AKST) to successfully meet development and sustainability objectives. Such a shift should emphasize the importance of the multi-functionality of agriculture, accounting for the complexity of agricultural systems within diverse social and ecological contexts and recognizing farming communities, farm households, and farmers as producers and managers of ecosystems. Innovative institutional and organizational arrangements to promote an integrated approach to the development and deployment of AKST are required as well. Incentives along the value chain should internalize as many negative externalities as possible, to account for the full cost of agricultural production to society. Policy and institutional changes should focus on those least served in the current AKST approaches, including resource poor farmers, women and ethnic minorities. It emphasizes that small-scale farms across diverse ecosystems need realistic opportunities to increase productivity and access markets.

Source: UNEP (2011)

3.1.2 Importance of agriculture in Kenya

Despite Kenya having only 17 per cent of its land area being arable, the agricultural sector including livestock, forestry and fisheries sub-sectors contribute over 25 per cent of GDP directly and about 27 per cent indirectly through linkages to other productive sectors such as manufacturing. The sector also employs more than 70 per cent of the labour force and contributes more than 50 per cent of export earnings. Historically, growth in the national economy is highly correlated with growth of the agriculture sector. After a slump in the 1980s and early 1990s, the growth of the sector averaged 2.4 per cent per year until this momentum was broken by the 2007-2008 post-election violence and

the 2008 global financial crisis. In 2010, the sector grew by 6.4 per cent, but in 2011 growth declined to 1.5 per cent mainly due to unfavourable weather conditions and high cost of farm inputs (GOK, 2012a). In 2012, the growth of the sector is estimated to have recovered to about 6.9 per cent mainly due to good weather.

The agricultural sector is far from ensuring food security in the country. Since independence nearly 50 years ago, Kenya has pursued the goal of self-sufficiency in food commodities that include the staple maize, beans, wheat, rice, milk, and meat. During the 1970s, the country temporarily achieved self-sufficiency in maize and even had surplus for export. In subsequent years, food insecurity continues to persist and is attributed to several factors including changes in weather patterns

resulting in frequent droughts and floods, high cost of inputs especially fertilizers leading to sub-optimal yields, displacement of farmers from high potential agricultural areas following the post-election violence in 2008, and generally low levels of innovation and commercialization of agriculture and livestock production systems.

Although agriculture is the backbone of the Kenyan economy, the sector is dominated by small scale mainly subsistence farmers in the high potential areas, and agro-pastoralists and pastoralists in ASALs. These are poor people with limited resources and assets, and whose livelihoods are negatively impacted by climate variability and change. In the following section, we analyze the risks associated with climate change, particularly droughts and floods, as they affect agricultural production, livestock, and fisheries which are the main sources of food. Forestry is included here because, like agriculture, it involves land use and agro-forestry is considered as a farming activity. Again, in accordance with IPCC 2006 guidelines for developing emission inventories, agriculture is combined with forestry and other land use (AFOLU) sectors.

The government accords the agriculture sector high priority as it is among the leading direct and indirect drivers of growth in GDP. In addition, the government has formulated policies and strategies aimed at enhancing food production in order to reduce recurrent food deficits, especially in the staple maize. The Kenyan food situation has over the

years been unsatisfactory despite the Government's declared intention to achieve national, household, and individual food security all over the country.

While a lot effort is being made to ensure that Kenya attains food self-sufficiency, the effects of climate variability and change are likely to delay the achievement of this goal. Table 3.1 below provides food balance sheet indicators for the period 2006 to 2010. The data in the table is derived from the food Supply and Utilization Account (SUA) which is used to compile the Food Balance Sheet (FBS). The FBS gives the food supply situation by looking at three indicators, namely the per caput daily energy supply (whose recommended minimum is 2250 kilocalories), Self Sufficiency Ratio (SSR) and Import Dependency Ratio (IDR). The data show that the country's ability to feed itself ranged from a low of 63.7 per cent in 2009 to a high of 79.3 per cent in 2007. There was a marked improvement in 2010 compared to 2009 as demonstrated by an increase of the self-sufficiency ratio from 63.7 per cent to 75.4 per cent. This improvement is attributed to government efforts to increase food production and by favourable weather conditions (GOK, 2011b). Due to the good domestic supply situation, food imports were minimal as shown by the decline in the import dependency ratio from 39.5 per cent in 2009 to 28.2 per cent in 2010. This ratio was very low for animal products where Kenya was self-sufficient over the five years under review.

Table 3.1: Food balance sheet indicators, 2006-2010

Indicator	Category/Commodity	2006	2007	2008	2009	2010
Per Caput Daily Supply	Calories	1,999	1,885	1,983	1,954	2,153
	Vegetable Products	1,863	1,748	1,682	1,657	1,829
	Animal Products	136	137	301	297	325
	Cereals	937	901	854	941	976
	Proteins	57	53	58	60	66
	Fats	36	34	42	42	49
Self Sufficiency Ratio	Total	78.9	79.3	77.9	63.7	75.4
	Vegetable Products	77.6	77.8	74.3	58.9	72.1
	Animal Products	100.9	100.9	100.2	100.2	100.3
Import Dependency Ratio	Total	24.5	24.9	26.1	39.5	28.2
	Vegetable Products	25.9	26.5	30.2	44.7	32
	Animal Products	1.5	1.5	1	0.9	0.9

Source: Economic Survey, 2011.

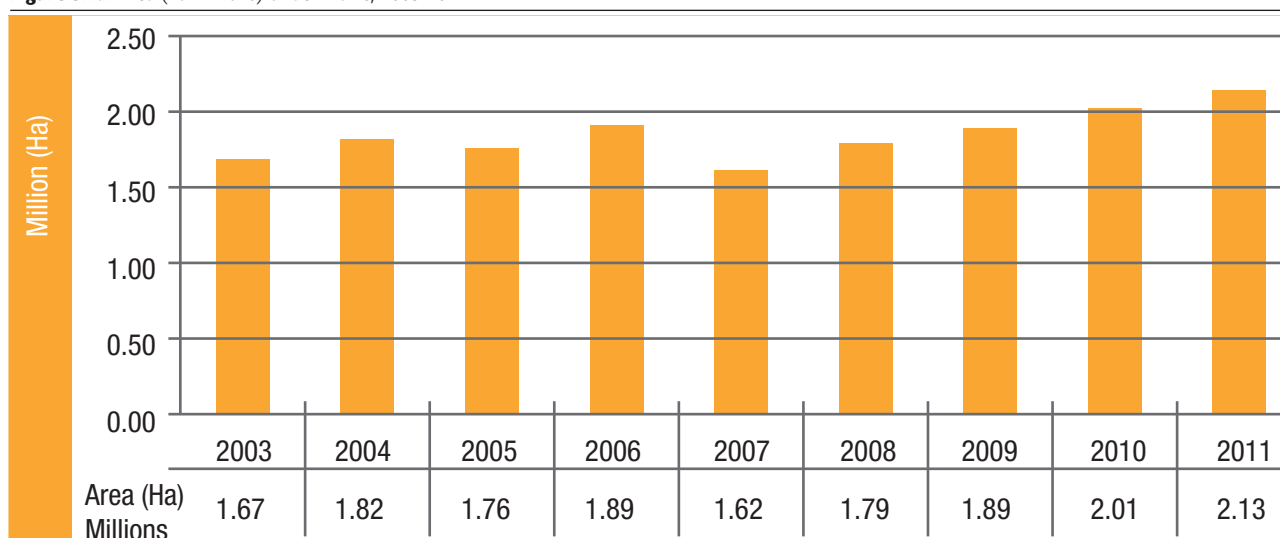
The Kenyan food situation has over the years been unsatisfactory despite the Government's declared intention to achieve national, household, and individual food security all over the country.



Figures 3.1a to 3.1c below show details of area under maize, production and yields for the period 2003-2011. The average area under maize is 1.84 million hectares ranging from a low of 1.62 million in 2007 to a high of 2.13 million hectares recorded for 2011. The average annual production is approximately 32 million 90-kilogram bags. The lowest production was recorded in 2008 while the highest at 38.5 million bags was in 2010. This good performance in 2010 helped to ameliorate

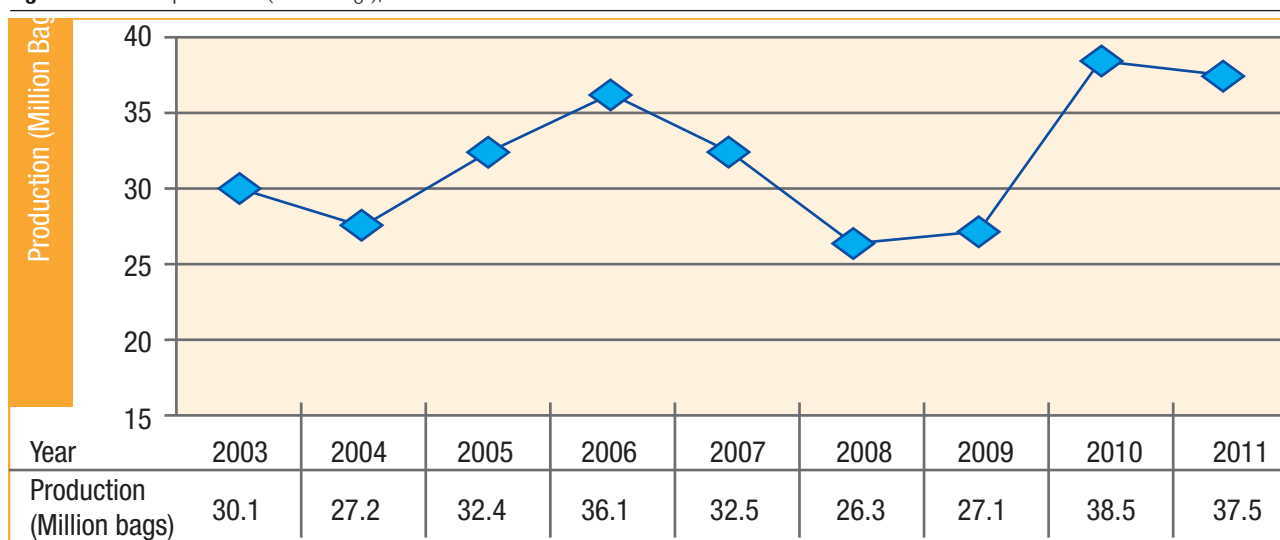
the food supply situation as noted in the food balance sheet analysis. The yields data depicted in Figure 3.1c, as expected, confirm that 2010 outperformed all the other years during the period under reference. Generally, 2008 and 2009 were bad years for maize production due to agronomic and climatic factors as well as the negative effects of the 2007/2008 post-election violence.

Figure 3.1a: Area (ha-millions) under maize, 2003-2011



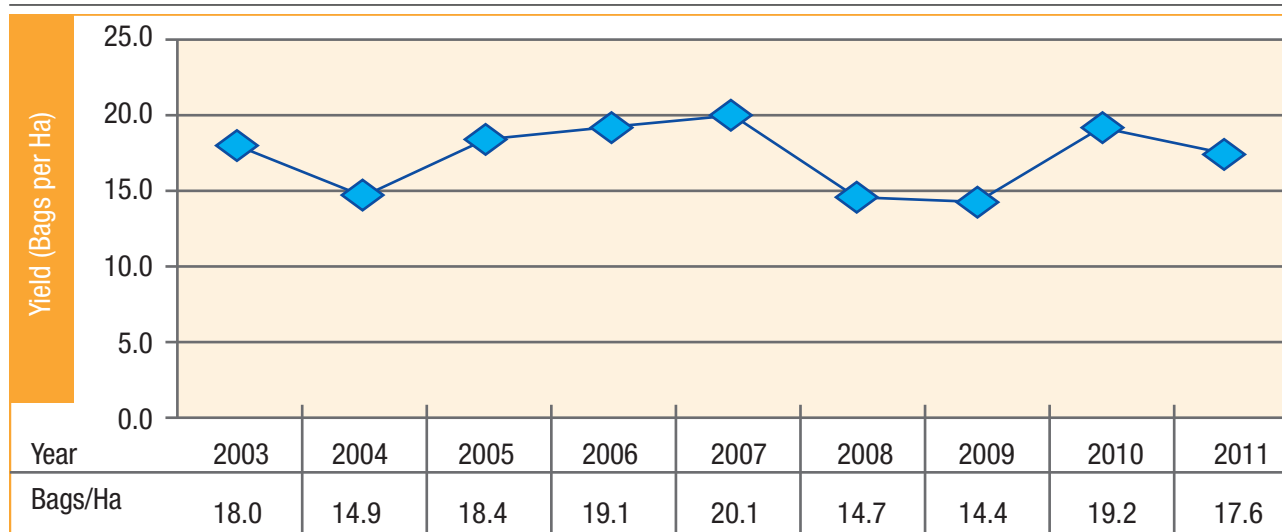
Source: Ministry of Agriculture, Economic Review of Agriculture 2008 and 2012.

Figure 3.1b: Maize production (million bags), 2003-2011



Source: Ministry of Agriculture, Economic Review of Agriculture 2008 and 2012.

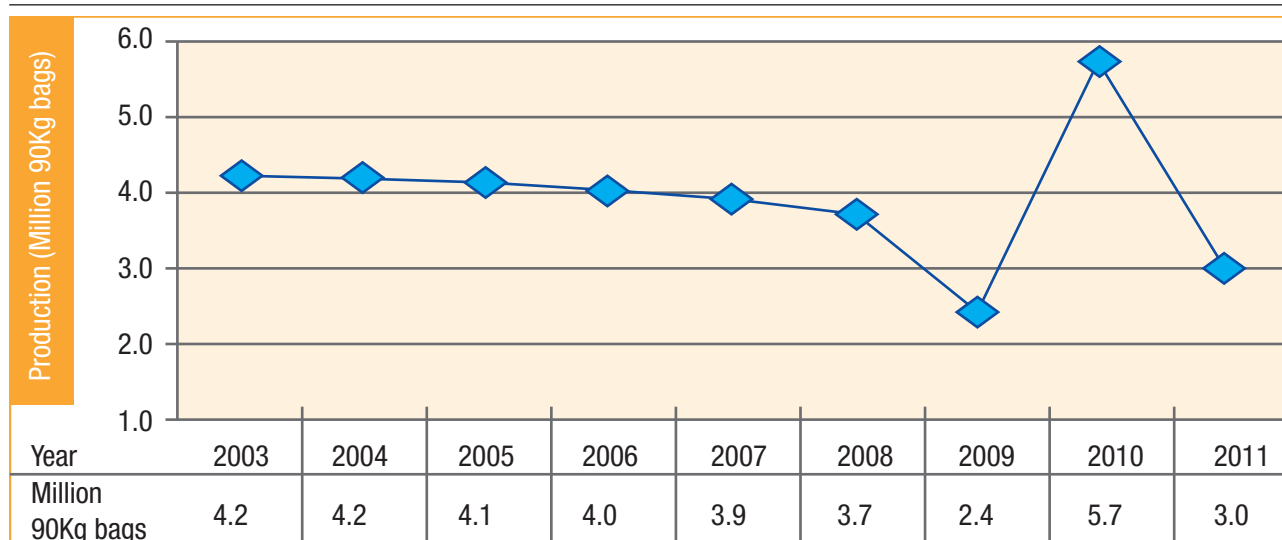
A key challenge for human development is the rather erratic production and yield trend for maize, which is Kenya's staple food (Figs. 3.1b & 3.1b). This demonstrates high vulnerability to climate variability and change.

Figure 3.1c: Maize yields (bags per ha), 2003-2011

Source: Ministry of Agriculture, Economic Review of Agriculture 2008 and 2012.

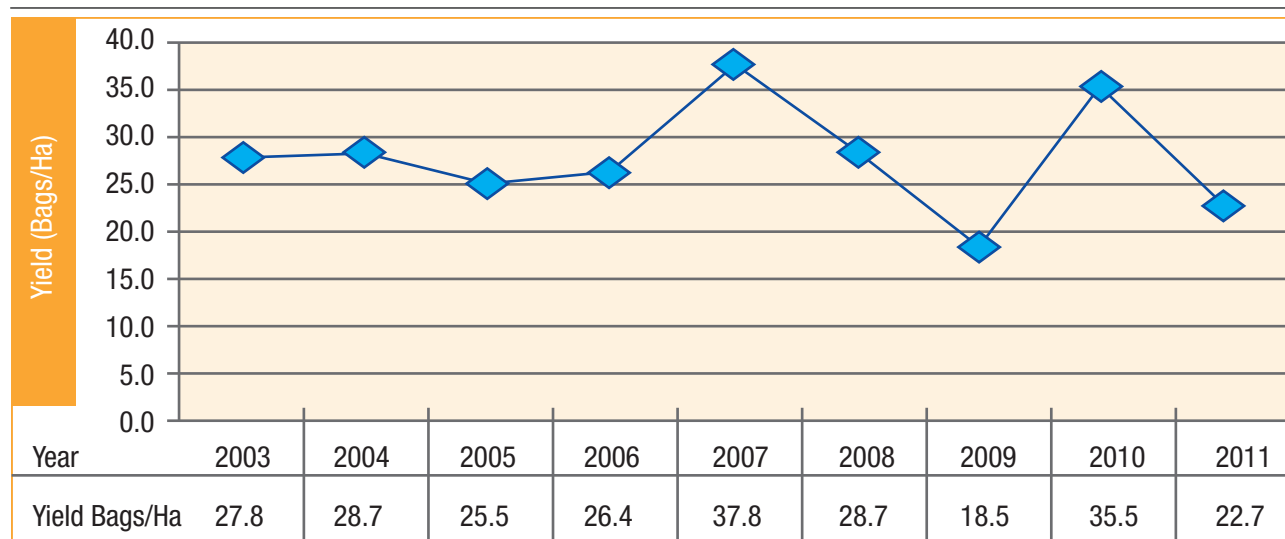
Figures 3.2a and 3.2b below show production and yield trends for wheat between 2003 and 2011. This crop is mainly grown by large scale farmers in Rift Valley. During the nine years under review, the highest production at 5.7 million 90kg bags was recorded for 2010. The lowest production was recorded for 2011 at only 3 million bags. This 47 per cent decline, according to the Crop Directorate of the Ministry

of Agriculture, was as a result of erratic rains in the main growing areas as well as increases in the cost of such inputs as fuel and fertilizer. The data on yield rates depicted in Figure 3.2b show that they ranged from a low of 18.5 bags per hectare in 2009 to a high of 37.8 bags in 2007. These trends also depict the vulnerability of food security to climate variability and change.

Figure 3.2a: Wheat production, 2003-2011

Source: Ministry of Agriculture, Economic Review of Agriculture 2008 and 2012.

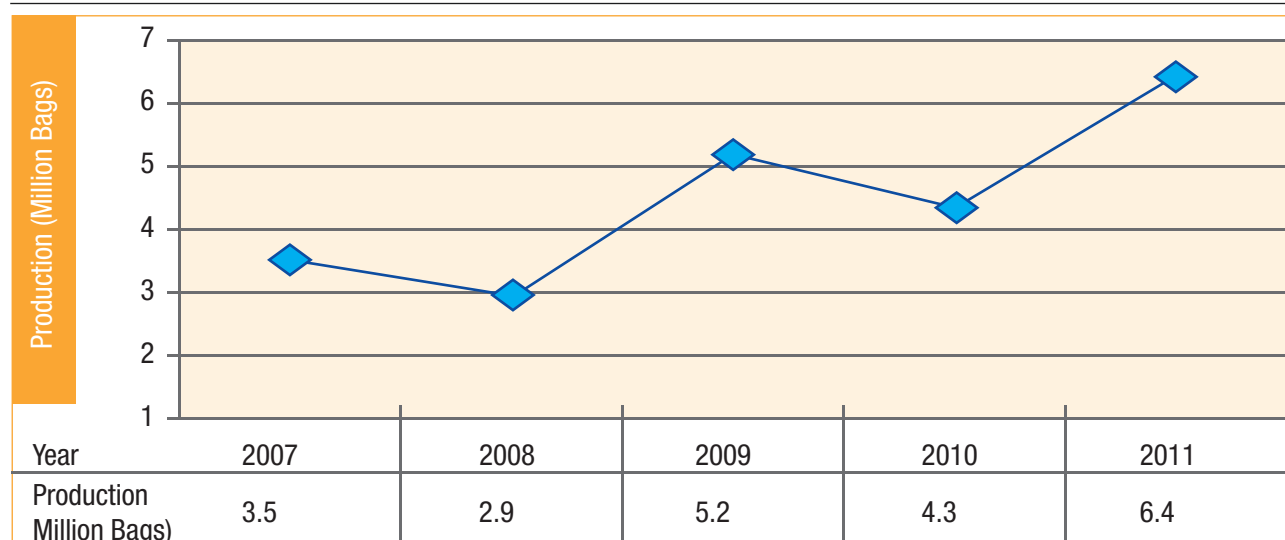
During the nine years under review, the highest production at 5.7 million 90kg bags was recorded for 2010 while the lowest was recorded for 2011 at only 3 million bags.

Figure 3.2b: Wheat yield (ha): 2003-2011

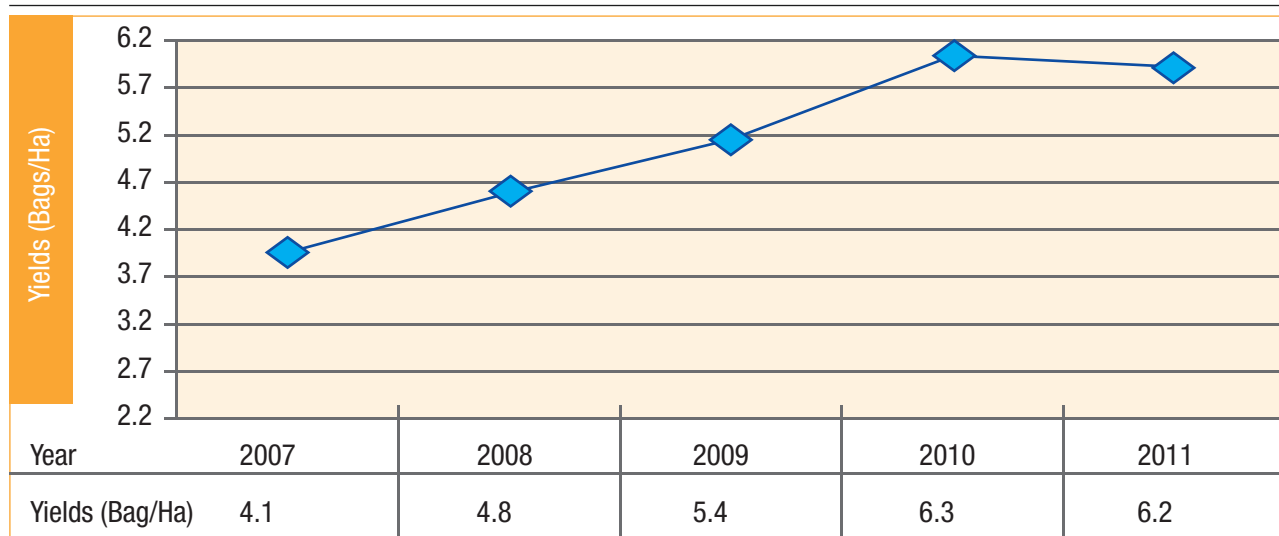
Source: Ministry of Education, Economic Review of Agriculture 2012.

The production and yields data for beans for the period 2007 to 2011 is presented in figures 3.3a and 3.3b below. Beans are important sources of plant protein, especially important for poor households and for children in institutions such as boarding schools. The average annual production over the five year reference period was 4.5 million bags. 2011 was the best year for beans when 6.4 million bags were harvested followed by 2009 with 5.2 million bags. Between 2010 and

2011, production increased by a notable 48 per cent although average yields were about the same at 6.3 and 6.2 bags per hectare respectively suggesting that there was more area under beans in 2011 compared to the previous year. The production and yield trend for beans over the period under review was generally encouraging.

Figure 3.3a: Beans production (million bags), 2007-2011

Source: Ministry of Agriculture, Economic Review of Agriculture 2012.

Figure 3.3b: Beans yields (bags/ha), 2007-2011

Source: Ministry of Agriculture, Economic Review of Agriculture 2012.

In addition to the food crops covered above, there are other important food crops including vegetables, root and tuber crops such as sweet potatoes, cassava, and Irish potatoes, and other horticultural crops including fruits that are grown both for the local and export markets. All these food crops help to alleviate food insecurity in the country.

There is a variety of cash crops grown in Kenya including tea, coffee, sugarcane, pyrethrum, and sisal which are affected by climate variability and change, mainly on account of dependence on rainfall for their production and yields. However, there are other important climate factors. In early 2012, for example, tea was damaged by frost in many tea growing areas. Although cash crops are mainly grown for the export market, there is substantial local consumption of tea, coffee and sugar. These crops are grown both by large scale estates and in the case of coffee, tea and sugar by small holders. The money earned by the latter category of farmers

helps to enhance food accessibility among other household needs including school fees and medical expenses.

Table 3.2 sets out details on tea production, area under the crop, yields, prices, exports, consumption and earnings for the 2007-2011 period. The table reveals that small-scale tea farmers, in aggregate, have more area under tea and consequently more production compared to large estates but their yield rates are lower. In 2011, for example, the estates recorded 3.1 tons per hectare while the small scale holders managed only 2 tons per hectare. The table shows an increasing trend in tea consumption as well as a welcome rising trend in tea export earnings. Between 2007 and 2011, tea export earnings rose by nearly 154 per cent from 43.1 to 109.4 billion shillings. Like in the case of food crops, however, the major vulnerability of cash crop production is dependence on rainfall.

Table 3.2: Tea production and yields, 2007-2011

Year		2007	2008	2009	2010	2011
Production Estates	Area(Ha)	51,011	50,605	51,126	56,893	64,470
	Production (Tons)	139,992	134,963	141,593	174,025	159,358
	Yield(tons/ha)	3.1	2.8	2.9	3.4	3.1
Production- Small Holders	Area(Ha)	98185	107115	107268	115023	123385
	Production Tons	229614	210854	172605	224981	218553
	Yield(tons/ha)	2.6	2.4	1.9	2.2	2.0
Total Area(Ha)		149,196	157,720	158,394	171,916	187,855
Total Production(tons)		369,606	345,817	314,198	399,006	377,912
Price of Black Tea(USD per 100 kg)		176	233	272	275	299
Consumption(tons)		17,643	17,387	18,102	18,704	20,017
Exports(Tons)		345,877	383,444	342,482	441,024	421,272
Exports (Million Ksh)		43,146	62,199	69,603	97,740	109,408

Source: Ministry of Agriculture, Economic Review of Agriculture 2012.

3.2 Climate Change Impacts, Vulnerability and Risks

The agricultural sector is affected by climate variability and change and it also affects climate change through GHG emissions. The available data indicates that the sector excluding forestry is currently the biggest source of emissions and contributes more than one-third of the total national emissions. It is also estimated that total emissions from agriculture will increase from 20 to 27 megatonnes between 2010 and 2030 (GOK, 2012c; Table 3.3). While the data on emissions are characterized by uncertainty, it is nonetheless estimated that the livestock sub-sector contributes more than 90 per cent of the emissions from the agricultural sector (GOK, 2012c).

Incremental climate change and extreme weather events are likely to adversely affect people and their livelihoods especially those who are already vulnerable such as women and children. There are a number of climate drivers which will impact the various agricultural sub-sectors. The following sections provide an analysis with regard to agricultural production, livestock production, fisheries, and forestry.

3.2.1 Agricultural production

The five most important climate variables that affect agricultural production are temperature, precipitation, atmospheric pressure and humidity, wind and sunshine, and cloud cover. Agricultural production is inherently sensitive to climate variability and change due to the close natural connections and dependencies that exist between climatic weather conditions and plant development. High temperatures, for example, are likely to directly reduce crop yields and, at the same time, introduce new pests and disease strains. On the other hand, changes in precipitation patterns increase the likelihood of short-term crop failure and ultimately

long-term decrease in productivity. Since rain fed agriculture is the dominant source of staple food production among the rural poor, climate variability and change poses a great risk to food security.

Drought is the main recurrent cause of food insecurity in Kenya. In recent years, intense droughts occurred in 1991/92, 1995/96, 1998/2000, 2004/2005 and 2008/2011 seasons (GOK, 2012b). The frequency of these droughts averages between two to three years compared to between five and seven-year cycles experienced in the 1960s and 1970s. Some of these severe droughts are very costly. The 1998/2000 drought for example, occasioned losses estimated at \$2.4 billion while the 2008/2011 drought was responsible for losses amounting to Ksh. 69 billion and Ksh 52 billion in reduced food and cash crops, respectively (GOK, 2012b). In 2012, the poor March-April- May (MAM) rains coupled with frost in the main tea growing areas did not augur well for agricultural production. The projections for climate change in Sub-Saharan Africa, although uncertain, point to an increase in the number of extremely dry and wet years during this century (IPCC, 2007). The same IPCC projections point towards rainfall in East Africa increasing by 5-20 per cent from December to February and decreasing by 5-10 per cent from June to August by 2050. Unfortunately, however, the projected increase in rainfall is unlikely to benefit agriculture as it is likely to be sporadic and sometimes coming in heavy rainstorms.

Table 3.4 below provides a history of drought and flooding episodes in Kenya between 1975 and 2011, showing the geographic coverage and the number of people affected. Box 3.2 indicates some of the interventions taken to deal with the drought challenge in the country.

Between 1975 and 1985, the drought and floods cycles averaged between 2 and 3 years, and although droughts were widespread, the numbers of people affected were generally small, except for the 1983/84 drought which affected 200,000 people. As expected, the floods were localized

Table 3.3: Emissions from agriculture, 2000-2030 (M_{tc}o₂e)

Source	2000	2010	2015	2020	2025	2030
Enteric Fermentation	15.2	18.0	19.7	21.0	22.4	23.9
Burning Residues	1.0	1.1	1.3	1.5	1.7	2.0
Manure Management	0.44	0.52	0.59	0.63	0.67	0.72
Nitrogen Fertilizer Use	0.32	0.23	0.30	0.33	0.36	0.39
Flooded Rice	0.06	0.07	0.09	0.11	0.12	0.13
Total	17.02	19.92	21.98	23.57	25.25	27.14

Source: Kenya Climate Change Action Plan 2013 -2017.



Table 3.4: Episodes of drought and floods in Kenya, 1975-2011

Period	Event	Area of Coverage	No. of People affected
2008/2011	Drought	Widespread	10 million
2004/2005	Drought	Widespread	2-3 million
2002	Floods	Nyanza, Busia, Tana river basin	150,000
1999/2000	Drought	Widespread	4.4 million
1997/1998	El Nino Floods	Widespread	1.5 million
1995/96	Drought	Widespread	1.41 million
1991/92	Drought	Arid and Semi-Arid districts of North Eastern, Rift Valley, Eastern and Coast provinces	1.5 million
1985	Floods	Nyanza and Western	10,000
1983/84	Drought	Widespread	200,000
1982	Floods	Nyanza	4,000
1980	Drought	Widespread	40,000
1977	Drought	Widespread	20,000
1975	Drought	Widespread	16,000

Source: National Policy on Disaster Management, Revised draft (2004).

and confined to Nyanza and Western Provinces. Between 1985 and 1990, there was a lull, but resurgence started with the 1991/92 drought which ravaged the ASALs in North Eastern Kenya as well as parts of Rift Valley, Eastern and the Coast provinces. The remainder of the 1990s had more frequent cycles with more intensity going by the affected population. During 2000s, there were severe droughts in 2004/05 and 2008/11 which affected 2.3 million and 10 million people respectively. In addition to economic costs of droughts and floods, human development is further affected by loss of livelihoods for the affected populations, death of people and livestock, damage to homes, and ill health occasioned by malnutrition. Floods, in particular, lead to population displacements with attendant social problems such as high school drop-out rates, crime, and infectious diseases. Overall, these episodes lead to an increase in poverty levels which negatively impact on human welfare.

On the whole, both food and cash crops in Kenya face the challenge of low yields particularly among subsistence farmers due to a combination of factors such as inadequate rainfall, high temperatures, low levels of inputs, and poor technology.

3.2.2 Livestock production

The livestock sub-sector in Kenya contributes approximately 13 per cent of GDP and employs about 50 per cent of the agriculture labour force. It is noteworthy that more than 60 per cent of the livestock is in ASAL areas which occupy 83 per cent of the total land area in Kenya and hold 30 per cent of the human population. The annual output of livestock products is estimated at Ksh303 billion (GOK, 2012e). Incremental climate variability and change, and the occurrence of extreme weather events such as droughts and flash floods, are the major causes of livestock morbidity and mortality which further exacerbates food insecurity in these areas. Climate variability and change is also responsible for an increase of livestock vector-borne and infectious diseases which causes decline in livestock

production. The 1991 drought, for example, led to loss of 28 per cent of cattle and 18 per cent of sheep and goats in Northern Kenya (IPCC, 2007). The impact of the 2008/2011 drought was particularly disastrous in ASALs as it led to depletion of pasture and water and triggered massive migration of livestock from the affected areas to higher altitude areas such as Mount Kenya and even to national parks. In the process of migration, widespread outbreaks of diseases such as Foot and Mouth, Newcastle disease and Peste des Petits Ruminants (PPR) occurred. During this period, combined drought-related damages and losses in the livestock sector amounted to more than Ksh 600 billion (SEI, 2009). The migration also led to conflicts between the pastoralists and crop farmers. During severe droughts, herds are reduced as pastoralists are forced to sell their cattle or risk losing them altogether (Kabubo-Mariara, 2009). Livestock is also affected by floods. During the floods of 1997/98, large numbers of livestock drowned in floodwaters leading to the collapse of the main source of income (Otiende, 2009).

There are other impacts of climate variability and change on livestock production, including degradation of the range lands, reduction of vegetative animal feeds, and disruption of pastoralists social systems and livelihoods.



Box 3.2: Drought interventions

Policy, strategy, legal frameworks and assessment documents that reflect the Government's position on drought management and the development of arid and semi-arid lands include Kenya's Vision 2030, specifically the Northern Kenya addendum, the Sessional paper on National Policy for Sustainable Development of Northern Kenya and other Arid Lands (Approved by the Cabinet on 11th October, 2012), the Draft Disaster Management Policy, the Agricultural Sector Development Strategy, the Food and Nutrition Security Policy, the draft National Social Protection Policy, the policy framework for Nomadic Education in Kenya, the strategy for Ending Conflict Among Communities in Northern Kenya and other Arid Lands 2010-2012 and the National Climate Change Response Strategy.

The Kenya Government has developed a series of approaches for the development of ASALs since independence in 1963. Those that have focused on building resilience of ASAL communities to drought include: i) Kenya Livestock Development Programme (KLDP), 1968–1982; ii) Emergency Drought Recovery Project, 1991–1996; iii) Arid Lands Resources Management Project (ALRMP), 1996–2010; iv) ASAL-based Livestock and Rural Livestock Support Programme (ALLPRO), 2004–2010; v) Kenya Drylands Livestock Development Programme 2010–2013; vi) Kenya Rural Development Programme (KRDP); vii) The DFID-supported Hunger Safety Net Programme; viii) Education for Nomads; and ix) Capacity Kenya.

The Nairobi Summit of the IGAD Heads of State of September 2011 called for an end to drought emergencies in the Horn of Africa. The Kenya Country Programme Framework for Ending Drought Emergencies (CP-EDE) signals two important shifts in the approach to drought management in Kenya. First, it reframes drought management in terms of the debate on vulnerability and resilience, arguing that drought resilience will only be built by investing in the basic foundations for development (as articulated in Kenya Vision 2030). Hence, the inclusion of commitments relating to peace, infrastructure, and human capital. Second, it strengthens the institutional and financing framework for drought management in Kenya, principally through the creation of a permanent institution, the National Drought Management Authority (NDMA), and calls for more effective international financing mechanisms. The CP-EDE is based on six Strategic Response Areas (SRAs) aligned to the IGAD Common Architecture as follows:

1. Development of a coherent strategy for peace and conflict transformation and prevention to be integrated across all major sectors and include all actors in order to strengthen and institutionalise the peace infrastructure at all levels.
2. Support the consolidation and coordination of scattered drought-management initiatives that currently operate independently of each other under one institution (the National Drought Management Authority), including the strengthening and support to early warning systems, risk management initiatives and funds flow from the National Drought and Disaster Contingency Fund (NDDCF).
3. Interventions to develop cost-effective, world-class climate-proofed infrastructure facilities and services in the ASALs, including construction of priority roads, physical markets and growth poles to promote value addition, mapping of established settlements in arid lands without permanent water, construction of multi-purpose dams, development of mechanisms that ensure timely maintenance of existing water sources, development and expansion of ICTs capabilities and infrastructure, development of disease control mechanisms and livestock marketing infrastructure, and development and harnessing of energy sources.
4. Increase participation rates in all sectors of education and training as a long-term measure to address human capital challenges and support livelihood diversification, and invest in appropriate health systems.
5. Focus on livelihoods improvement to enable adaptation to increased climate variability over the short term and to climate change over the medium term.
6. Strengthen the NDMA to ensure it is responsible for the supervision and coordination of all drought management activities and coordination of all stakeholders implementing drought management programs in Kenya.

According to the Kenya Drought Management Bill 2012, the functions of NDMA are to (www.kenyalaw.org):

- (a) Exercise general supervision and coordination over all matters relating to drought management including implementation of policies relating to drought management;
- (b) Coordinate drought response initiatives being undertaken by other bodies, institutions and agencies;
- (c) Promote the integration of drought response efforts into development policies, plans, programmes and projects in order to ensure the proper management of drought;
- (d) Operate an efficient drought early warning system;
- (e) Facilitate national and county level drought contingency processes and the preparation of national and county level drought contingency plans;
- (f) Establish and review, in consultation with stakeholders and relevant institutions and agencies, drought preparedness strategies;
- (g) Identify projects and programs to be undertaken within the drought preparedness strategies;
- (h) Publish and disseminate manuals, codes or guidelines relating to drought management and prevention or abatement of the extreme effects of drought on human, plant and animal life;
- (i) Render advice and technical support to persons, bodies or institutions engaged in drought response management so as to enable them to carry out their responsibilities effectively;
- (j) Prepare and issue an annual report on the state of drought management in Kenya; and
- (k) Perform such other functions as are incidental or conducive to the exercise, by the Authority, of any or all of the functions provided for under this Act.

Source: LTS International & Acclimatise (2012), www.kenyalaw.org

3.2.3 Fisheries

The fisheries sector contributes about 5 per cent of the GDP and plays an important role in socio-economic development through its positive support to employment creation, revenue generation, and food security. It is estimated that the sector supports about one million people directly and indirectly. Freshwater fisheries make up 90 per cent of the sector and are mainly concentrated in lakes Victoria, Turkana, Naivasha and Jipe, as well as Tana River. In addition, fish farming or aquaculture, is also a growing activity. In 2012, aquaculture production amounted to 19.3 metric tonnes which was nearly 60 per cent more than the 12.2 metric tonnes produced in 2010 (GOK, 2012a).

Climate variability and change impacts fisheries in a variety of ways. The increase in average annual temperature causes a decline in fish species composition and productivity in lakes and rivers while a decline in mean annual precipitation causes reduction in lake levels and river flows, with seasonal rivers drying up and fish stocks declining. An increase in sea surface temperature due to global warming leads to a decline in marine fish stocks, which has a negative impact on earnings and food security (GOK, 2012c). In recent years, the fisheries sub-sector has experienced detrimental consequences of climate variability and change, especially droughts. The 2008/2010 drought, for example, greatly curtailed productivity and occasioned huge damages and losses to the fisheries stakeholders and the nation at large. The prolonged drought coupled with high evaporation and reduced river flows caused receding water levels in lakes Turkana, Naivasha and Baringo as well as drying up of fish ponds in areas where aquaculture was being practiced. The overall effect was the reduction of fish breeding area and the resultant low catches. Prior to the onset of the drought, fish production was forecast at 165,129 metric tonnes in 2008 but the actual production in that year declined by 18% to 135,408 tonnes (GOK, 2012a). The quantity of fish landed in 2009 was the lowest at only 133,600 tonnes compared with 140,751 tonnes in 2010 and a provisional figure of 149,046 tonnes in 2011. Between 2008 and 2010, the sector sustained damages and losses estimated at Ksh 4.2 billion (GOK, 2012c). According to the Kenya T21 Model²², interventions in the sub-sector will lead to higher investment in fishery ecosystem and up-scaling of fish production.

3.2.4 Forestry

According to the World Resources Institute, the forestry sub-sector in Kenya contributes 1.3 per cent of the GDP equivalent to US\$ 141 million. However, this figure is underestimated since it does not include household wood fuel and other non-timber forest products. The forest products manufacturing sector provides some 18,100 direct jobs in Kenya (GOK, 2007). Moreover, according to Vision 2030, forest products contribute Ksh 7.8 billion per year, and comprise approximately five per cent of the manufacturing sector's GDP. Forests also provide important attractions for the tourism industry because they serve as important wildlife habitats, and also provide aesthetic and biodiversity benefits. Moreover, Kenya's forests provide important ecosystem services such as reducing soil erosion, natural pest control, preserving water availability, and maintaining water quality.

Unfortunately, deforestation in Kenya is a big problem as shown in Table 3.4. Between 1990 and 2010, for instance, forest cover declined by 6.5 per cent. Apart from private plantation forests whose area increased by 32 per cent and indigenous mangroves which remained the same, the other categories registered depletion. This is likely to have had the effect of increasing GHG emissions and thus reducing the country's chance to benefit from reducing emissions from deforestation and degradation (REDD). Furthermore, since forests provide supplementary nutrition through provision of fruits, nuts and in some cases bush meat, their destruction will impact negatively on livelihoods and food security of communities living near them. Forests also provide herbs and other medicinal plants which local communities use for the treatment of a variety of ailments.

The sector is vulnerable to climate variability and change, which is expected to have marked effects on composition, growth rates, and regenerative capacities of forests with the concomitant implications on livelihoods and human development. These detrimental effects will lead to increase in desertification and forest degradation while protracted droughts will increase the recurrence and magnitude of forest fires as well as increase the ecosystem range of pathogens and pests. In addition, potential temperature rise will lead to increase in carbon-to-nitrogen ratio of many plants whose nutritional value as animal feed will be reduced.

Table 3.5: Forest cover in Kenya by type, 1990-2010

Name of variable	Area ('000 ha)			
	1990	2000	2005	2010
Indigenous closed canopy	1,240	1,190	1,165	1,140
Indigenous Mangroves	80	80	80	80
Open Woodlands	2,150	2,100	2,075	2,050
Public Plantation Forests	170	134	119	107
Private Plantation Forests	68	78	83	90
Total Forests	3,708	3,582	3,522	3,467

Source: FAO, Global Forest Resource Assessment Country Report: Kenya 2010

²² Kenya T21 model; Report on strengthening Institutional capacity for Integrated Climate Change Adaptation and Comprehensive National Development Planning in Kenya, June 2012.

3.3 Adaptation to Climate Change

Adaptation to climate change involves learning to manage risks and vulnerabilities as well as building resilience in the face of change. In this way, adaptation is very closely linked to Disaster Risk Reduction (DRR) as both aim to reduce vulnerability of communities and attain sustainable human development. However, DRR deals with current climate variability while adaptation deals with the current and future climate change. McGray(2007) notes that there are roughly two distinct perspectives that inform the approach to adaptation: one focuses on creating response mechanisms to specific impact of climate change, and the other on reducing vulnerability to climate change by building the required capacities that can help deal with the various challenges including climate change.

3.3.1 The food and agriculture sector

Soil erosion and nutrient depletion, deforestation due to the need to open up new croplands, extension of farming to marginal lands and continuation of basic rain-fed farming systems and other capacity deficiencies make the current farming system unsustainable in the long term. In addition, projected future increases in temperature, erratic rainfall patterns, rise in sea level and frequency and severity of extreme climate events will place enormous strain on agricultural natural resources such as land and water and contribute to deterioration in food security, poverty, health and even political stability. The overall result may be reversal of human development. This trend is already discernible in recent Global Human Development Reports, which now categorize Kenya as a low human development country, compared to the medium human development category which it occupied, for example, in the 2007/2008 Human Development Report. It is for this reason that top priority should be given to adaptation and mitigation policies and strategies aimed at achieving the goal of sustainable agricultural development in Kenya in tandem with Vision 2030.

In response to the climate change impacts, vulnerabilities and risks, the Government has formulated various adaptation and mitigation policies and strategies such as the Climate Change Response Strategy (CCRS) which was formulated and published in April 2010. This is a comprehensive strategy document covering all sectors of the economy and which focuses on the adoption of a low carbon, climate resilient pathway. Due to the importance of the agriculture sector and its close relationship with climate change, the Government considers it a priority sector. In 2011, the National Climate Change Action Planning process was commenced and a report prepared in August 2012, which culminated to the validation of the Action Plan on 22nd November 2012, thereby making NCCRS operational.

3.3.2 Adaptation goals and interventions

Agricultural production in Kenya is heavily reliant on weather and, there is therefore need to put in place a robust adaptation mechanism which will address the climate change-related vulnerabilities and risks which have already been experienced and those expected in future. Climate change adaptation planning should not be viewed as a new branch

of public policy but rather as an integral part of a raft of strategies aimed at poverty reduction and the realization of sustainable human development. In the agriculture sector in Kenya, there is no shortage of policies and strategies for dealing with the various aspects of agricultural development. Vision 2030 emphasizes the need to increase value in agriculture, livestock and fisheries and outlines seven flagship projects in the agriculture and livestock sector. The most recent additional policies include the Agricultural Sector Development Strategy (ASDS, 2010-2020), the National Food and Nutrition Security Policy, the National Agribusiness Strategy and the National Agricultural Sector Extension Policy. The overall policy goal of all these strategies is to stimulate the sector towards the desired growth path to achieve the vision of "a food-secure nation". This is a noble and desirable goal but the road towards its achievement is not easy. To what extent, for example, are these policies and strategies climate proofed? The answer to this question will hopefully be found in the work in progress with regard to Kenya National Adaptation Plan by the Climate Change Secretariat of the Ministry of Environment and Mineral Resources (MEMR). According to Mcgray et al. (2007), there are three different types of adaptation approaches that countries follow:

- "Serendipitous" where activities undertaken to achieve developmental objectives incidentally achieve adaptation objectives.
- Climate-proofing of on-going development efforts such as the flagship projects formulated for the agriculture and livestock sector in Vision 2030.
- Discreet adaptation where activities are undertaken specifically to achieve adaptation ends. This seems to be the approach taken in the Kenya Climate Change Response Strategy where discreet actions are listed for different sectors.

It is important to point out that for any adaptation planning process to succeed, the involvement of the affected local communities is critical. The poor subsistence farmers and pastoralists are the most vulnerable to climate variability and change and are the ones to cope with the impacts. However, it is important to look at the gender factor in the process of formulating policies and strategies for adaptation and mitigation in the face of climate change. In Kenya, like in other Sub-Sahara African countries, as water sources dry up and sources of firewood decrease due to climate change and other factors, women and girls have to walk longer distances to fetch both water and firewood. Further, poor rural women are the primary producers of staple food and work at water and soil conservation to help their families to cope and build resilience (Box 3.2). Unfortunately, this aspect of work is considered as informal and is excluded in official statistics published in the annual Statistical Abstracts by the Kenya National Bureau of Statistics (KNBS).

With regard to the food and agriculture sector, good practices for adapting to climate variability and change include:

- Support for community-based adaptation strategies to help small-scale farmers, pastoralists and fisher folk to protect their food supplies, assets and livelihoods through risk management. This support should include innovative low-premium micro-insurance schemes, introduction of drought-resistant and early maturing crop varieties as well as encouraging the farmers to grow traditional or "orphan" crops such as cassava and millet. Towards this end, the Government should invest more in R&D to identify new appropriate technologies.
- Management Information is a key tool in decision-making especially

Box 3.3: Conservation Agriculture Improves Yields

Yields from Rosemary Oganga's one acre-farm in Siaya County have increased from almost nothing to four bags even though she did not have to till the farm or use fertilizers. She is among several other farmers in Western Kenya who benefitted from conservation agriculture through which growers suppress weeds using the environmentally friendly chemicals instead of traditional weeding.

A novel technology being funded by the Australian Government and implemented by Kenya Agricultural Research Institute (KARI) with focus on Eastern and Western regions, conservation farming has seen a considerable increase in output per acre and cut production costs. "I could spend well over Shs10,000 in preparing my small piece of land and purchase of fertilizer and seeds but I would be lucky to harvest half a bag of maize", said Ms. Oganga.

Source: Daily Nation, February 26, 2013.

with regard to climate variability and change where there is a very high degree of uncertainty. The Kenya Meteorological Department (KMD) provides agro-meteorological data collected from 14 stations but the observation network is not well distributed throughout the country. The department needs to be strengthened through capacity building and acquisition of modern equipment and other agro-meteorological infrastructure needed to enhance its early warning systems as well as medium-term and long-term weather forecasting. This will help the various stakeholders in the agriculture sector, including government institutions, private sector, individual farmers and households to deepen their own adaptive and resilience capacities.

- Promote irrigated agriculture in order to boost food production and improve agricultural water management. There is a very high potential of rehabilitating many irrigation schemes spread out all over the country as well as opening up new schemes. During the 2010/2011 season, the area cropped in all functioning irrigation schemes amounted to 21,101 hectares compared to 17,611 hectares during the previous agricultural year (GOK, 2012a). According to a report on food security prepared by the Ministry of Agriculture in August 2009, there is potential of opening up additional 15,000 hectares at an estimated cost of Ksh 10 billion.
- Encourage adoption of conservation agriculture which avoids regular soil tillage and leads to sustainable and profitable farming systems through enrichment of soil cover. This, coupled with crop rotation and crop diversification, will boost agricultural production and improve livelihoods (Box 3.2 and 3.3).
- Combat land degradation through improved soil management practices such as tree planting, bench terracing and construction of gabions to avert soil erosion and excessive water runoff during floods.
- Encourage people to adjust their food consumption and expenditure patterns by relying more on local produce as well as reducing consumption of animal products since livestock puts a heavy demand on scarce land and water resources. It would also be useful to promote urban agriculture, to the extent possible and allowable by urban planning authorities. This will help some vulnerable urban households to meet their dietary requirements and at the same time shielding them against rising food prices.
- Improving livestock management. In general, livestock, unlike crops, are better at adapting to climate variability and change mainly due to their mobility in search of water and pasture. Livestock keepers are usually adept at adapting to environmental and climatic changes by utilizing their in-depth traditional knowledge of the environment in which they live. However, due to factors such as increasing population, environmental degradation and increasing demand for livestock products, some of the coping mechanisms are being rendered less effective. Better livestock management systems will involve optimizing stock herds, breeding livestock suitable for the various agro-ecological zones as well as combating diseases through regular vaccination and provision of reliable veterinary services. The establishment of disease-free zones will result in healthy animals which will produce quality products for both local and export markets.
- Improving fisheries management. Although the fishing industry in Kenya has been on a growth path in the last five years mainly due to efforts made by the Government to commercialize fishing and expand aquaculture through the Economic Stimulus Programme, there is need for more robust management in order to enhance food security and to raise incomes in a more sustainable manner. Good adaptive strategies should address overexploitation, transformation and pollution of fish habitats through establishing a biodiversity monitoring system. This will ensure that fish stocks will be tracked as climate variability and change occurs and corrective measures such as diversification of livelihoods undertaken. In Lake Victoria, for example, there has been noticeable decline of the dominant Nile Perch species in recent years, which has had the effect of reducing sources of both food and income to poor fishermen and women fish traders.
- Improving forestry management. The current poor state of Kenyan forests is a culmination of nearly five decades of mismanagement through excision and encroachment, illegal logging and general overexploitation of forest products. Adaptation activities should include intensified and sustained afforestation and reforestation programmes, encouragement of agro-forestry and restoration of receding mangrove forests. The Government's ambitious programme of planting 7.6 billion trees in 4.1 hectares of land in the next 20 years is aimed at addressing this problem. As these activities are going on, it is important for communities who live close to forests to be trained on how to conserve the forests as well as being encouraged

Box 3.4: Crop diversification reduces hunger and boosts food security

Even as leaders grapple with the hunger puzzle, experts believe that Africa only needs to think outside the box to replenish its stores. And Mr. Elijah Kamanda, a farmer in OlKalou, Nyandarua County, seems to have heeded the advice. He has ditched maize for yams, which are said to be more resilient to harsh weather and, if his last harvest is anything to go by, the farmer will soon be smiling all the way to the bank. "I have tried maize, beans and even potatoes but I am now tired. I read about how yams turned a Ugandan farm into a money minting machine and thought I should give it a shot. It is discouraging when sometimes you have the land but you can't even feed your own family", said Mr. Kamanda. The farmer, who relies on his piece of land to feed and educate his family, says that growers have to think outside the box because of the erratic weather. "Most of my neighbours lost a lot of their harvest to the rains that pounded the area towards the end of last year during the harvest season. They had enough yields but the rains overwhelmed them," said the father-of-four.

And as farmers in OlKalou ponder their next move; their counterparts in Homa Bay County are using a simple technology to produce disease-free seed yams for planting, which has so far raised production by 20 per cent after years of losses.

Source: Daily Nation, Smart Business, 12th February, 2013.

to take up other activities such as beekeeping, gum Arabic farming and silkworm rearing. There is great potential for beekeeping, for example in Rift Valley Province (in Baringo, Laikipia, West Pokot, Turkana and Narok counties). However, due to environmental degradation, charcoal burning, forest fires and pollution emanating from aerial spraying of large scale wheat and flower farms, the population of bee colonies is also under threat. This underscores the importance of an integrated forest management approach.

- Overall, Kenya needs to embrace climate smart agricultural practices which sustainably increases productivity particularly among small scale farmers and pastoralists, enhances resilience, improves food security and other developmental goals which raises the level of human development (Box 3.4). Appendix table 3.2 shows some practices which are useful in smallholder agricultural production.

agriculture waste rather than burning, reduction of emissions from commercial fishing, and mechanized agriculture.

- Reducing methane and nitrous oxide through such measures as improvement of feeds for ruminant animals, better management of manure and other animal wastes, and more efficient application of nitrogen-based fertilizers.
- Sequestering carbon or carbon sinks through such good practices as better soil management through adoption of conservation agriculture, better livestock management systems, encouragement of reforestation and afforestation, planting of new trees in degraded grasslands, and other marginal lands including agro-forestry.

The combined effect of the above actions is expected to be the reduction of the current and future levels of greenhouse gas emissions in order to achieve a low carbon transition pathway which will result in reduced global warming and the other impacts associated with climate change. Luckily for Kenya, the current levels of emissions are relatively low but steadily increasing as was pointed out in a 2009 report prepared by the Stockholm Environment Institute (SEI). In the following sections we consider mitigation efforts in agriculture and forestry which are some of the sectors associated with GHG emissions in Kenya. The other two are energy and transport which are covered in chapter 7 on infrastructure.

3.4 Mitigation to Climate Change

Mitigation actions which are directly related to agriculture and food security can be grouped in three categories, namely:

- Reducing emissions of carbon dioxide mainly through reduction of deforestation, control of fires, adopting other methods of disposal of

Box 3.5: Farmer Climate Coping Strategies in Western Kenya

In her work, Thorlakson identified that smallholder farmers in western Kenya are aware that their climate coping strategies are not sustainable because they are forced to rely on actions that have negative long-term repercussions. These include eating seeds reserved for planting, selling assets (livestock, tree poles, etc.) at below market value, or building up debt in order to survive. Farmers in the study believe that the most effective way to adapt to climate-related shocks is through improving their general standard of living. Interviews with food insecure and food secure farmers showed that poorer farmers were not investing in agro-forestry or other improved management practices because they were entirely focused on activities related to improving their household's food supply. Food secure farmers, however, discussed goals related to children's education, expansion of land holdings and other long-term investments.

Similar results for China show that the opportunity costs for land are much higher for smallholder farmers than those with larger areas of land. Large-scale farmers took only 1 year after introducing improved grazing management practices to achieve net positive incomes. In contrast, small-scale farmers took 10 years to achieve similar results.

Source: ICRAF Policy Brief No. 12 (2011).

3.4.1 Mitigation in agriculture

There are three main sources of emissions in agriculture excluding forestry (Table 3.3):

- Enteric fermentation and manure management in livestock husbandry.
- Burning of agriculture waste/crop residue.
- Use of nitrogen-based fertilizers.

The following are some mitigation actions which need to be promoted with a view to increasing the capacity of the agricultural sector to increase food security and at the same time, help the overall economy to achieve the targeted 10 per cent annual growth rate as envisioned in Vision 2030 with minimal GHG emissions:

- Encourage the use of modern agricultural technologies in the management of crop and livestock systems with a view to increasing food security and at the same time reducing GHG emissions. The limiting factors here are feasibility and affordability. While it is desirable, for example, to reduce methane emissions from livestock, the nature of the grazing systems used in the ASALs may preclude the use of technology to improve pasture and other livestock feeds in an extensive grazing system.
- Promotion of conservation agriculture to avoid regular tillage which increases methane emissions from the soil. This is a cost-effective method although it calls for education of farmers as well as capacity building in agriculture field extension staff.
- Practicing intercropping especially tree-based intercropping which

increases carbon storage in soils and biomass. Perennial crops store more carbon than annual crops.

- Encouraging climate-friendly livestock production systems through rotational grazing and avoidance of overgrazing which leads to degradation of grasslands.
- Promoting organic farming by substituting or minimizing the use of artificial fertilizers with compost and green manures.
- Better management of animal manure and other agricultural waste to reduce methane emissions. Farmers should be encouraged and helped to use biogas digesters to turn waste to biogas.

3.4.2 Mitigation in forestry

Due to long term reduction of forest cover in Kenya through deforestation and other extractive and destructive actions, it is doubtful whether the country is in a position to reap climate benefits from her current forest stands. According to FAO's Global Forest Resource Assessment Country Report of 2010, forestry and other land uses in Kenya are a net source of carbon emissions rather than carbon sink. For this reason, there is urgent need to intensify mitigation efforts which seek to prevent or slow down the increase of current and future emissions of GHGs. This will entail adopting strategies such as Nationally Appropriate Mitigation Actions (NAMAS) and Reducing Emissions from Deforestation and Degradation (REDD+). These efforts include:

- Afforestation and reforestation programme targeting 4.1 million hectares between 2010 and 2030 according to NCCRS as well as



Pic. Kenya Forest Services

rehabilitation and restoration of all degraded forests. This will involve the production of 3.5 billion seedlings in 35,000 schools, and 4 billion by the Kenya Forestry Service (KFS). This ambitious programme is supposed to achieve the target of at least 10 per cent forest cover required by Chapter 5 of the Constitution and Kenya Vision 2030.

- Enhancing conservation and proper management of all types of forests throughout the country. The development and implementation of sound management plans will require a robust forest resources database starting with the on-going forest mapping project.
- Engagement with a wide portfolio of stakeholders such as schools, youth and women groups and other community associations in an all-inclusive participatory manner.
- Mainstreaming gender in forest and environmental adaptation and mitigation actions in realization of the different roles men and women play in conservation and exploitation of forest resources especially in rural areas.
- Operationalization of forestry legislation such as the 1999 Environment Management and Coordination Act and the 2005 Forestry Act.
- Intensify forestry research by strengthening the Kenya Forestry Research Institute's (KEFRI) capacity to direct research towards current and future climate variability and change threats to the forestry sector.
- Embrace innovative funding mechanisms for forest development through payment for environment services (PES) by setting up a Forest Management and Conservation Fund.

3.5 Managing Challenges and Embracing Opportunities

Appropriate response to climate variability and change offers opportunities at the household, community, and national levels as well as internationally. At the national level, proper implementation of the identified policies and strategies in modernizing the agricultural land use systems will bring beneficial effects to both climate and livelihoods. At the international level, there are potential opportunities to participate in carbon trade and to access funding from multilateral and bilateral sources. Unfortunately, the carbon markets are not fully functional while the funding levels are generally insufficient given the scale of the global climate change problem.

3.5.1 Opportunities to be derived from national efforts

Well managed agricultural, forestry, and other land use systems will increase food productivity, improve livelihoods, and enhance agrobiodiversity. These co-benefits will accrue to those countries which will embrace and implement the right strategies in adapting to and mitigating climate change. For Kenya, several of these strategies and desirable

The biggest promise is held by the Adaptation Fund which has capacity to generate more resources and has a better governance structure.

actions have been enumerated in the sections dealing with adaptation and mitigation. With regard to mitigation, for example, agro-forestry and conservation agricultural projects and programmes hold the best promise for low carbon development which offers enormous opportunities for abatement of GHG emissions. Kenya should also learn good practice climate change interventions from countries such as Costa Rica, which managed to increase its forest cover from 21 per cent in 1986 to 51 per cent by 2006.

What is required now, however, is to ensure that an integrated adaptation and mitigation plan of action is implemented through setting up of the right institutions, channelling investment funds to priority areas and promoting good practices among the various stakeholders in agriculture, forestry and other land use supply chains. In this regard the National Climate Change Response Strategy (NCCRS) has various recommendations including an Action Plan and estimated costs amounting to Ksh 236 billion per year with agriculture, forestry and wildlife taking Ksh 43 billion or 18 per cent.

After the promulgation of the new constitution in August 2010, there is now a raft of enabling legislation including the National Land Commission Act and the Land Act which, if well conformed to, should spur the much needed momentum for growth and development of the sector. While there are opportunities to be gained, there will definitely be challenges to be overcome before full benefits can be realized. The country is in a transition stage as it grapples with implementing the new constitution with some far-reaching implications such as devolution, land reform and above all a new political structure ushered in after the March 2013 General Elections.

3.5.2 Opportunities to be derived from international cooperation

At the international level there are two main sources of funding climate change interventions. The first is the formal climate change financing mechanisms by UNFCCC and the second is the Official Development Assistance (ODA) from bilateral partners.

The UNFCCC funding is channelled through four streams as follows:

- The Least Developed Countries Fund (LDCF). This is meant to assist these countries develop their National Adaptation Programme of Action (NAPAs). Kenya does not, however, qualify for this fund as it is not in the category of the Least Developed Countries.
- The Special Climate Change Fund (SCCF). This was started in 2005 and is meant to address long term adaptation needs for developing countries.
- The Adaptation Fund which was created to fund concrete activities under CDM projects.
- The Global Environment Facility (GEF) has Trust funds which are used for grants aimed at improving the global environment including climate change and biodiversity among other priority areas.

Kenya should take advantage of the above facilities to supplement her own efforts to the extent possible. The Funds channelled through GEF are generally in small amounts and accessibility not easy because of complex application procedures. The biggest promise is held by the Adaptation Fund which has capacity to generate more resources and has a better governance structure. It is important to note that Kenya's NEMA has been

accredited by the Adaptation Fund Board as the National Implementing Entity (NIE) and is now in a position to facilitate accessing adaptation funds.

Assistance from ODA will be determined by the different donors themselves and it will depend on whether climate change financing will be in addition to the existing donor funds. The desirable situation is where donors provide supplementary funding for climate change adaptation and mitigation programmes as opposed to fragmentary projects.

3.6 Conclusions

Agriculture is a pivotal sector in the Kenyan economy. It is a source of export earnings, employment and provides almost all the food requirements in the country. However, the sector is dominated by small scale subsistence farmers and pastoralists who mainly rely on rain-fed agricultural and livestock systems which are extremely vulnerable to climate variability and change. As a result, food insecurity is a persistent and recurring challenge which poses serious threats to health and overall human development particularly among the rural poor and inhabitants of slums or informal settlements in urban areas.

All the agricultural sub-sectors namely crop production, livestock, fisheries and forestry affect and are affected by climate change both directly and indirectly. Under Business As Usual (BAU) scenario, incremental climate change and extreme events risks will adversely impact agricultural productivity.

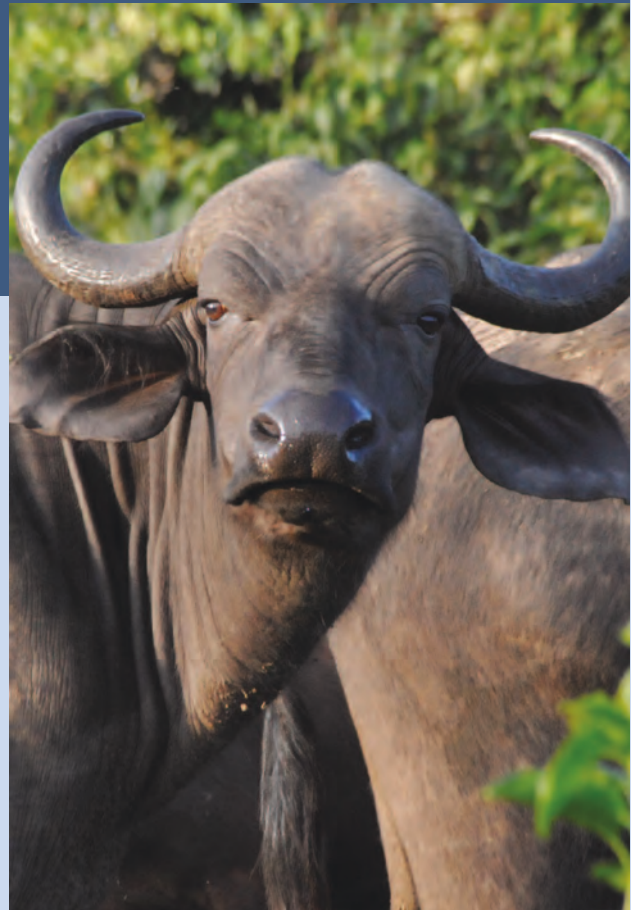
The Government accords agriculture high priority as exemplified by the various policies and strategies such as Vision 2030, the National Climate Change Response Strategy and the Agricultural Sector Development Strategy (2010-2020), among others. However, much more needs to be done, in a more deliberate and systematic manner with regard to climate change adaptation and mitigation interventions. In particular, adaptation planning needs to be integrated into national and county planning processes. This task is not easy particularly now that the country is in transition into a devolved system of governance in tandem with the new constitution promulgated in 2010 and the March 2013 General Election which has brought a new government administration. The Government will also need to embrace opportunities brought about by climate change both nationally and internationally with a view to enhancing adaptive and resilient capacities of the most vulnerable group of subsistence farmers and pastoralists by creating favourable conditions necessary for climate-smart and sustainable agricultural development.



4 TOURISM SECTOR

Key messages

1. The tourism sector is important for human development because of its potential to reduce poverty and create employment. It has been identified as one of the critical sectors for poverty alleviation in Kenya's Vision 2030.
2. This sector is a significant contributor to climate change as it contributes about 5-14 % of the total global CO₂ emissions.
3. Mitigation of CO₂ emissions from the tourism sector needs urgent attention.
4. Kenya does not have empirical research on the impact of climate variability and change on the tourism sector. Given the important role played by tourism in Kenya's economy, there is need to commission studies that would address this glaring lacuna.
5. Climate change provides an opportunity for the Government to enact legislation that supports mitigation and adaptation of strategies for sustainable tourism. Tour operators have played and continue to play a critical role in the growth of international tourism and are therefore expected to promote products that contribute towards sustainable tourism.



4.1 Introduction

This chapter has five aims: firstly, to demonstrate the importance of the tourism sector to Kenya's economy and human development; secondly, to describe the link between climate variability and change, and tourism; thirdly, to present evidence of the impacts of climate variability and change on the tourism sector, and link this to human development; fourthly, to propose adaptation and mitigation measures and prospects in this sector; and finally, to present the opportunities of climate variability and change in the tourism sector.

4.2 Emissions from Global Tourism: Status and Trends

The contribution of tourism to human-induced climate change globally, and Kenya in particular, has never been comprehensively assessed. Table 4.1 shows the estimated contribution of tourism to global warming (including transport, accommodation, and other tourism activities) in terms of CO₂ emissions as well as of radiative forcing (RF).

The contribution of aviation to RF was derived from existing research (Sausen et al., 2005). For other means of transport, accommodation, and other tourism activities, the RF was calculated proportionally to these sectors' contribution to emissions of CO₂. To do so, the authors have assumed that the growth rate of emissions from aviation has been equal

to that of all other tourism sectors since 1945, as the calculation of RF is based on accumulated emissions of CO₂. Table 4.1 shows first detailed attempt to assess the global share of CO₂ emissions attributable to tourism, which is here estimated to be around 5% (within a range of 3.9% to 6.0%) (UNWTO, UNEP & WMO, 2008). Measured in radiative forcing, the contribution of tourism to global warming is estimated to be 4.6% (excluding cirrus-related effects), with a range from 3.8% (excluding cirrus-related effects) to a possible maximum of 9.0% (including maximum cirrus-related effects). The ranges reflect the uncertainty associated with current assessments (UNWTO, UNEP & WMO, 2008).

4.3 Tourism and Human Development

This report is about the implications of climate variability and change on human development. While tourism is not one of the sectors usually associated with human development, its importance in the achievement of Kenya's Vision 2030 necessitated its inclusion in this report. The sector is important for human development because of its potential to reduce poverty and create employment. It has been identified as one of the critical sectors for poverty alleviation in the Government's Economic Recovery Strategy for Wealth and Employment Creation 2003-2007 (GoK, 2003) and Kenya Vision 2030 (GoK, 2007). The sector is also a major source of employment. Due to its many linkages to other sectors (including agriculture, manufacturing, banking and finance, wildlife, entertainment and handicrafts), tourism has great potential to generate employment and

Table 4.1: Estimated emissions^(a) from global tourism (including same-day visitors), 2005^(b)

	CO ₂		Contribution to RF (W/m ²) (c)	
	Mt	Share in tourism (%)	Excluding cirrus	Including maximum cirrus impact
Air transport	515	40	0.0395	0.0979
Car	420	32	0.0176	0.01973
Other transport	45	3	0.0021	0.0021
Accommodation	274	21	0.0116	0.0116
Other activities	48	4	0.0020	0.0020
Total tourism	1,302	100	0.0734	0.1318
Total world^(d)	26,400	-	1.6	1.7^(e)
Share of tourism in total world (%)	4.9	-	4.6	7.8

Sources: Authors' calculation

Notes:

- (a) Estimates include international and domestic tourist trips, as well as same-day visitors (base year 2005).
- (b) Colours represent the degree of certainty with respect to the data and underlying assumptions. Green represents a degree of uncertainty of +/-10%, blue +/-25% and red +100%/-50%.
- (c) The share of tourism in total radiative forcing is lower than in CO₂ emissions alone because the global CO₂ emissions account just for the year 2005, while radiative forcing gives the impact of all CO₂ emissions accumulated in the atmosphere since the industrial revolution. The contribution for aviation and tourism started to become significant only after 1945, and thus accumulated over a much shorter timespan.
- (d) Annual fossil carbon dioxide emissions (including those from cement production), according to IPCC (2007b), The Physical Science Basis.
- (e) This value is higher to account for the impact of cirrus.

Source: UNWTO, UNEP & WMO (2008)

wealth. The sector is also a major source of government revenue in the form of taxes, duties, license fees, and entry fees, among others, while the spatial distribution of tourist attractions contributes to equitable distributions of economic and infrastructural development.

4.4 Link between Tourism and Human Development

Tourism continues to occupy an important position in the international economy. It contributes substantially to the improvement of the standards of living, economic growth, the enhancement of people's opportunities and chances to a better life, and the intensification of environmental protection activities. As a major source of growth, employment, and revenue, tourism is increasingly recognized as having a decisive role in fighting poverty and achieving the UN Millennium Development Goals (MDGs). Therefore, expansion of this industry is now one of the main priorities for many countries (Zafar et al., 1997). Tourism, a transversal economic sector interacting with many other industries and services, can also contribute significantly towards the transition to a Greener Economy, 'an economy that results in improved human wellbeing and reduced inequalities over the long term, while not exposing future generations to significant environmental risks and ecological scarcities.'

Kenya as a country with natural and historical attractions and a deep background in tourism has a high potential to benefit from tourism industry

improvement. Human improvement is one of the main considerations in this regard. Tourism is considered as an economic field that is most compatible with sustainable development, because of its human aspect. The concept of human development is currently one of the most used phrases. According to a UNEP Human Development Report (2011), "human development is the expansion of people's freedoms and capabilities to lead lives that they value and have reason to value. It is about expanding choices". Human development is the route of widening opportunities for people. Such a development assumes the creation of opportunities for individuals to choose the values and lifestyles that they consider proper for their existences. One of the most important indices to measure human development is HDI (Human Development Index). The fundamental dimensions and components of HDI are selected based on the primary capabilities and abilities of people to participate and play a role in the society. Such capabilities and abilities are: ability to have a healthy and long life, ability to gain knowledge, and ability to access necessary resources and facilities for a proper level of life. Specialized literature considers that improvement in human development in a country leads to more tourist arrivals (Zafar et al, 1997).

4.5 Climate Change and Tourism

Climate is a principal resource for tourism, as it partly determines the suitability of locations for a wide range of tourist activities (Steyn and Spencer, 2012). The distribution of the climate resource varies in space and

time; it is not a tourism resource in all places. There are climates that limit tourist activities and others which favour them. It suffices to note that wherever this resource is found, it is subject to great temporal variations – from one day to the next, one season to the next, and one year to the next (Besancenot, 1991).

Climate is a principal driver of global seasonality in tourism demand, and has an important influence on operating costs, such as heating and cooling, snowmaking, irrigation, food and water supply, and insurance costs (Steyn and Spencer, 2012). Thus, changes in the length and quality of climate-dependent tourist seasons (for example those for sun-and-sea or winter sports holidays) could have considerable implications for competitive relationships between destinations, and therefore profitability of tourism enterprises. Furthermore, changes in the number of weather extremes as a result of climate change could produce similar results.

The tourism industry forms a vital part of Kenya's economy—one that is expected to grow, as the country aims to become one of the top-10 long-haul destinations in the world (GoK, 2007b). Achieving this goal will be challenged by climate risks that include the loss of tourism attractions such as coral reefs, coastal beaches, and Mt. Kenya's glaciers; changes in wildlife migration patterns and species diversity; damage to infrastructure; water restrictions; and higher demand for air conditioning. The government has called for the development of a national wildlife adaptation strategy to help better understand the risks facing this industry (GoK, 2010).

4.6 Contribution of the Tourism Sector to Kenya's Economy

The service sector constituted 62 per cent of the Kenyan economy in 2010 (CIA, 2011). Tourism constitutes a large part of this sector, as Kenya's coastal rainforests, marine ecosystems, and wildlife, as well as Mount Kenya, make Kenya one of the top tourist destinations in the world (WRI et al., 2007). A significant proportion of wildlife conservation activities take place in Kenya's ASALs, where tourism is the major economic activity (WRI et al., 2007). Between 2004 and 2009, tourism generated US\$737 million in revenues (World Bank, 2011). Following a decline after the post-election violence of 2007/2008, the sector regained growth momentum by growing at 15 per cent in 2010 and generated earnings estimated at Ksh 73.68 million (approximately US\$0.88 million) (Ministry of Tourism, n.d.).

Expansion of the services sector forms a significant part of Kenya's economic development strategy. As stated in Vision 2030, Kenya aims at becoming a rapidly industrializing middle-income country by 2030 (GoK, 2007a). In the services sector, Kenya intends to position herself among the top 10 long-haul tourist destinations in the world (GOK, 2007a), and to make her financial services globally competitive (GOK, 2007b). The first goal is to be achieved by developing two new resort cities, improving existing parks, creating new high-value niche products, attracting high-end international hotel chains, and investing in new conference facilities (GoK, 2007a). Tourism earnings, which are a key source of foreign exchange earnings, rose by 32.8% - from Ksh. 73.7 billion in 2010 to Ksh. 97.9 billion in 2011 (KNBS, 2012). Total arrivals grew from 1.6 million in 2010 to 1.8 million in 2011 (KNBS, 2012).



Pic: Shutterstock

Kenya is endowed with a unique combination of tourist attractions, comprising tropical beaches, abundant wildlife in natural habitats, scenic beauty, and a geographically diverse landscape. The diversity of Kenya's habitat is equalled by the remarkable variety of flora and world famous wildlife heritage. Kenya's cultural history stretches back over 4.5 million years, with some of the oldest known evidence of early man. Thus, Kenya can truly be promoted as a destination that offers the visitor - whether foreign or domestic - an unparalleled variety of travel experiences. Factors that have contributed to the growth of tourism include (KNBS, 2012):

- Promotion in new markets (e.g. Asia)
- Repositioning the country as a high value destination (e.g. Brand Kenya Initiative)
- Political stability
- Improved security

Tourism currently accounts for about 10 per cent of the Gross Domestic Product (GDP), making it the third largest contributor to GDP after agriculture and manufacturing, and Kenya's third largest foreign exchange earner after tea and horticulture. As noted earlier, the sector also has strong linkages with other sectors, and therefore its capacity to generate employment, reduce poverty, and increase wealth is high. Furthermore, tourism promotes regional development and equity by attracting infrastructure in otherwise remote areas through its multiplier effect. It also has the capacity to create new commercial and industrial enterprises, stimulate demand for locally produced goods and services, and provide a market for agricultural products.

Given that the necessary infrastructure and superstructure are already largely in place, tourism has the potential to expand rapidly. The main strengths, weaknesses, opportunities, and threats for the country's tourism sector are summarised in Table 4.2.

Table 4.2: A SWOT analysis for the tourist sector in Kenya

STRENGTHS	WEAKNESSES
Sophisticated and efficient industry	Deteriorated infrastructure
Known to tour operators	Insecurity and crime
Quality wildlife	Poor public relations
Quality beaches	Mass market image
Nairobi regional hub	Perceived as cheap beach destination
Customer awareness	'Tired' hotel infrastructure
Hospitable and friendly people	Old product
Excellent all-year climate	Anti-competitive trade practices in the marketing and sales distribution system
Change of government in 2003	Limitations on air access & seat capacity
Good medical/rescue facilities	Entry and visa impediments
Good tourism training facilities	Malaria and HIV/AIDS
English speaking	Lack of quality control and standards
No jet lag from Europe	Inadequate database and information
	Beach harassment
	Tourists herded and restricted by operators
OPPORTUNITIES	THREATS
Ecological and topographic diversity	Lack of controls, planning, management
Potential product diversity	Acts of terrorism
Films and books about the destination	Negative travel advisories
Upgrading visitor interpretation	Increased competition
Diverse heritage, cultures and traditions	Tour operator price pressures
East African Co-operation	Community envy/resentment
Kenya's teas, flowers, coffee, etc.	Human-wildlife conflict
Kenya's sport personalities	Animal poaching
Tourist Police and KTF Safety Centre	Shortage of future investment capital
Public/Private partnerships	Over-reliance on a few major markets
Boutique camps, lodges, home stays	Corruption and bribery

Source: GoK, National Tourism Policy (2006b)

4.7 Climate Variability and Change Impacts on the Tourism Sector in Kenya

4.7.1 Wildlife-human conflicts

Conflicts are common in all areas where wildlife and human populations coexist and share limited resources. Climate variability and change affect the intensity and frequency of such conflicts indirectly, by modifying environments and their productivity, and favouring some species that cause problems for humans. Together with increased human population densities, this is exacerbating existing conflict situations around the world. Conflicts become more intense where livestock and agriculture are important to rural livelihoods. In rural communities of developing countries, competition with wild animals over natural resources is intense and the people are vulnerable to high economic losses. Severe droughts cause a decrease in natural resource productivity and are associated with a considerable increase in human-wildlife conflicts (Lamarque et al., 2009).

Considering current human population growth rates, climate change trends, increasing demand for resources and the growing demand for access to land, it is clear that human-wildlife conflicts will continue in the near future.

In Kenya, most traditional dispersal and migration areas for wildlife are now occupied by humans as populations have increased exponentially. With changing climatic conditions, wild animals move to these areas and human-wildlife conflict escalates. The consequence is that the animals are usually killed. Humans also invade wildlife reserves in search of natural resources – often fodder for their livestock – increasing the conflicts between wild and domestic animals. One critical impact of these changes is the threat to connectivity between wildlife populations. For example, Nairobi National Park survives in the shadow of Kenya's capital city, with a healthy population of large mammals, but only because it is connected to other suitable habitats, such as the Kitengela Conservation Area and Athi-Kapiti plains. Increasing farming pressure risks isolating the site and careful

Box 4.1: Water competition worsening farmer-wildlife conflict in Kenya

Like hundreds of other farmers in Kenya's Rift Valley region, EneMerumpei had hoped to fill the two granaries tucked in the corner of her homestead with freshly harvested grain at the start of the dry season last August, 2012. One month into the hot, dry period, however, one of them was only half full and the other stood empty. Marauding elephants from a neighbouring wildlife sanctuary had broken into her two-acre maize plantation and flattened three quarters of her crop. Now, she will struggle to find enough to feed her family, who live at Kimana village in Kajiado, a district some 260 Km south of Nairobi, particularly as continuing drought affects the remaining pockets of vegetation that feed her small herd of goats. "We are no longer protected from the wildlife that used to be confined to the Kimana sanctuary," said Merupepi, 52. "When the animals are not destroying our crops, they're competing for pasture with our livestock. I don't understand why this is happening." Experts say the problem is linked to climate change. Periods of drought are becoming more frequent in the east African region, drying up wetlands, changing ecosystems and forcing wildlife to look further afield for water. In addition, communities in the wetlands, faced with worsening drought, are increasingly turning to irrigation to support their crops, putting huge pressure on water resources. This is why we are seeing both wildlife invading human settlements and communities encroaching on wildlife territories, out of competition for the shrinking water resources." The Kenya National Climate Change Response Strategy document, which outlines patterns of climate change in Kenya since the 1960s, supports this view. The document, released in September, 2010 observes that climate change is exacerbating conflicts between humans and wildlife as drought pushes lions, elephants and other wildlife closer to water holes and vegetation that lie near human settlements.

Source: David Njagi, AlertNet 14.2.2011

negotiations are in place to ensure that wildlife corridors remain open. Warmer temperatures reduce plant and vegetation productivity in semi-arid environments, and wildlife in those areas usually competes with domestic livestock for both food and water. In northern Kenya, longer and more frequent droughts have ravaged pastoralist populations in recent decades, increasing the pressure on the limited resources available, which have to be shared with wildlife (Conservation Development Centre, International Institute for Sustainable Development and Safe World, 2009). This situation has led to lower tolerance for damages caused by wildlife and higher rates of retaliation towards predators. The story in Box 4.1 partially illustrates the extent of these conflicts.

The upper catchment area of Mount Kenya comprises the afro-alpine zone, which is protected by the Mount Kenya National Park (about 70 000 ha) and the Mount Kenya National Forest Reserve (about 200 000 ha). This vast zone is one of Kenya's five crucial sources of freshwater and is home to biodiversity of national and global importance. Six rare and threatened species of large mammals live here: the African elephant (*Loxodontiaafricana*), the country's largest remaining forest population; the black rhinoceros (*Dicerosbicornis*) – only a few are remaining; the leopard (*Pantherapardus*); the giant forest hog (*Hylochoerusmeinertzhageni*); the mountain bongo (*Tragelaphuseurycerosisaaci*), a critically endangered African antelope; and the black-fronted duiker (*Cephalophusnigrifronshooki*). There are also many ungulates, primates, carnivores, and small mammals, along with 53 out of Kenya's 67 African highland biome bird species, including the threatened and little-known Abbott's Starling (*Cinnyricinclufemorals*) (Kenya Wildlife Service, 2010; Bird Life International, 2011).

Mount Kenya glaciers have lost 92 per cent of their mass in the last century and their volume and extent have shown a drastic decrease in recent years.

The protected areas of the upper catchment are separated from the middle catchment by multiple-use "buffer" and "transition" zones, along the outer perimeter of the National Reserve. The integrity of the whole ecosystem has direct benefits to the agricultural use of surrounding areas by protecting them against land degradation and erosion with their severe negative impacts such as siltation, landslides, and loss of soil fertility. Studies have calculated that the presence of the Mount Kenya forest (Category II, 58,800 ha and Biosphere Reserve, 71,759 ha) alone has saved Kenya's economy more than US\$20 million by protecting the catchment for two of the country's main river systems, the Tana and the EwasoNgiro (Emerton, 2001).

Climate variability and change now affects the water catchment area of Mount Kenya, which is experiencing diminishing ice caps and a reduction in rainfall. Mount Kenya glaciers have lost 92 per cent of their mass in the last century and their volume and extent have shown a drastic decrease in recent years. In the recent past, melting snow has contributed to the rivers and kept the catchment humid, while moderating the dry seasons. Presently, early and shortened snow-melt periods have implications for rivers and springs: dry season flows progressively decline and the land becomes drier and less productive. The forest is affected by more frequent fires and slower regeneration of vegetation. Local farmers report that this process is exacerbating the human-wildlife conflict, due to the close proximity of human settlements to the protected areas (UNEP, 2009). Lack of melt-water and degradation of the vegetation were reported to cause wildlife to migrate downstream in search of water and food, placing wildlife conflict at the top of the concerns expressed by the members of the Mount Kenya East Environmental Conservation Forest Association living in the Meru South District (IFAD, 2009). To respond to this situation, the International Fund for Agricultural Development Mount Kenya East Pilot Project for Natural Resource Management and an associated project financed by the Global Environment Facility (GEF) are promoting diverse mechanisms for reducing human-wildlife conflict over resources and limiting damage to agricultural crops. These measures include development of a long-term strategy on wildlife migration corridors, the

establishment of wildlife barriers like solar-powered electric fences, together with building the capacity of communities to maintain them. Measures to rehabilitate certain indigenous and plantation forest areas, accompanied by training Kenya Wildlife Service staff to address conflicts, will further help ensure peaceful interaction between wildlife and the communities surrounding the protected area (IFAD, 2009; Global Environment Facility, 2004; GoK, 2002).

4.7.3 Emerging wildlife disease outbreaks

Emerging infectious diseases (EIDs) are defined as infections that have recently appeared in a population or have existed previously but are rapidly increasing in incidence or geographic range (Morens et al., 2004). Multiple factors contribute to increased pathogen emergence, including rapid population growth of people and livestock, the intensification of agriculture, encroachment into wildlife areas, increased exploitation of wildlife and natural resources, modification of landscapes and ecosystems, and globalization. These factors undoubtedly contribute to pathogens increasing in virulence, jumping to new species, or spreading to new environmental niches. Climate change can also play a more or less direct role in the changing dynamics and ecology of diseases in natural systems. Changes in temperatures, seasonality, and precipitation patterns may have a significant impact, especially on vector-borne diseases at the pathogen and vector levels: abiotic parameters regulate insect bionomic, lifecycles, and home ranges (Harvell et al., 2002). Warmer temperatures could increase the incidence of disease both by increasing the vector population size and distribution, and by increasing the duration of the season in which infectious vector species are present in the environment. Climate-driven change of ecotypes and the alteration of climate-dependent resources such as vegetation cover, may also force animals to adjust their movements or migration patterns into new ecosystems where they may encounter or introduce novel pathogens (Altizer et al., 2011). Climate change will increase the frequency of extreme climatic events that impact disease cycles and this could emerge as more important than the changes in average climatic conditions (de La Rocque et al., 2008).

As recently as 2010, outbreaks of Rift Valley fever, a mosquito-borne disease, have correlated with a higher than average seasonal rainfall and have even occurred with shorter heavy rainfall in the country. Many insect vectors have population booms associated with large amounts of rain, particularly after long periods of drought. The flooding that accompanies heavy rainfall can increase the spread of waterborne pathogens, exposing more animals to potential infections. Conversely, decreased rainfall and drought can result in animals congregating around limited food and water resources, thus increasing population densities and often resulting in increased transmission of pathogens and parasites. The Biodiversity Research Unit of the KWS warned in its annual report of 2007 that unless urgent strategies are developed to counter the effects of climate change, management of wildlife could suffer irreparably. Box 4.2 summarizes the extent of climate change related outbreak of emerging diseases among wildlife in Kenya.

Box 4.2: Climate change devastating wildlife in Kenya

Researchers at the Kenya Wildlife Society (KWS) climate unit say climate change is to blame for drying up of rivers and migration of species to new habitats, causing changes in ecosystems. This has led to animals, such as lions, killing domestic animals like sheep and goats in villages near the animal parks. Villagers have also complained of elephants, rhinos and buffalos destroying food crops as they wander away from the parks in search of food and water. The researchers add that these events are compromising eradication of rinderpest, a viral infection of cattle, sheep and goats, ahead of a 2010 global elimination target set by the Global Rinderpest Eradication Programme (GREP). The KWS says climate change and ecological disturbances could have caused a recent increase in deaths in wildlife populations from infectious diseases. Birds and mammals have been the worst affected, with climate change blamed for the sudden mass death of flamingos around Lake Nakuru in the Rift Valley in 2006. The KWS initially suspected bird flu, but 493 samples proved negative for H5N1 avian influenza. According to the report, Kenya's 66 animal parks are all experiencing changes in animal disease patterns that pose a very serious threat to wildlife.

4.7.4 High Vulnerability of the low lying coastal region, a major tourism region

Kenya's pristine beaches with abundant sunshine are prime attractions for tourists, especially during the northern hemisphere winter months. Mombasa city is the epicentre of tourism activities in the coastal region. Three factors contribute to Mombasa's high level of vulnerability to climate change: low altitude, high temperatures, and high humidity levels. Regarding the first of these, Mombasa is on the coastal plain, which is 4–6 kilometres wide and lies between sea level and about 45 metres above sea level. Parts of the city and its surroundings are likely to be submerged with a rise in sea level, and this would consequently disrupt ecosystem functions and balance, disrupt agricultural and industrial activities, cause the destruction of human settlements, and interfere with water supply (GoK, 2002b). This will impact negatively on the city's economy and, by extension, on the national economy due to the many activities and investments found in the area.

According to the IPCC Fourth Assessment Report, it is estimated that during the twentieth century, sea level has been rising at a rate of about two millimetres per year, with the fastest recorded rates averaging along the global coastline (four millimetres per year) occurring in the 1990s (Bindoff et al., 2007). It is estimated that about 17 per cent of Mombasa, or 4,600 hectares of land area, will be submerged with a sea-level rise of only 0.3 meters (Mahongo, 2006). At the same time, there will be large areas that may be rendered uninhabitable as a result of flooding or water logging, or will be agriculturally unsuitable due to salt stress, especially in the peri-urban space where agriculture is practiced. Sandy beaches and other features, including historical and cultural monuments such as Fort Jesus, several beach hotels, industries, the ship-docking ports, and human settlements could be negatively affected by sea-level rise.

Other potential impacts of sea-level rise that could affect Mombasa include increased coastal storm damage and flooding; sea-shore erosion; salt water intrusion into estuaries and freshwater aquifers and springs; changes in sedimentation patterns; decreased light penetration to benthic organisms leading to loss of food for various marine fauna; and loss of coral reefs, contributing to loss of biodiversity, fisheries, and recreational opportunities, among others.

The high average temperatures (26.40C) and humidity (65 per cent at noon) are already approaching intolerable limits and can be uncomfortable at times (GoK, 2002a). An increase in temperatures and humidity could create health-related problems such as heat stress, both on land and in the ocean, leading to ecosystem disruption, migration, and the possible extinction of various species of fauna, flora, and microorganisms. In addition, increased temperatures could result in the increased use of energy to power air conditioners. This increased use of energy for cooling would essentially mean increased use of fossil fuels.

In addition to the low altitude and high average temperatures and humidity, socioeconomic factors, particularly unplanned settlements and structures, are also contributing to the city population's increased level of vulnerability to climate change impacts. The high population densities, together with the large number of unplanned settlements that have encroached into areas demarcated for infrastructure such as roads, drainage, and sewerage lines, not only increase the risk of flooding whenever it rains, but also make rescue operations difficult whenever disasters strike. The Mombasa District Commissioner, while inspecting the extent of damage caused by floods in April/May 2006, attributed the poor drainage to the mushrooming of slums

and land grabbing in Mombasa.²³ The District Commissioner also noted that the building of perimeter walls and unplanned structures along waterways interferes with water drainage, which leads to flooding in most parts of the city.

The impacts of climate variability and change pose grave threats to city dwellers' lives and livelihoods, as well as to the country's socio-economic development. Mombasa is already affected by extreme climatic events, especially floods, droughts, and strong winds. These climate-related disasters are projected to increase in frequency and intensity with long-term climate change. Table 4.3 gives a summary of disasters that have occurred in Mombasa in the recent past. Wind storms, cyclones, and floods damage productive land, thus causing agricultural losses and increased food insecurity. They also damage transport and telecommunications infrastructure such as roads, bridges, and pipelines, as well as electricity and telephone lines. When they occur, they negatively affect economic and commercial activities. Sea-level rise and frequent flooding may not only cause damage to existing infrastructure in cities such as Mombasa, but may also result in inundation, rendering many areas uninhabitable and unsuitable for food production. This, in turn, can lead to migration in extreme cases and loss of cultural heritage, especially historical and archaeological sites and monuments. It could also cause the spread of climate-sensitive diseases such as cholera, which may affect large numbers of people due to high population densities in cities, and could lead to a high loss of life as health institutions and residents are often caught unawares. These impacts also disrupt normal livelihood activities and school attendance.

Table 4.3: Climate-related Disasters in Mombasa City, Kenya

Climate-related disasters: typology, trends, and impacts				
Disaster type	When it is/was experienced	Established incident rate or return period	Impact profile: who/what was affected most and quantity/extent of damage	Remarks
El Niño	1947 1961 1997	Approximately five years	<ul style="list-style-type: none"> Houses destroyed Property lost Livestock and crops lost Human lives lost Increased incidence of disease (cholera & typhoid) 	Most affected areas are estates located near the ocean that either lack or have poor drainage structures or systems.
Floods	Frequently (almost annually)	Unpredictable	<ul style="list-style-type: none"> Houses destroyed Property lost Livestock lost (all types) Human lives lost Increased incidence of disease (cholera, typhoid) 	Most affected areas are estates that either lack or have poor drainage structures or systems.
Tsunami	2006	Unpredictable	<ul style="list-style-type: none"> Several fishing boats reportedly destroyed 	One human life reportedly lost.

Continued overleaf

23. The Daily Nation Newspaper (2007), "Kenya: climate change fuelling conflicts", Nairobi, May 8.

Drought	2005/6	Every 4–5 years	<ul style="list-style-type: none"> All agricultural activities are affected Women spend more time looking for water 	As time is spent looking for water, other activities suffer from time allocation. Droughts also cause famine.
Hunger/famine	Every year	Every year	<ul style="list-style-type: none"> Loss of human lives from starvation (not quantified) Gross malnutrition and underfeeding leading to poor economic productivity 	Effects are felt across all age groups and gender.

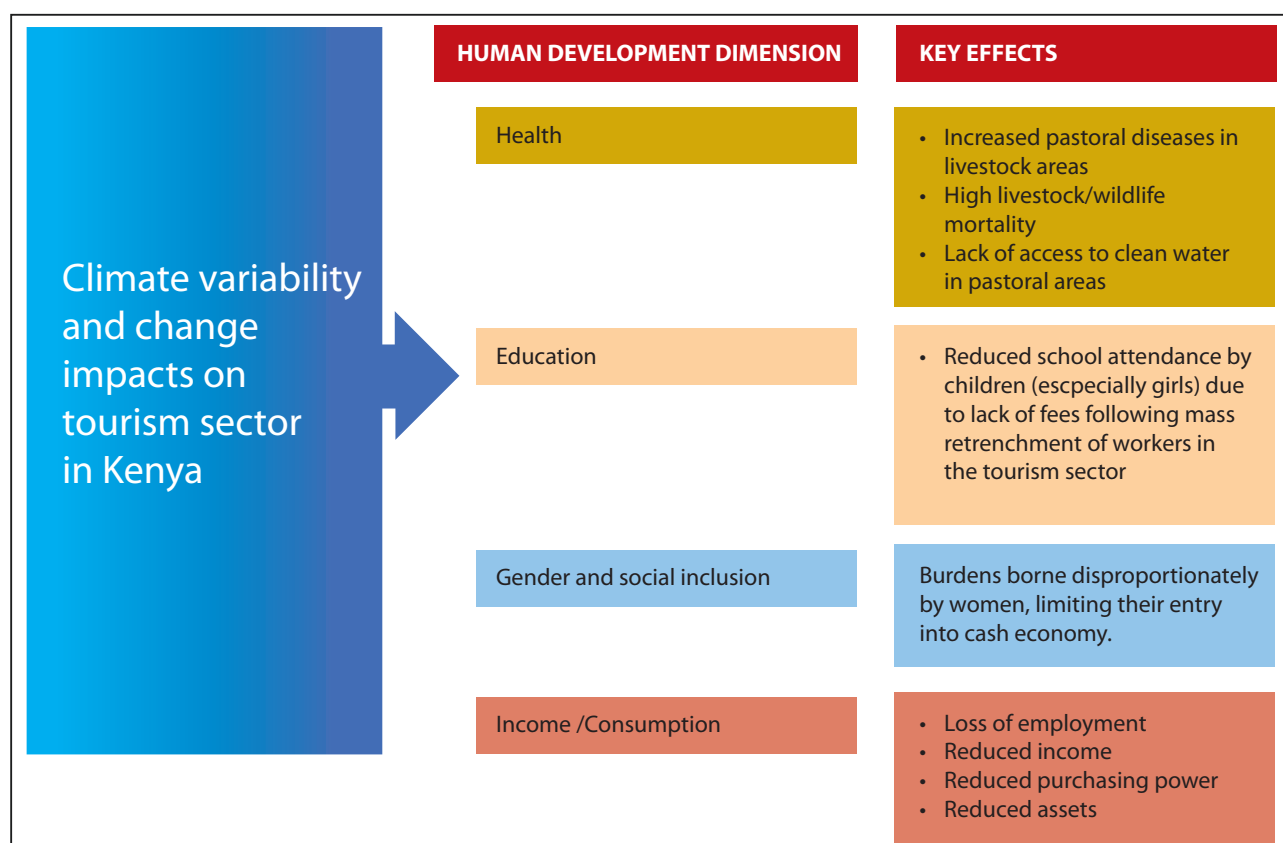
4.8 The Link between Climate Variability and Change Impacts on the Tourism Sector and Human Development

As described earlier, there is a direct link between climate variability and change impacts on the tourism sector in Kenya and human development dimensions. This is summarised in Fig. 4.1.

Climate variability and change will severely affect wildlife habitats in Kenya. These habitats are already witnessing high mortality of wildlife due to diminished food resources and water, and emerging diseases that threaten to decimate wildlife population. Lack of clean water in these areas has often led to waterborne disease outbreaks such as cholera, which is a health risk factor among the pastoralists who inhabit these habitats. The pastoral

communities living adjacent to these wildlife habitats are thus caught up in this web. Their livestock often graze within these wildlife habitats and easily contract these diseases, whose impact has been witnessed in terms of high mortality rates among the livestock. The consequence of this has been a threat to the livelihood foundation of pastoral communities. As a result of the expected high wildlife mortality, most game reserves and national parks will witness reduced numbers of tourists visiting them. This will result in massive closures of hotels and lodges and the attendant loss of employment. The mass layoffs of employees in this sector will mean loss of income and hence inability of these former employees to meet their basic financial obligations that support human development (e.g. inability to educate their children, acquire assets, and feed the family, among others).

Figure 4.1: Climate change impacts on tourism and implications on human development



Source: Author's own conceptualisation

4.9 Adaptation and Mitigation to Climate Change in Kenya's Tourism Sector

Countries like Kenya, where tourism depends to a high degree on natural heritage and biodiversity, are highly vulnerable to the consequences of climate variability and change. It is not difficult to imagine how increased climatic variability may exacerbate tourism volatility (for example, droughts that may affect tourists' visits to Maasai Mara game reserve, among others). Changing climate and weather patterns at tourist-generating and destination countries can significantly affect tourists' travel decisions. While the tourism sector is affected by climate change, it is also a significant contributor to climate change, mainly through greenhouse gas (GHG) emissions generated mostly through the transportation of tourists and their energy consumption at destination points (Table 4.2). Some estimates have noted that the tourism sector contributes 5% to the global CO₂ emissions; therefore, it is imperative for the sector to respond to climate change within the evolving national responses (National Climate Change Response Strategy and National Climate Change Adaptation Plan), thus progressively reducing its carbon footprint so as to grow in an environmentally sustainable manner. Four major mitigation strategies for addressing the emissions of GHG in the tourism sector can be distinguished (Steyn and Spencer, 2012):

- **Reducing energy use** is the most essential aspect of mitigation, which can be achieved by altering destination development and marketing (tour operators), destination choices (tourists), as well as shifts in transport from car and aircraft to rail and coach. Tour operators could also increase lengths of stay, which would effectively reduce the carbon footprint per tourist day. However, there is a trend toward shorter and more frequent holidays, which has to be addressed. Regarding aviation, the industry favours emission trading over the taxation of fuel emissions (UNWTO, 2007b). More efficient technology would have to be introduced faster, but the prices of airline tickets could increase substantially to offset the costs of replacing older aircraft with newer, more fuel efficient models.
- **Improving energy efficiency** can also decrease energy demand. New technology in aviation could lead to reductions in emissions per kilometre of travel by 32% between 2005 and 2035 (Peters et al., 2006), while new technology in car transport has a potential of reducing 7% of all tourist emissions of CO₂ (UNWTO, 2007b).
- **Increasing the use of renewable energy in tourism.** Virtually all sources of renewable energy are relevant for tourism: wind, water, photovoltaic, solar, geothermal, biomass, and energy regeneration from waste. This approach appears to be specifically significant for island destinations, where energy supplies based on fossil fuels are expensive to acquire and maintain.
- **Sequestering carbon through sinks** is another option. CO₂ can also be stored in biomass (for example, through forestation and avoiding deforestation), in aquifers or oceans, and in geological sinks (for

example, worked-out mines). Within the tourism industry, this is currently practised through carbon compensation or carbon offsetting, which means that the amount of GHG emissions equal to that caused by a certain activity (for example a flight) will be reduced elsewhere through planting of additional trees (Becken and Hay, 2007).

Regardless of the success in reducing GHG emissions by the international community, there will undoubtedly be costs associated with adaptation to climate change. These costs cannot be borne solely by those affected, that is, the tourist and local population benefitting from tourism. The capacity of the tourism sector to adapt to climate change is thought to be relatively high due to its dynamic nature, and therefore there will be important opportunities for tourism to reduce the vulnerability of communities to climate change (UNWTO, 2007b). Mather et al. (2005) summarise a number of options available at different types of tourist destinations to deal with the effects of climatic change:

Coasts, beaches, and islands

Protecting the coast and its hinterland requires three categories of strategies; Protect, Accommodate, and Retreat. All three need to be considered in the broader context of coastal management. Measures to do this include timely identification and mapping of potential risk areas, building of sea wall defences and breakwaters, and enhancement and preservation of natural defences, such as preservation of mangrove swamps.

4.10 Opportunities that could be Harnessed

The tourism industry is neither a victim nor victor of climate change. If tourism was to flourish at projected rates, action must be taken to safeguard the environment and resources upon which tourism depends by embracing sustainable tourism. To further enhance this, the government has been urged to review weak environmental laws that had failed to safeguard key ecosystems from over-development, and to provide incentives for individuals and communities to conserve areas outside protected areas and to embrace sustainable technologies.

Climate change provides an opportunity for the Government to come up with policies that address sustainable tourism development, fragmentation in the tourism industry, lack of investment capital to drive change in technology, and loss of species that would threaten any action taken to address impacts of climate change. Perhaps, the formation of private-public-civic sector partnership is one way to gain momentum in creating awareness and to push for practical actions by key organisations in private and public sector. Such partnerships would ensure the attainment of the "quadruple bottom line" of environmental, social, economic, and climate responsiveness in tourism development.

For an industry that depends on climate as a resource, the stakes are high and lip service is not an option. Impacts of climate change like melting snow on mountain, water scarcity, flooding, mudslides, rising sea levels, loss of species, and coral bleaching, are being experienced in Kenya. A combination of regulatory and voluntary actions is required to address these impacts. The government must give high priority to the environment

For an industry that depends on climate as a resource, the stakes are high and lip service is not an option. Impacts of climate change like melting snow on mountain, water scarcity, flooding, mudslides, rising sea levels, loss of species, and coral bleaching, are being experienced in Kenya.



Coral Reef, Indian Ocean, Kenya.
Pic: Shutterstock

The sector's current strength is mainly based on Kenya's natural attractions, which include wild game. However, climate variability and climate change, partnered with broader environmental degradation, has the potential to significantly affect this vision for the tourism sector. Change in biodiversity will likely affect the tourism industry, which is a major foreign exchange earner for some of the countries like Kenya

(Huq and Reid, 2002)

in its development plans. It must develop policies to safeguard the environment and support industry's mitigation and adaptation strategies. The tourism industry must rethink the packages they offer and ensure they minimise overall carbon footprints of a holiday. This will require that they rethink activities, itineraries, the destinations they promote, and the product. The country and industry must think mitigation and adaptation.

Tour operators need to influence the destinations/products they sell to adapt cleaner and greener technologies, to save energy and water, to embrace energy efficient travel, to design more energy efficient activities and to conserve the areas in which they operate. They need to encourage low-energy tourist activities, design long-stay tours to reduce between site travels, diversify activities/destinations to spread impacts, support creation of new conservation areas, provide carbon-offset opportunities for travellers, and influence policy. They can do this by consciously selecting

to promote destinations that are managed and developed in a sustainable way, by educating travellers to make informed choices on destinations, by presenting accurate information on destinations, and by promoting properties that show commitment to environmental conservation and social responsibility. Industry associations too have a role. In Kenya, there are more than 2000 registered tour operators. Of these, about 250 are members of the Kenya Association of Tour Operators (KATO). Other associations representing tour operators' interest include Mombasa and Coast Tourism Association (MCTA), and the newly registered Kenya Association of Local Tour Operators (KALTO). Ecotourism Kenya accepts membership from tour operators who commit to sustainable tourism. Traditionally, associations are service organisations with codes of conduct to guide member activities. The secondary role of associations is to lobby governments for favourable policies that recognise the significance of tourism as an economic activity and support the growth of the sector.

However, climate change will require associations to move beyond their traditional roles to supporting members to mitigate and adapt to climate change. The first step is to create awareness and conduct studies to determine the carbon footprint of the sector. The second step is to come up with strategies for mitigation and adaptation to climate change. Third, is to lobby the government to commit to sustainable development and allow the industry to self-police development and activities of tour operators through the associations. Last but not least, the associations need to enter into partnerships on behalf of their members, with credible organisations for management of carbon-offset programmes. In brief, the associations and tour operators cannot ignore climate change, as was the case with sustainable tourism.

4.11 Conclusion

The tourism industry forms a vital part of Kenya's economy—one that is expected to grow, as the country aims to become one of the top 10 long-haul destinations in the world (GOK, 2008). Achieving this goal will be challenged by climate risks that include the loss of tourism attractions such as coral reefs, coastal beaches, and Mt. Kenya's glaciers; changes in wildlife migration patterns and species diversity; damage to infrastructure; water restrictions; and higher demand for air conditioning. The government has called for the development of a national wildlife adaptation strategy to help better understand the risks facing this industry (GOK, 2010).

Tourism should be harnessed as a vehicle for the expansion of local employment and poverty reduction – one that takes into account equity and equality considerations, including gender empowerment dimensions, which are very critical for human development. For Kenya, endowed with natural resources and biodiversity backed by a rich culture and the peace dividend, the potential is enormous. The promotion of the sector should be ambitious, while maintaining the equilibrium of ecosystems and reducing the sector's vulnerability to the adverse effects of climate change. These actions would contribute toward the country's attainment of the related Millennium Development Goals and Kenya Vision 2030.

Kenya's economy and people are vulnerable to climate-related risks due to their high degree of dependency on natural resources. In particular, the tourism sector is adversely affected. Historically, this dependency has led to climate hazards, which has significant adverse economic consequences, in addition to the loss of human lives and tourism attraction habitats. Projections suggest that these negative consequences will increase in the future due to climate change. The additional economic cost of climate change, over and above current losses due to climate variability, could equal 2.6 per cent of GDP each year by 2030— not taking into account the cost of future extremes (floods and droughts) and potential effects on ecosystem services (SEI, 2009, p. iii). The implications of this projection for achievement of Kenya's development goals as articulated in Vision 2030 are profound and suggest the need to directly address the country's sources of vulnerability, and improve management of current and future climate risks.

The sector's current strength is mainly based on Kenya's natural attractions, which include wild game. However, climate variability and climate change, partnered with broader environmental degradation, has the potential to

significantly affect this vision for the tourism sector. Change in biodiversity will likely affect the tourism industry, which is a major foreign exchange earner for some of the countries like Kenya (Huq and Reid, 2002). The magnitude of potential impacts cannot be ignored. All levels of government would be wise to analyse the situation and to develop planning and development guidelines to sustain the tourism industry in the best possible way, and to guide urban and resort development in high risk areas. Perhaps an item that should be high on the agenda in this sector is an economic analysis of the myriad potential consequences of a changing climate on this sector, and how these impacts might be ameliorated. Greater understanding is needed of possible changes in habitat distribution, composition and function, wildlife abundance and migration patterns, and tourism demand. Completion and implementation of the national wildlife adaptation strategy should contribute to achieving this agenda item. In addition, research should be conducted on how Kenya's coastal areas could be affected by climate change, including the impact of sea-level rise on the loss of low-lying areas, salt-water intrusion into freshwater resources, and damage from storm surges. Additional analysis of potential impacts on coastal resources such as coral reefs and inshore fisheries would also enhance capacity to manage climate risks.

Climate change provides an opportunity for the government to enact legislation that supports mitigation and adaptation strategies in this sector in order to realise sustainable tourism. Tour operators have played and continue to play a critical role in the growth of international tourism by linking suppliers to consumers (travellers). As intermediaries, tour operators serve to improve the flow of information between principles and consumers. They provide expert product knowledge and advice to consumers, they offer customers greater choice through aggregation of products and services, they attract consumer confidence by acting as guarantee for service, and are therefore seen as reducing consumer risk. Ideally, tour operators assemble the main elements of a holiday and sell it to a consumer. Climate change debates have exposed impacts of tour operations that were hitherto invisible like transport and energy, and which have a direct implication on global warming. Energy use contributes more than 40% of greenhouse gases, while air transport contributes 5% of greenhouse gases. As tourism grows, the contribution of air transport to greenhouse gases will increase significantly since moving people is a key role of tour operators. Tour operators move people on-site, to site/destination, and between sites. This movement requires some form of motorized equipment/ vessels, which depend on energy. This makes tour operations a high-energy business. Thus, tour operators have an opportunity to sell products that contribute towards minimizing the carbon footprint of the tourism sector.

5 HUMAN HEALTH

Key messages

1. Although globally there are uncertainties about the actual magnitude of climate change, there is now evidence that climate change is real and has affected and continues to affect some human health outcomes which impact negatively on human development.
2. Developing countries such as Kenya are more vulnerable to climate-induced diseases such as malaria, whose geographic distribution is shifting as a result of changing weather patterns which expose some regions to unprecedented health risks. This problem is further compounded by a weak public health infrastructure and high poverty levels among some segments of the population.
3. The current and future adverse impacts of climate change on human health can be reduced through adaptation and mitigation strategies. In Kenya, health is a key component of the social pillar of the Vision 2030 government blueprint. However, despite the efforts which are being made by the health sector, challenges related to paucity of financial, physical and human resources continue to slowdown the progress towards achieving the set health goals.
4. In dealing with the challenges noted above, the new government is keen to meet the expectations of its people by raising the level



of economic and social development within a devolved system of governance. Health services have been devolved to counties and greater efforts should be directed towards embracing opportunities available both nationally and internationally for climate change mitigation and adaptation, particularly with the objective of reducing vulnerability to climate-related disease burden in the country.

5.1 Introduction

This chapter aims at analysing the linkages between climate change, health, and human development. It addresses the issue of vulnerability to increasing climate induced health risks as well as an overview of the salient adaptation and mitigation measures. The chapter also looks at the challenges and opportunities associated with climate change adaptation and mitigation in Kenya.

The preamble to the World Health Organization (WHO) constitution defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (WHO, 1948). It is an important attribute of well-being and a determinant of sustainable human development, hence its inclusion in the Human Development Index (HDI).

Globally, there is growing interest on the subject of climate variability and change and health, mainly due to uncertainties such as:

- The extent of climate variability and change;
- The local and regional impacts of climate variability and change; and
- How humans will adapt to and mitigate impacts of climate change.

Despite the above uncertainties, however, it is now widely acknowledged that climate change is a challenge of the 21st Century which needs to be addressed in order to avert an immediate threat to human development and for the future generation (UNDP, 2007). Although the current evidence provided by climate science does not fully and correctly predict the magnitude of impacts of climate change, it nonetheless points to the likelihood of impact on six existing broad health concerns particularly in developing countries:

- Health effects related to extreme weather events;
- Cardio-respiratory diseases;
- Temperature related health effects;
- Malnutrition;
- Waterborne diseases; and
- Vector borne diseases.

5.2 Climate Change, Health, and Human Development

There are intrinsic links between climate change, human health, and sustainable development. Climate change, in all its manifestations, will expose populations to changing patterns of climate-sensitive health risks and also affect health determining sectors such as agriculture and water (Box 5.1).

Globally, there is evidence that average temperatures have been rising over the last 50 years mainly due to increased emissions of anthropogenic greenhouse gases. The resultant global warming has had, and will continue to have, negative health effects on humanity in both developed and developing countries. However, due to high levels of poverty and poor public health infrastructures, developing countries particularly in Sub-Saharan Africa will be more at risk. About 25 per cent of the total burden of diseases worldwide is caused by environmental hazards and as many as

13 million deaths per year can be prevented by keeping a healthier environment (UNEP, 2010). The biggest chunk of this disease burden is borne by developing countries. These countries are also the most vulnerable to extreme weather events such as prolonged droughts and floods which bring in their wake many waterborne and vector borne diseases. Malaria, for example, is one disease which is of major concern in Africa. It kills over 800,000 children under the age of 5 in Sub-Saharan Africa, making it the third largest killer of children in the world (UNDP, 2007). Thus, climate change threatens to exacerbate inequities both between nations and between and within communities, with the severest impacts being felt by children, the poor and women.²⁴ The other category of the population at risk are slum dwellers in urban areas mainly in low and middle income cities.

Global climate change affects human health through complex pathways of diverse complexity and scale and with different timing (McMichael, 2003). The impacts of climate change vary geographically in accordance

Box 5.1: Climate Change and determinants of health: facts and figures

Air

Extremely high air temperatures can kill directly. It has been estimated that more than 70,000 deaths occurred in the extreme heat of summer 2003 in Europe. By the second half of this century, such extreme temperatures will be the norm. In addition, rising air temperatures will increase levels of important air pollutants such as ground-level ozone, particularly in areas that are already polluted. Urban air pollution currently causes about 1.2 million deaths each year, mainly by increasing mortality from cardiovascular and respiratory diseases.

Water

Shifting rainfall patterns, increased rates of evaporation and melting of glaciers, combined with population and economic growth, are expected to increase the number of people living in water-stressed water basins from about 1.5 billion in 1990 to 3–6 billion by 2050. By the 2090s, climate change may bring a doubling in the frequency of extreme drought events, a six-fold increase in mean duration, and a 10–30-fold increase in the land area in extreme drought. Almost 90% of the burden of diarrheal disease is attributable to lack of access to safe water and sanitation. Reductions in the availability and reliability of freshwater supplies are expected to amplify this hazard.

Food

Increasing temperatures and more variable precipitation are expected to reduce crop yields in many tropical developing regions. In some African countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020. This is likely to aggravate the burden of under nutrition in developing countries, which currently causes 3.5 million deaths each year, both directly through nutritional deficiencies and indirectly by intensifying vulnerability to diseases such as malaria, and diarrheal and respiratory infections.

Shelter

By the second half of this century, climate change is projected to cause a several-fold increase in the frequency of extreme storms, heavy rainfall and heat waves. In the absence of improvements to protection, sea level rise could also multiply the number of people exposed to coastal flooding more than 10-fold, to more than 100 million people a year, by 2080. These trends will also increase the hazards of weather-related natural disasters, which killed approximately 600,000 people during the 1990s. Repeated floods and droughts may force population displacement – which, in turn, is associated with heightened risks of a range of health effects, from mental disorders such as depression to communicable diseases and, potentially, civil conflict.

Freedom from disease

Rising temperatures, shifting rainfall patterns and increasing humidity affect the transmission of diseases by vectors and through water and food. Vector-borne diseases currently kill approximately 1.1 million people annually while diarrhoeal diseases are responsible for 2.2 million deaths.

Source: WHO (2009), *Protecting Health From Climate Change: Connecting Science, Policy and People*.

24. WHO (2011), *Gender, Climate Change and Health*, Geneva, World Health Organisation.

with topography, the environment and the degree of vulnerability of the local population. Climate variability and change affects natural processes such as temperature and rainfall which in turn lead to heightened incidence of diseases (Fig. 5.1).

In order to attain meaningful human development, good health is essential. Furthermore, good health enables people to alleviate poverty. Bloom and Canning (2000) show that improvements in health would move 30 million people out of absolute poverty globally by 2015. There are also socio-economic benefits to be derived from addressing climate change related morbidity and mortality. The social benefits include alleviation of the costs of human suffering due to illness, and also of death. The economic benefit would include higher incomes due to good health and release of resources devoted to public health to other social sectors such as education which is a catalyst for human development.

Climate change affects human health in different ways, both directly and indirectly. Some of the direct effects include health consequences of extreme weather events such as heat waves and floods, while indirect effects include transmission by disease carrying vectors and parasites such as mosquitoes. For human health to be sustained, there are a number of prerequisites such as fresh air, clean water, nutritious food, tolerable temperatures as well as high levels of biodiversity, and ecosystem balance. People also need shelter in secure and viable human settlements in both rural and urban areas. To the extent that climate variability and change negatively impacts these determinants of well-being, human health will be similarly affected.

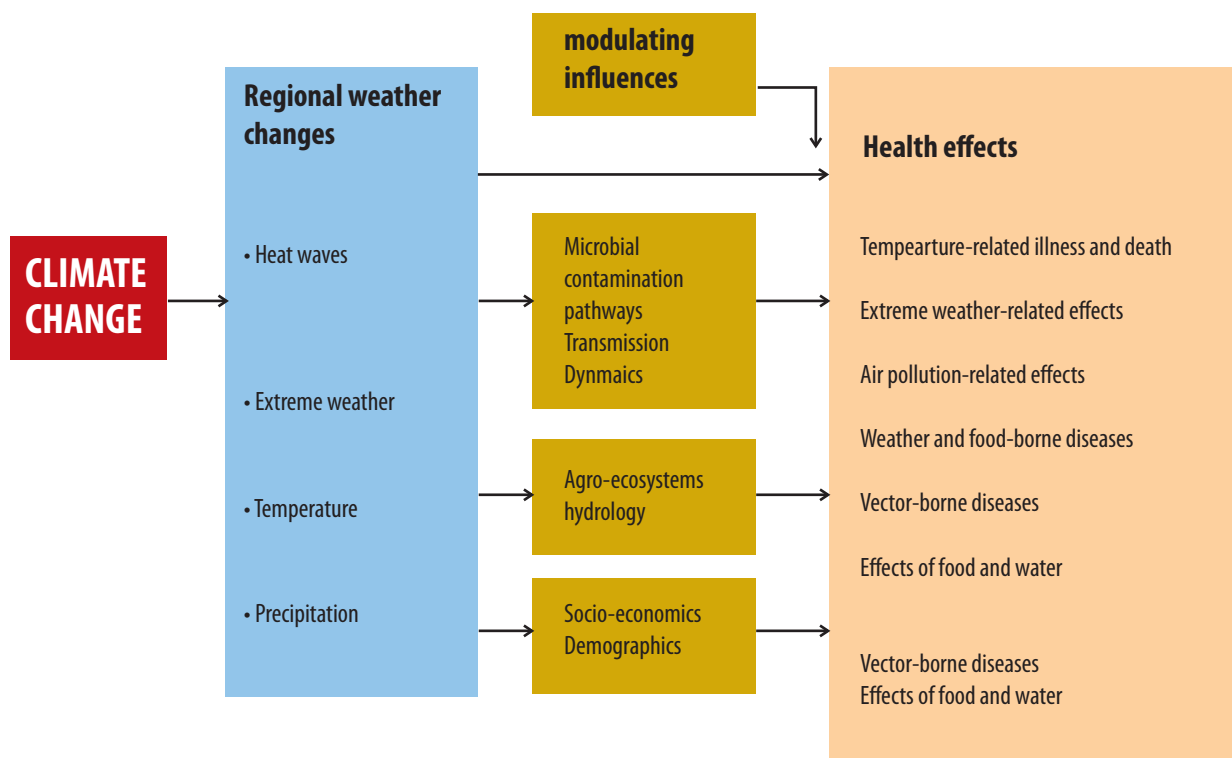
The decline in agricultural productivity due to frequent climate-driven droughts, for example, means that, in a country like Kenya where the majority of small-scale subsistence farmers depend on rain-fed agriculture, many rural households will be exposed to high levels of malnutrition which is particularly detrimental to maternal and child health.

The occurrence of floods aggravates water-borne diseases such as cholera, bilharzia, and other diarrhoea diseases while air pollution originating from manufacturing processes and from smoke caused by wild forest fires as well as from indoor smoke pollution, are responsible for respiratory and cardiovascular diseases. As climate continues to change, increased respiratory allergies from pollens and spores in the air accentuate respiratory and cardiovascular diseases. Overall, the poor state of health occasioned by climate-induced infectious and other diseases will reduce immunity and make the people susceptible to other non-communicable diseases such as diabetes and even HIV/AIDS.

5.3 The State of Human Health in Kenya

Kenya, with an estimated population of about 43 million, has inadequate medical facilities and personnel to serve the growing number of the sick especially in rural areas where nearly 80 per cent of the population reside. According to Economic Survey 2013, the number of health institutions in the country increased from 8,006 in 2011 to 8,375 in 2012 including small dispensaries, health centres, sub-district and district hospitals, and provincial hospitals.

Figure 5.1: Pathways through which climate change affects human health



Source: Kenya State of Environment Report: 2010

The provincial distribution of health institutions reveals that Rift Valley had 2,166 health institutions or nearly 25.9 per cent, Eastern had 1,548 or 18.5 per cent, and Central 1,438 (17.1 per cent). On the other hand, Nyanza had 965 or 11.5 per cent, Coast 873 (10.4 per cent) while Western and Nairobi had 532 and 562 just about 6.4 per cent and 6.7 per cent respectively. North Eastern Province had the least at 291 or 3.5 per cent.

The data shows that, despite the effort by the Government to improve the health status of the people, there are still notable disparities in public health facilities which do not foster equitable access to health services.

With regard to staffing, there were only 19 doctors and 267 medical personnel per 100,000 people in 2012. Expenditure on health is about 5 per cent of GDP and about 12 per cent of the government expenditure on social services (GOK, 2012a). In 2010, public health expenditure amounted to 7.3 per cent of total Government expenditure (World Bank, 2012). This proportion falls short of the 15 per cent recommended by the African Union (AU) through the 2001 Abuja Declaration. This level of investment in health services is inadequate given the huge disease burden especially among the poor households in rural and slum settlements in urban areas. This is despite the provision in the new constitution²⁵ that every person has the right "to the highest attainable standard of health, which includes the right to health care services, including reproductive health care".

An examination of the available health indicators from Threshold 21 database, such as infant mortality and life expectancy between 1980 and 2010, show erratic trends as shown below. Between 1980 and 1990, there was a steady decline in infant mortality which was followed by a rise which peaked at 70.5 deaths per 1,000 live births in 2000 before dropping to 63.9 and 57.2 in 2005 and 2010 respectively. The life expectancy trend displays similar features and is symptomatic of a population with a low level of human development.

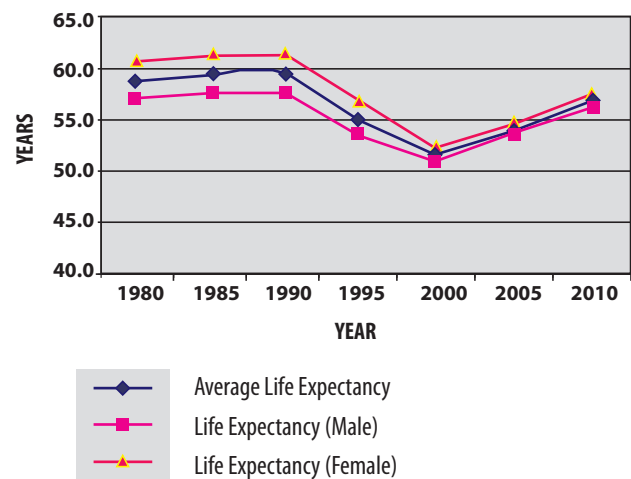
The health sector is one of the key sectors under the social pillar of Vision 2030 and is also responsible for achieving three of the Millennium Development Goals, namely reduction of infant and child mortality (MDG goal 4), reduction of maternal mortality (MDG goal 5) and combating HIV/AIDS, TB, malaria and other diseases (MDG goal 6).

According to the Third Annual Progress Report²⁶ on the implementation of the first medium term plan of Vision 2030 (MTP), the set targets remained largely unmet. During 2010/11, under-5 mortality remained at 74 per 1,000 live births against a target of 45 while maternal mortality stood at 414 per 100,000 against MTP target of 200. Immunization coverage fell short by 7 percentage points from a target of 90. However, moderate gains were made in the fight against malaria and in reduction of HIV/AIDS prevalence. The in-patient rate for malaria victims fell from 30 to 14 per

cent, slightly missing the MTP target of 13 per cent. During the review period, HIV/AIDS prevalence rate fell from 7.4 per cent to 6.3 against a target of 6.4 per cent. However, wide regional disparities remained with Nyanza remaining high at 13.9 per cent and North Eastern, the lowest at 0.9 per cent.

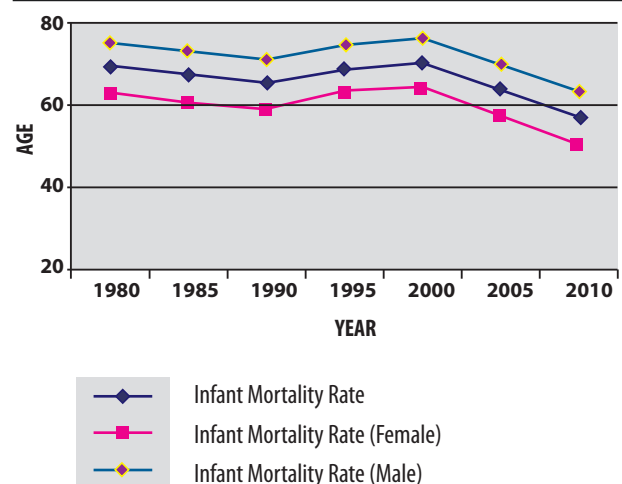
The statistics presented above show that the health sector is beset by a variety of challenges including inadequate health staff, low funding, and generally an inadequate and fragile infrastructure which can hardly deliver the medical and public health services that most of the poor Kenyans need. With the expected complication of climate variability and change, more effort particularly with regard to funding is needed. The problem becomes even more daunting with the advent of devolution in 2013, after the first general election under the new constitution, where counties are supposed to be responsible for their own health services.

Figure 5.2: Life Expectancy: Male-Female and average, both sexes



Source: Kenya Threshold 21 Database 2011

Figure 5.3: Infant Mortality (Male, Female and both sexes)



Source: Kenya Threshold 21 Database 2011

25. The Constitution of Kenya, 2010: Article 43 (1) (a)

26. GOK (2012), Third Annual Progress Report 2010-2011 on the implementation of the first Medium Term Plan 2008-2012 of Kenya Vision 2030, April 2012.

Devolution of health services to county governments in line with the 2010 Constitution is expected to bring services closer to the people who need them most. Vision 2030 also envisages greater emphasis on promotion of preventive health services to reduce the burden of curative medical services. This strategy would work well if local communities are involved through training and advocacy and the necessary social safety nets promoted to help the poor and the aged access health care.

5.4 Vulnerability to Climate-induced Health Risks

Depending on where and how people live, some populations will be more vulnerable to the effects of climate variability and change and will suffer worse impacts. IPCC, in its fourth assessment report in 2007, identifies regions and populations at particular health risks such as:

- Areas at risk from combined climate impacts relevant to health like stress on food and water supplies, and risk of inland and coastal flooding.
 - Areas or population within or bordering regions which are highly endemic to infectious diseases such as malaria.
 - Areas with an observed association between an epidemic disease and extreme weather events, for example, El Niño-linked epidemics (Box 5.2).
 - Areas at risk from concurrent environmental or socioeconomic stresses and with little capacity to adapt, for example, local stress from land use practices or impoverished or underdeveloped health infrastructure.
- Such events like changes in river flows, increase in droughts and floods, decreased food security and biodiversity loss are especially of concern to Sub-Saharan Africa.

Young girls in North Eastern Kenya going to fetch water. The poor are the most vulnerable to the impacts of droughts including ill health.



Box 5.2: Health consequences of El Niño-induced floods in 1997/1998

Unusually high rainfall in East Africa, associated with ENSO-related Pacific and Indian Ocean sea surface temperature (SST) anomalies, coincided with major epidemic outbreaks between 1950 and 1998. El Niño of 1997/98 was particularly acute by affecting over 1.5 million people in four East African countries, including Kenya, and the capacity restraints on health resources as a result, led to over 3 million families suffering from poor health. Fifty three (53) fatalities were accounted for in Kenya (Otiende, 2009). Morbidity patterns reveal that over 60% of the top 10 diseases in Kenya are waterborne or sanitation-related; malaria accounts for about 32.2%, and diarrhoea and intestinal worms account for 17% (Ongeri, 2002). Consequently, there was an upsurge in these diseases following the floods. Environmental diseases such as typhoid, amoeba, cholera, and bilharzias normally associated with contaminated water and poor sanitation reached epidemic levels in areas where water and sanitation facilities were destroyed, forcing communities to obtain water from unsafe water sources (unprotected wells, rivers, ponds, lakes, and rainwater). Damage to health facilities disrupted the delivery of quality health care services at a time when there were epidemics of both water-borne and vector-borne diseases. Food shortage had a major effect on the health of children less than five years old, as shown by the prevalence of delayed malnutrition disorders such as kwashiorkor and marasmus. In some districts, for example Tana River, Garisa, and Lamu, cases of marasmus soared for several months after El Niño floods. Hospitalisation and treatment costs of water-borne diseases arising from El Niño-induced floods were estimated at \$56 million (World Bank, 2006).

Kenya generally has a good tropical climate. It is hot and humid at the coast and in parts of the Lake Victoria basin, temperate in inland highlands, and very hot and dry in ASALs which are located in North Eastern and some parts of Eastern and Rift Valley Provinces. It has a bimodal rainfall system with the long rains season between March and May (MAM) and the short rainy season between September and November (SON). The country is prone to cyclical droughts and floods whose frequency and intensity is likely to be accentuated by climate change. Drought is the most common natural hazard with almost 70 per cent of the country being at

risk (UNDP, 2010b). The other climate sensitive diseases include diarrhoea, hepatitis A, and typhoid fever, as well as vector borne diseases such as malaria, dengue, and Rift Valley fevers.

The current epidemiological profile indicates that there is a big burden of existing climate-sensitive diseases. This burden is expected to worsen with future climate variability and change. The magnitudes of the diseases will increase as well as their geographical distribution. Climate change will also affect some of the vectors and parasites and result in new strains and new breeding habitats as has already been observed in the case of mosquitoes. Malaria is a major vector-borne disease which is highly debilitating and one of the main causes of death in Kenya. According to KEMRI estimates, 25 million people are at risk. Further, at any time, malaria accounts for between 30 and 50 per cent of outpatients in health facilities and about 20 per cent of admissions.

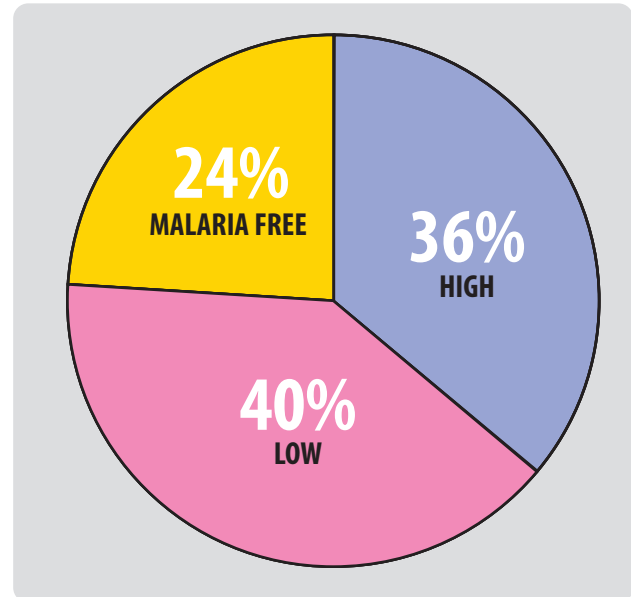
Out of a projected population of nearly 41 million in 2010, 14.6 million or 36 per cent had one or more cases while 16.2 million or 40 per cent had up to one case leaving only 24 per cent of the population as malaria free (Fig. 5.4).

According to the 2010 Kenya Malaria Indicator Survey (KMIS) malaria is the leading cause of morbidity and mortality in the country and combating the disease is one of the major public health objectives. The eco-epidemiology of malaria is stratified in four zones which generally follows climatic zones:

- Endemic Zone: Covers areas with altitudes of up to 1,300 meters

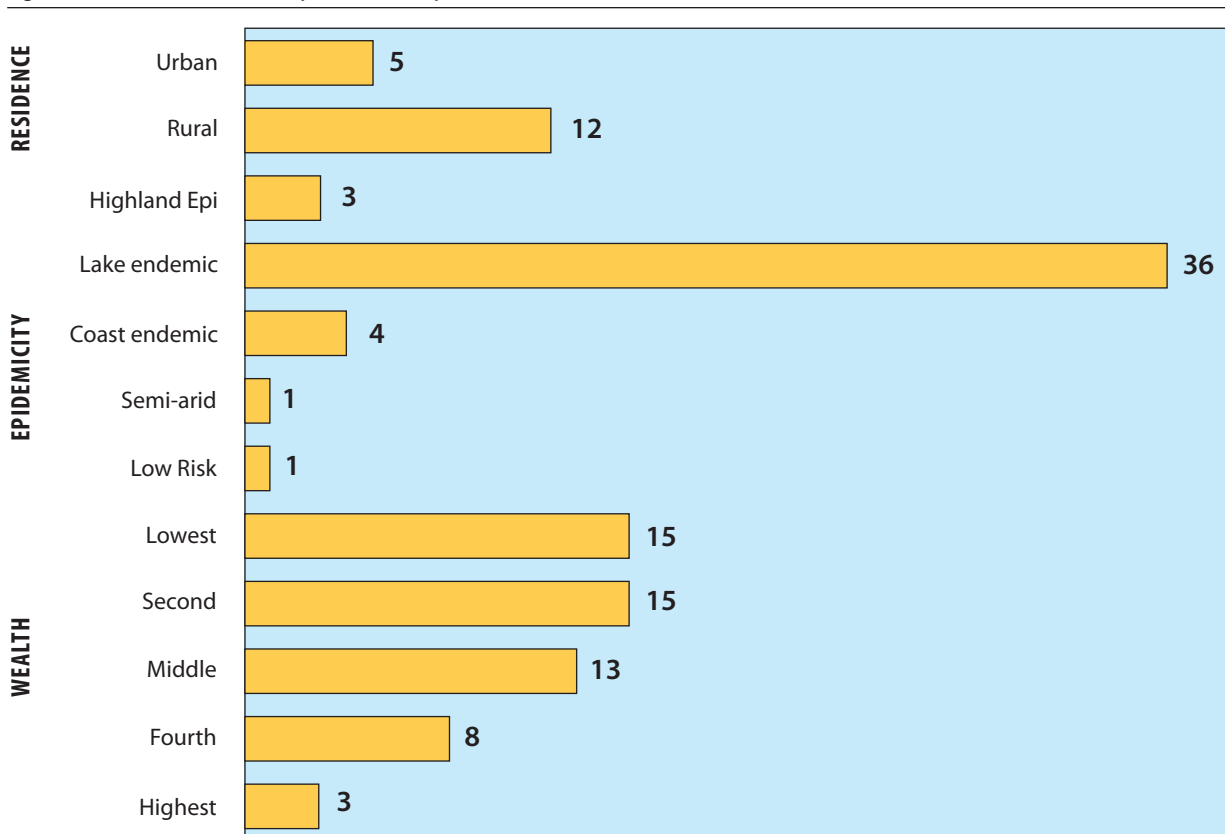
around the Coast and the Lake Victoria Basin. In this zone, rainfall, temperature and humidity are the determinants of perennial transmission with prevalence rates as high as 38 per cent in Lake endemic area and as low as 4 per cent in the coastal endemic area (Fig. 5.5).

Figure 5.4: Malaria transmission rates per thousand people



Source: UN Population Division, 2011

Figure 5.5: Differentials in malaria prevalence, Kenya, 2010



Source: Kenya Malaria Indicator Survey 2010

- Highland epidemic prone zone: In this zone, transmission is seasonal and with substantial year to year variability. The main determinant factor is increase of minimum temperature to around 18°C especially during the long rains season. Vulnerability in this zone is high and fatalities during an epidemic can be up to ten times higher than in the endemic zone.
- Seasonal malaria transmission areas: This zone covers ASALs of northern and south-eastern Kenya. The areas experience short spans of intense transmission during the rainy season. Extreme weather events such as flooding leads to epidemics which result into high morbidity due to the low level of immunity.
- Low risk malaria areas: These areas include the central highlands and Nairobi. The temperatures are too low to allow breeding of mosquitoes although climate change is changing this scenario.

As temperatures rise and rainfall patterns become more erratic, it is expected that the Kenyan highlands, which have been relatively malaria-free, will be exposed, while the lowlands, where the disease is endemic, are likely to have reduced malaria prevalence. Indeed, some research studies (such as Wandiga et al., 2006) have shown the existence of highland malaria in Kenya, Uganda, and Tanzania. People in these areas are particularly vulnerable to malaria due to low levels of income, lack of information about malaria and its treatment, and lack of proper curative drugs and preventive insecticide treated nets (ITNs) in local public health centres. According to KMIS, there was only one net for every 5 persons at the risk of malaria in 2010.

The other category of climate-sensitive diseases are water and food-borne such as diarrhoea, cholera, and bilharzia. These ailments become particularly rampant during periods of high rainfall and floods, and are quite prevalent in western Kenya and the Lake Victoria Basin. Diarrhoea diseases affect mainly children under 5 as well as people living in poor sanitary conditions, and are a major cause of death. IPCC predicts, with a 50 per cent certainty, that climate change increases the burden of diarrhoea diseases. Globally, diarrhoea is estimated to kill 1.5 million children each year. 88 per cent of these deaths are attributed to faecal contamination due to poor sanitation and water problems (WHO, UNICEF, 2010). In Kenya, it is estimated that a child dies every 15 minutes due to diarrhoea (MOH, 2008) which translates to nearly 40,000 deaths per year.

Rising annual temperatures also lead to increased prevalence of respiratory and cardiovascular diseases which are also affected by air pollution. This class of diseases includes asthma, respiratory allergies, and occupational lung diseases. According to WHO estimates in 2007, there were 300 million people with asthma globally, most of whom were in low and middle income countries. The most vulnerable people are children, women, and the elderly- particularly the poor.

Persistent droughts result in famines during which many people in the affected areas suffer malnutrition due to low food intake. This dietary condition is particularly prevalent among young children and lactating mothers, leading to increased maternal and child morbidity and mortality. According to 2012 World Vision International report, close to 500,000 children under the age of 5 are currently affected by acute malnutrition in Kenya, and that the trend is rising. The most affected are the drought-prone

areas of Turkana, Marsabit, Isiolo, Wajir, and Mandera.

Extreme weather events are responsible for the proliferation of Rift Valley Fever, which affects livestock mainly, but also human beings. During the heavy rains in 2006/2007 about 155 people died and 684 were infected in North Eastern and Coast provinces between November 2006 and March 2009, according to a technical report prepared for the Kenya National Adaptation Plan in mid-2012.

In coastal areas, increase in sea surface temperature and upwelling events cause harmful algal blooms (HABs) which negatively impact human health through consumption of contaminated seafood such as oysters which may harbour neurotoxins. HABs also affect salmon and shellfish and make them unfit for human consumption.

5.5 Adaptation to and Mitigation against Climate Change Health Risks

The impacts of climate variability and change on many of the environmental and socio-economic determinants of human health will prove devastating to people all over the world and are already becoming a threat to international efforts to promote sustainable development. The impacts are concentrated on the poorest populations and affect some of the largest disease burdens including malaria, malnutrition, and diarrhoea which together kill over 5 million people globally (WHO, 2008). In this connection, health is an important direct and indirect outcome of successful adaptation. In this case, therefore, building resilience and addressing health impacts within the UNFCCC Cancun Adaptation framework (CAF) is a step towards protecting the most vulnerable populations. One of the key CAF principles is for countries to follow a country driven, gender-sensitive, participatory and fully transparent approach which takes into account vulnerable groups, communities, and ecosystems.

It should be noted that the health sector, on its own, has little or no mitigation potential but it benefits from mitigation in other key sectors such as transport, energy, food and agriculture and electricity generation. The potential for these co-benefits is well documented in the WHO series, "Health in the Green Economy" (WHO, 2010).

Kenya continues to shoulder a big health burden which is likely to be made worse by climate variability and change. Kenya needs a healthy population in order to develop towards achieving the goals stipulated in Vision 2030. In the health sector, the aim of the Government is to provide an "efficient and high quality health care system with the best standards" (GOK, 2007). Given the current situation where most of the population especially in the rural areas face considerable health risks, several adaptation actions need to be put in place in order to create resilience and help them cope with the situation. These include:

- Improving the public health systems by building more hospitals and other health institutions which are well equipped, staffed, and have medicine and other needed medical supplies. Since the majority of the vulnerable people are poor, the issue of affordability of health services is a matter to be considered during the process of adaptation planning.
- Improving water availability and accessibility in order to reduce the

Box 5.3: Development choices to enhance health and address climate change**Household energy**

In the least-developed countries, enabling households to move from inefficient burning of coal and biomass fuels for domestic use to cleaner sources would significantly reduce the warming effect of black carbon, and would also decrease the estimated 2 million annual deaths from indoor air pollution. In India, for example, a proposed programme to introduce 150 million low-emission cooking stoves would be expected to gain approximately 12,500 years of healthy life per million population by the year 2020, roughly equivalent to eliminating half of the total cancer burden in the country. In temperate, developed countries, better housing insulation can increase energy efficiency, cut household heating bills, and improve health. Research from New Zealand demonstrated that such interventions resulted in improvements in self-rated health, school and work attendance, as well as reduced visits to general practitioners.

Electricity generation

Over the next 20 years, improved technology and reduced reliance on the most polluting fossil fuels for electricity production is expected to reduce the current 1.2 million annual deaths from outdoor urban air pollution. Adding international trade in carbon emissions would help to direct cuts to where they are most efficient, bringing further gains both in reduced greenhouse gas emissions and in health: approximately 100 more healthy life years per million population annually in the EU, 500 in China, and 1500 in India. The direct health benefits of improvements in household energy and electricity generation alone would offset a significant fraction of investment costs.

Urban transport systems

Promotion of sustainable transport systems, with opportunities for safe public and active transport, could dramatically cut greenhouse gas emissions. It would also help to reduce the 3.2 million annual deaths from non-communicable diseases associated with physical inactivity, and the 1.3 million annual deaths from road traffic accidents. In the United Kingdom, for example, introduction of selected policies aimed at reducing transport emissions by 60% by the year 2030, would be expected to bring major health gains: 10–20% reductions in heart disease and stroke, 12–13% in breast cancer; 8% in dementia, and 5% in depression. Health gains in rapidly developing economies are expected to be even larger.

Food and agriculture

The food and agriculture sector contributes about 10–12% of global greenhouse gas emissions, with additional contributions from associated land-use change. Moderating meat consumption and favouring foods that are lower in the food chain has the potential both to enhance health and to reduce impacts on the global climate. For example, recent studies show that a 30% reduction in adult consumption of saturated fat from animal sources would cut heart disease in the population by around 15% in the UK, and 16% in the city of São Paulo, Brazil. Such dietary changes would also be expected to reduce the 2.8 million annual deaths from overweight and obesity, as well as a range of cancers.

Family planning

Unsustainable and inequitable patterns of production and consumption will dominate effects on the global climate over the next few decades. Over the long-term, however, population stabilization would also help to ease pressure on the local and global environment. At the same time, approximately 200 million women in developing countries express an unmet need for family planning services and supplies. Supporting rights-based reproductive health services can empower women and girls, as well as helping to reduce the half-million maternal deaths, and approximately 9 million deaths of children under five, that occur every year. Safeguarding reproductive health and rights can also ease population pressure, which many developing countries have identified as increasing their vulnerability to climate change, as well as eventually reducing greenhouse gas emissions.

Source: WHO (2009), *Protecting Health from Climate Change: Connecting Science, Policy and People*.

high prevalence of water-borne diseases in the various parts of the country.

- Promoting awareness among vulnerable people regarding their own personal hygiene and the need to keep the environment clean, in order to stem water and food-borne diseases as well as malaria. Kenya is pursuing the ambitious target of making rural Kenya open defecation free by 2013, as announced during the celebration of the World Toilet Day on 19th November 2012.
- Committing to undertake health impact assessments or use other appropriate methods in order to minimize the adverse effects of climate change on health.
- Intensifying disease surveillance and creating capacity for rapid response to deal with new disease outbreaks and epidemics especially during extreme weather events.
- Undertaking vaccination and immunization campaigns as a preventive

measure against mainly childhood diseases.

- Establishing partnerships with players in the private sector, faith-based institutions, multilateral and bilateral organisations, particularly with regard to funding various programmes and projects which the Government needs to undertake in the health sector. These include one aimed at strengthening national focus and adaptive capacity to prevent epidemic highland malaria in Kenya whose time frame is 2010–2014. This project is being implemented by the Ministry of Health with the joint support of WHO and UNDP, utilizing funds from GEF Special Climate Change Fund (SCCF).
- Clear need for Kenya to take advantage of regional climate change partnerships offered by EAC, IGAD, COMESA, and AU. There are a number of on-going projects and programmes being undertaken through such organisations as the Africa Adaptation Programme (AAP), Climate Change Adaptation in Africa (CCAA), and the Kenya

Sound policies and strategies are needed and should be mainstreamed in the health sector. Furthermore, with the advent of the new constitution and a devolved system of governance, there is a very high expectation of a strengthened public health system at the national and county levels.

- Adaptation to Climate Change in Arid and Semi-Arid Lands (KACCAL).
- Intensifying medical research by creating local capacity in the various medical research institutions including universities covering the different fields such as curative, preventive, and environmental health.
- Incorporating health concerns in National Adaptation Plans (NAPs) and linking them with the on-going efforts to strengthen the national health system and adapt to changing patterns of diseases.
- Enhancing information and communication of climate change adaptation and mitigation programmes and projects at the national, county, and community levels in order to improve monitoring and reporting functions.
- Undertaking robust health impact assessments in order to facilitate mainstreaming and prioritization of health issues in adaptation and mitigation planning. The assessment studies should choose the right indicators which are useful in measuring human wellbeing.

With regard to mitigation, Kenya is in the process of developing nationally appropriate mitigation actions Nationally Appropriate Mitigation Actions (NAMAS) with the objective of adopting a low carbon development pathway. Investment in these NAMAS is imperative and should be directed to the key economic and social sectors as detailed in Vision 2030. A key social sector is health which will benefit from effective mitigation actions from all other sectors.

5.6 Managing Challenges and Embracing Opportunities

Within the operational mechanisms of UNFCCC, potential opportunities beneficial to human health can be realized through the Clean Development Mechanisms (CDM) and possibly the Nairobi Work Programme (NWP) on impacts, vulnerability, and adaptation to climate variability and change. Through such measures as adopting clean and renewable energy technologies, reduction of environmental degradation, increased agricultural production, and food security, the likelihood of improvement of public health and health systems is high. Availability of electricity in the rural areas, for example, would trickle down to rural health facilities and improve their service delivery in line with Vision 2030 goals, besides reducing illness from use of dirty fuels. In this regard, the CDM projects on geothermal energy by KenGen and the 35MW Bagasse Cogeneration power project by Mumias Sugar Company are quite relevant. Overall, by September 2012, there were 14 CDM projects in Kenya. While these are not health related, they have health co-benefits.

In Kenya, there are also other technology related projects such as the energy saving cook stoves which in addition to reducing deforestation, have direct health benefits of reducing indoor smoke pollution which causes respiratory diseases. However, there are only a few meaningful CDM projects in Kenya and in Sub-Saharan Africa compared to Asia and Latin America. There are even fewer projects directly related to health. This opportunity should be fully exploited by the country. With regard to

REDD+, for example, Kenya is making progress towards exploiting opportunities accorded by international climate finance through compliance and voluntary carbon markets.

5.7 Conclusion

The main message of this chapter is that climate variability and change places considerable risk to the basic determinants of health such as clean air and water, adequate food and nutrition, as well as acceptable shelter for human habitation, and the right temperature level. As a consequence, climate variability and change poses new challenges in the form of control of infectious climate-sensitive diseases such as diarrhoea and malaria which are endemic in different areas of the country. The most vulnerable sections of the population are the poor, particularly children, women, the elderly, and the disabled, who bear the greatest health burden. These health impacts threaten overall well-being and human development, especially if a business as usual (BAU) approach is maintained.

Since health is a fundamental human right and one of the most important indicators of development, its protection from negative impacts of climate change should be the responsibility of individuals, households, communities, national governments, and the international community. In Kenya, there is need for an effective approach to climate change adaptation and mitigation. Sound policies and strategies are needed and should be mainstreamed in the health sector. Furthermore, with the advent of the new constitution and a devolved system of governance, there is a very high expectation of a strengthened public health system at the national and county levels. While Kenya, for example, has embraced the African Plan of Action for Public Health Adaptation to Climate Change (2012-2016), it has not yet fully developed a strategy for its implementation. There is need to put in place comprehensive adaptation and mitigation measures aimed at reducing vulnerability to climate-related diseases and other health threats which curtail economic and social development, and militate against the attainment of the broader goal of Vision 2030.

6

WATER AND SANITATION

Key messages

1. Kenya is already one of the most water-scarce countries in Africa, and access to water is likely to become further constrained due to population growth, economic expansion, and changes in rainfall patterns (Parry et al., 2012).
2. Water is a basic commodity for sustaining life and is undelivered to a majority of Kenyans. It is estimated that 41% of the country's population (17% of the urban and 48% of the rural population) still does not have access to an improved water supply.
3. Even worse, 69% of the population (73% of the urban and 68% of the rural population) does not have access to improved sanitation services.
4. The country lacks an effective system to establish the water supply and sanitation coverage, making it very difficult to track the Millennium Development Goals (MDGs) or national targets. However, efforts are being made to find a solution through improved data systems such as MajiData, which focuses on the poor urban areas, and the Water Service Board's Investment Tool (WaSBIT) which compiles data at a sub-location level and is currently being pilot tested in the country.
5. The low access rates to water and sanitation services translate into social costs and economic inefficiencies that have far reaching implications for human development. When people do not have access to water, either a large amounts of their disposable income have to be spent on purchasing water from vendors or large amounts of their time, in particular for women and children, have to be devoted to fetching and transporting it. This erodes the ability of the poor to engage in other meaningful activities that would go a long way in improving their individual or collective welfare. Poor sanitation services translate into high incidence of water-borne diseases, which costs Kenya about USD 324 million (approximately, 0.9% of GDP) annually.
6. Unless urgent, innovative and effective measures are taken to address it, climate variability and change threatens to turn an already bad situation of water and sanitation challenges into a monumental crisis.
7. Climate change has created good investment opportunities in the water and sanitation sector.



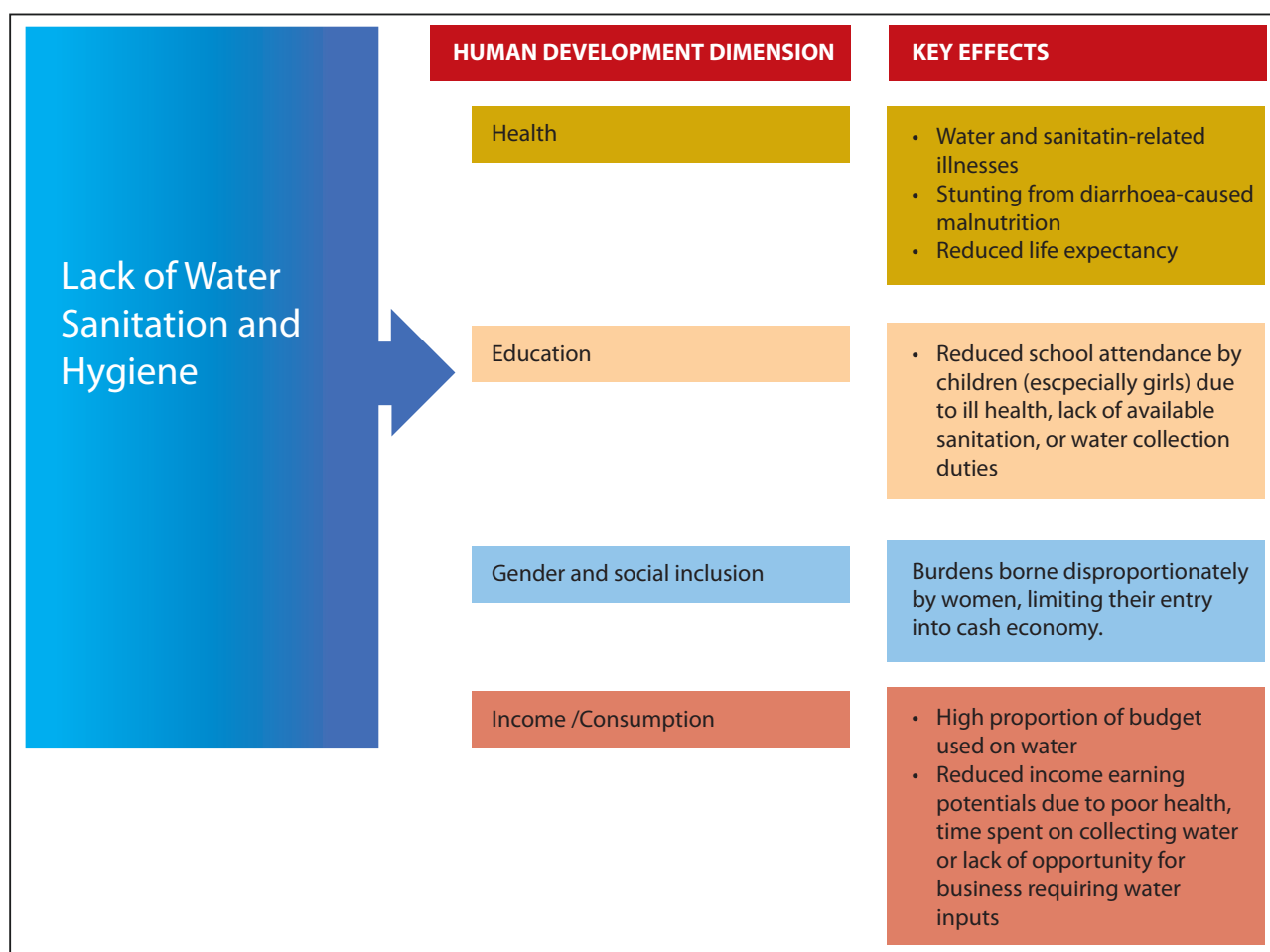
6.1 Introduction

This chapter has four broad aims. First, it highlights the historical and current trends in the water and sanitation sector in Kenya. Second, it puts into context water and sanitation under a changing climate, and with the help of suitable examples, links the two to human development in Kenya. Third, the chapter explores adaptation and mitigation measures being implemented or that have potential in the sector. Finally, the chapter considers opportunities emerging from climate variability and change for the water and sanitation sector.

6.2 Human Development, Water and Sanitation: Understanding the Links

Human development, water and sanitation are clearly linked (Fig. 6.1). Despite the significant investments made in the sector during recent decades by governments, nongovernmental organizations, bilateral and multilateral agencies and the private sector, the outlook on access to safe

and adequate supplies of water and environmentally sustainable sanitation remains grim. Coverage varies substantially by country, but well over a third of rural populations in most lower-income countries lack access to safe water or sanitation. This is despite water being consistently identified as a basic need and a top priority by those who lack convenient or affordable access to it. Lack of access arises both from income shortages and the specific cultural, economic, regulatory and institutional environment prevailing at the country in question. An urban household located in an informal settlement may not be connected to the piped water system because it does not have the property rights to the land it occupies, preventing the utility from building fixed assets on illegally inhabited land. Among the rural or urban poor, lack of a political voice may prevent their needs being heard by those who are in charge of allocating the funds earmarked for water supply and sanitation improvements. In other situations, it may be manmade pollution of water bodies and aquifers that limits easy and less costly access to safe water resources. The costs of treatment and the cost of technologies that extract water from deeper aquifers often cannot be afforded by the poor without major consumption

Figure 6.1: Linkages between selected human development dimensions, water and sanitation

Source: After Bosch et al. (2001)

sacrifices. Although both poorer and higher income segments of the population may face the same polluted resources or inadequate services, higher income households can afford private solutions to these problems solutions too expensive for the poor population.

6.2.1 Health effects

Diarrhoea accounts for nearly 30 per cent of the burden of childhood communicable disease, with an estimated 2.2 million child deaths annually and a much larger number of children (and adults) suffering illness. Repeated bouts of diarrhoea contribute to malnutrition. Water and sanitation – and hygiene – are intimately related to diarrheal diseases. The interactions are complex, but adequate quantities of water, even low quality water, are necessary if people are to adopt the hygiene habits needed to break the disease transmission pathway. Just as everyone needs water daily, everyone, rich and poor, defecates and urinates daily. But where that takes place has a significant impact on family health. Households with private toilets have measurably lower morbidity rates than households without. Private toilets benefit not only the household but also neighbours who gain protection from the household's faeces. The poor and their neighbours often lack private toilets, forcing defecation in public spaces, and leaving them more vulnerable to communicable diseases than the non-poor.

Figure 6.2 illustrates the key channels through which physical improvements of water and sanitation services influence health outcomes. The provision of hygiene education, in addition to the physical interventions, helps ensure that faeces are safely disposed off, hand washing is done properly, and water is stored safely. Additionally, inadequate water and sanitation infrastructure slows other health improvements. With regard to sanitation, women often have different privacy requirements from those of men. When the absence of latrines forces them to use public spaces, they can do so only in the shelter of darkness, during early morning and late evening hours. One response is urine retention, which leads to health problems. From the community perspective, the adequacy of drainage plays a large role in health outcomes. Where drains don't exist, or are blocked, and wastewater stands in the streets, children are particularly vulnerable to disease transmission through direct contact. The standing water may also serve to host other disease vectors, such as mosquitoes that transmit malaria and other diseases.

6.2.2 Effects on education

In some cultures, lack of toilets in schools serving the poor is known to be a major factor in deterring girls from continuing their education, particularly after puberty. In these cultures, private toilets (if only latrines) and even the availability of drinking water provide a necessary condition to reach school enrolment goals, as is highlighted in Box 6.1.

Box 6.1: Girls, Sanitation and Education

In Kenya, 1 in every 100 schools has no toilet and close to half the schools have no water. The challenges in the provision of good quality water and sanitation facilities in schools are varied, and include economic and socio-cultural factors. Girls, especially in rural areas, are doubly disadvantaged where schools do not provide water for use by pupils, where washrooms are not available, where gender segregated toilets are absent, and where information on sustainable water management is missing. Many girls miss school due to menstruation, sometimes up to four days in a month, leading to a decline in their academic performance and placing them at risk of dropping out of school before completing primary level education. Examples of interventions that address some of the identified challenges in an integrated and sustainable manner include Girls' Education Movement (GEM) as a good practice that integrates water and sanitation education into its girls' empowerment programme. The key features of the GEM programme are:

- Use of child-to-child or peer approaches for water, sanitation and hygiene education;
- Inter-generational dialogue for attitudinal changes;
- Active involvement of teachers in the process;
- Community outreach for ensuring sustainability; and
- Addressing special needs of girls through the menstrual management component.
- Advocacy and support for construction of washrooms for adolescent girls and gender segregated toilet facilities.

Source: Wamahu et al. (2011)

Figure 6.2: Effects of water and sanitation interventions on health

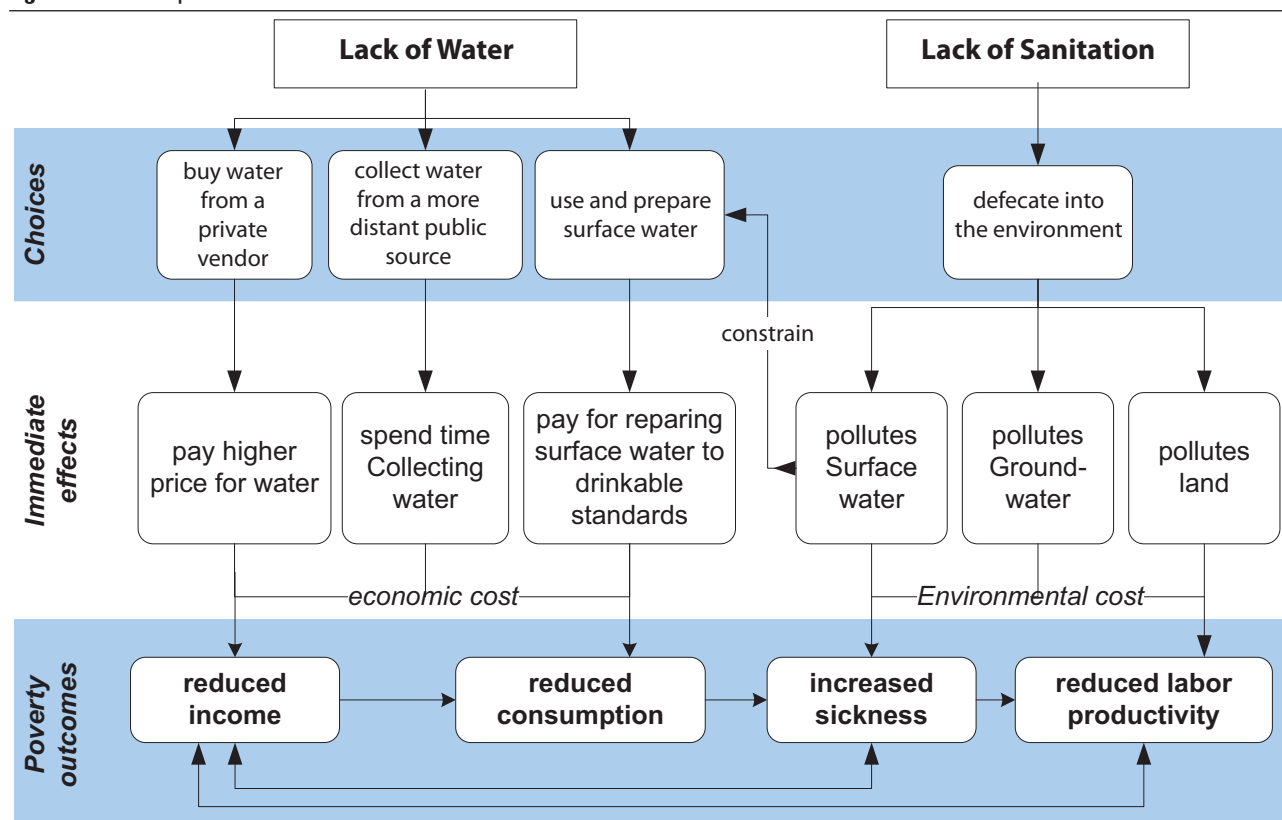
INTERVENTION (INPUT)	EFFECT (OUTCOME)	HEALTH IMPACT
<ul style="list-style-type: none"> Increasing the quantity of water Increasing the quality of water Providing means of safe extra disposal 	<ul style="list-style-type: none"> Better hygiene (hand-washing, etc). Reduced ingestion of pathogens Reduced number of pathogens in the environment 	<ul style="list-style-type: none"> Reduced morbidity and mortality

Source: After Bosch et al. (2001)

6.2.3 Effects on income and consumption

Lack of water and sanitation infrastructure has complex effects on consumption patterns, which significantly influence people's overall well-being. These effects are illustrated in Figure 6.3 and discussed in more detail in the following paragraphs.

The economic cost of water: Traditional poverty measures focus on income, but the rural and urban poor may not only have lower incomes, they probably face higher costs for water than the better off. The lack of

Figure 6.3: Consumption and income effects

Source: After Bosch et al. (2001)

network water connections for the urban poor, or of any water service for the rural poor, typically leaves them buying from water vendors at high per litre prices; or waiting in long queues at, or walking long distances to, public sources; and incurring additional costs for storing and boiling water.

The lack of convenient and affordable access to water reduces a poor household's consumption of other commodities and services, leaves it consuming less than the optimum amount of water for good hygiene, and impacts health and labour productivity of the household members. It may also reduce income-generating opportunities of the household thereby further reducing income and consumption. WHO has established a norm of 20 litres per capita per day (lcd) for water use to satisfy basic personal and hygiene requirements. Of that amount, about 10 lcd serve drinking and cooking needs, while the remainder goes to bathing – particularly hand washing. When water is expensive, either in cash terms or in the time and energy needed to collect it, the poor often cut total consumption to 15 lcd or less, and cut back on bathing.

A number of studies (Munasinghe & Deraniyagala 2006 and DFID, 1998, for example) have shown that the volume of water collected varies little for water sources from about 30 to 1,000 meters from the house. For sources closer than 30 meters, use increases, and over 1,000 meters, falls. Distance matters, but so does queuing time. If users can walk 10 meters to a stand-post, but then must queue an hour before use, they will collect no more water than someone travelling 200 meters to a stand-post that has no queuing.

The environmental cost: Threats to water sustainability arise in both quality and quantity dimensions, driven by pollution and competing demands from many sectors, including industry, agriculture and energy. Environmental degradation reduces labour productivity by contributing to the increased burden of diseases and by limiting income potentials (especially in aquaculture). Nationally, dwindling availability of clean water per capita will increase the economic cost of water and, in a situation of scarcity, limit the potential for economic development. Locally, communities that fail to protect their surface and ground waters from pathogens have fewer options for drinking water and require more expensive technologies for extracting water from deeper aquifers or for treating surface water to drinkable levels. In the urban context, where water may be supplied from a utility, increasing costs of extraction or treatment are passed on to consumers in terms of higher prices. The poor have fewer resources and thus suffer disproportionately from the consequences.

Water, sanitation, and risk: Inadequate water and sanitation services can bring with them a particular risk in each of the dimensions already described. Water availability and quality may both be highly seasonal. During the dry season, the urban poor face higher water prices, while the rural poor face longer treks for lower quality water. Also, sewage return flows to water bodies, bearing pollutants of various types, make up a bigger proportion of total flows, reducing water quality and making effective treatment more difficult. The risk is faced in household consumption and in the use of water in economic activity such as agriculture. The poor are particularly unequipped to cope with this risk, since coping requires expensive storage or additional treatment. During the wet season, inadequate drainage and other sanitation infrastructure becomes

problematic, as overflowing polluted water may stand in the streets for long periods.

6.2.4 Gender and social inclusion effects

Groups such as female-headed households, the elderly and ethnic minorities are disproportionately poor, and among the poor they tend to be most adversely hit by a lack of water and sanitation services. The voices of these most vulnerable poor groups may be the last heard when such services are established. Even when they are the primary managers of household water, women are often not included in public decision-making processes concerning water and sanitation services. Geographically dispersed poor groups (often ethnic minorities) may be excluded in the process of setting up community water and sanitation services. Situations in which marginalized groups are excluded from wider community decision-making activities will lead to continued use of unsafe water as well as limited access to existing or future services by these same groups. Furthermore, a lack of adequate sanitation will endanger girls and women in those cultures where they have to wait until the evening to be able to defecate and urinate. The health consequences have already been mentioned *inter alia*, but security issues also arise as women and girls are more vulnerable to violence, sexual harassment, and other types of crime during the hours of darkness.

6.3 Vulnerability and Risks in Water and Sanitation Sectors

A range of global and regional studies have assessed Kenya's vulnerability to climate change using global datasets (1,2,3,4,5) (Table 6.1) and produced indices for each country to enable simple comparison. The table below presents the scores (measure of vulnerability) for Kenya for 9 global indices. The indices, which assess the impact of climate change on water resources, indicate that Kenya only has a medium level vulnerability. This is likely a result of the indices being distorted by the larger amounts of water available in the 2 wet catchments. In the arid and semi-arid lands there is chronic scarcity and low utilisation of water resources and climate change will be a major problem. Kenya has a reasonably low social vulnerability indicating that the government and economy are reasonably stable and relatively able to adapt to climate change.

6.4 Situational Analysis

The water and sanitation sector in general has made good progress towards improving delivery of services since the reforms in the water sector commenced almost a decade ago. The government has pursued aggressive legal and institutional reforms in the water sector, resulting in increased confidence among sector actors to up-scale support to the sector. In line with development targets set in Kenya Vision 2030, the government has rolled out a significant investment programme over the last few years. As a percentage of GDP, spending on the water sector has increased from 0.5% to 1.1% of GDP between 2003/4 and 2008/9. As a share of total resources, the sector has gained over the same period, and currently comprises 2.4% of total government expenditure.

The new Constitution recognises water as a human right that every Kenyan

Table 6.1: Vulnerability assessment in the water sector

Index	Score	Vulnerability	How it's calculated
Water Resources			
Water Scarcity Index (2004) ¹	0.5	Medium	Water extracted from rivers divided by the low flow (flow exceeded 90% of the time). E.g. If ≥ 1 then consumption exceeds supply.
Ground Water Dependence (2004) ¹	0.25	Medium	Ground water withdrawn as a fraction of total water withdrawn in region.
Total freshwater withdrawal as percentage of total renewable freshwater resources (2009) ²		8.9% Medium	Total freshwater withdrawn in a given year, expressed as percentage of the total actual renewable water resources. It is an indication of the pressure on the renewable freshwater resources (data from 1998-2002).
Annual Renewable Water Supply per capita Projections for 2025) ²	840 m ³	Scarcity	Runoff (data from 1950-2000) divided by Population (2025) (prediction from UN population division).
Social Vulnerability (1st = lowest vulnerability)			
Human Vulnerability A (2007) ³	0.578	30th/49 (Africa)	Social vulnerability to climate change (the index consists of 5 weighted factors, each of which is scored). The factors are economic well-being and stability (20%), demographic structure (20%), global interconnectivity (10%) and dependence on natural resources (10%). HVB also includes institutional stability and infrastructure (corruption) (40%).
Human Vulnerability B (HVB, includes corruption) (2007) ³	0.603	11th/49 (Africa)	
Sensitivity and Adaptability (2007) ⁴	0.541	147th/182 (global)	Human Development Index (used as generic indicator for adaptive capacity).
Sensitivity Index (2004) ¹	3	Medium	Combination of Water Scarcity Index, GW Dependence and Sensitivity and Adaptability Index.
Climate Vulnerability Index(2007) ⁵	-	Medium - High	The index links water resource modelling with human vulnerability assessments to contribute to a meaningful assessment for generic use.

Notes:

- Petra Doll (2009). Vulnerability to the impact of climate change on renewable groundwater resources: a global-scale assessment. *Environmental Research Letters* 4(3).
- World Business Council for Sustainable Development Global Water Tool (2009). Available at www.abcscsd.org/templates/TemplateWBCSD5/layout.asp?type=p&Meuld=MTUxNQ&doOpen=1&ClickMenu=LeftMenu
- Vincent, K. (2004). Creating an index of social vulnerability to climate change for Africa. Tyndall Centre Working Paper 56.
- Human Development Index (2009). Available at: www.hdr.undp.org/en/statistics
- Centre for Ecology and Hydrology (2007). Oxford Centre for Water Resources. The Climate Vulnerability Index. Available at: www.ocwr.ouce.ox.ac.uk/research/wmpg/cvi/

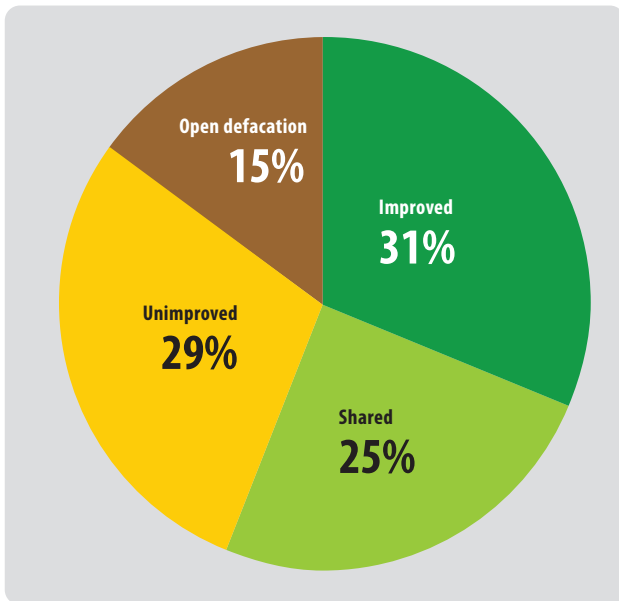
has a right to clean and safe water in adequate quantities which entails availability, quality, and accessibility. In 2006, access by Kenyan urban households to improved water source was 85% compared with Uganda's and Tanzania's access levels of 90% and 81%, respectively. According to the latest Joint Monitoring Programme (JMP) report (2010), Kenya is on track to achieve water MDG targets. However, regional disparities prevail with lower than national average coverage rate especially in Arid and Semi-Arid Land (ASAL) and peri-urban areas. Currently, overall coverage stands

at 59% while, in the north eastern province of the country, less than 22% of the population has access to safe water.

Sanitation remains one of the biggest development challenges in Kenya. The country is not on track to achieve the Millennium Development Goal (MDG) target for sanitation according to the JMP report. The report estimates the overall sanitation coverage at 31%, with rural areas at 32% and urban areas at 27%. About 6 million Kenyans, 15% of the total

population, still defecate in the open which results in prevalence of diseases such as diarrhoea, amoeba, typhoid, and cholera (Fig. 6.4).

Figure 6.4: Kenya sanitation coverage



Source: WSP(2012)

While the situation in terms of low access is more critical in the rural compared to the urban areas, the health risk in the latter is higher especially in densely populated informal settlements.

According to the WSP (2012), poor sanitation costs Kenya Ksh 27 billion (US\$ 324 million) annually, equivalent to about 0.9% of the national GDP. Open defecation alone costs Kenya US\$ 88 million per year (Fig. 6.5). The costs of poor sanitation are inequitably distributed with the highest burden falling disproportionately on the poorest and on women (and girls) as caregivers (Fig. 6.6). Approximately, 19,500 Kenyans, including 17,100 children under 5, die each year from diarrhoea, nearly 90% of which is directly attributed to poor WASH services.

As a water-scarce country, Kenya is critically exposed to the adverse effects of environmental degradation and climate change. Its arid and semi-arid lands (ASALs) have suffered for many years from recurrent food insecurity, mainly caused by drought. The unpredictability and severity of weather have increased in recent years. In addition, heat, drought and flooding, coupled with rapid population growth and unsustainable natural resource management practices have led to severe soil and water degradation which will further exacerbate food security vulnerability. Forest cover in Kenya has fallen from 12% in 1960 to 2% in 2010, which in turn has affected water catchment. The arid and semi-arid lands (ASALs), presently covering

Figure 6.5: Cost per capita of unimproved sanitation

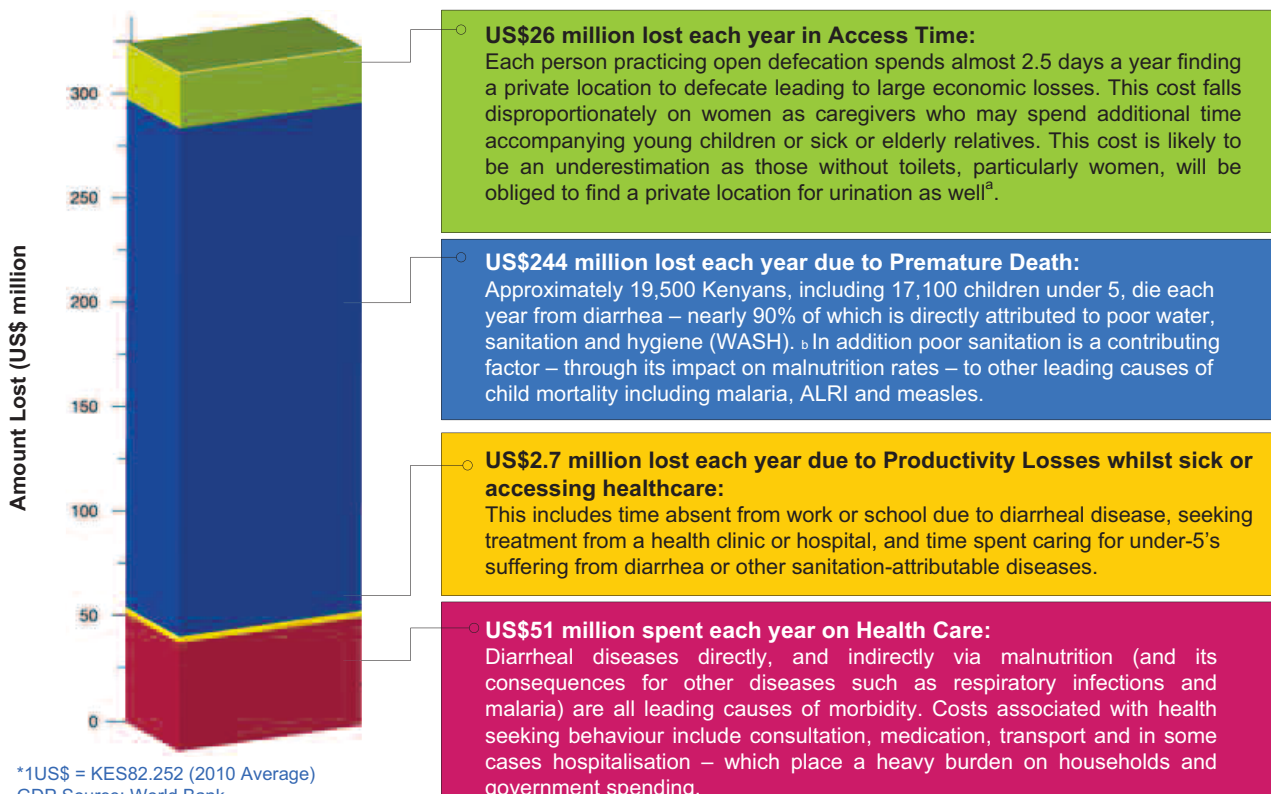
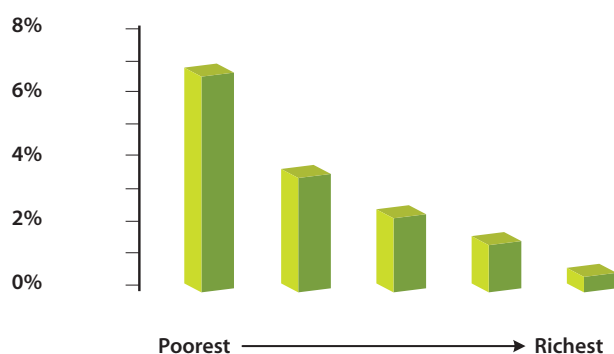


Figure 6.6: Cost per capita of unimproved sanitation

Source: WSP (2012)

A well-coordinated and aligned sector is critical for achieving the desired results and thus the Sector Wide Approach (SWAp) to planning has been adopted. The Ministry responsible for water has established various instruments with which to achieve the SWAp agenda.

about two-thirds of Kenya's landmass, are expected to increase in size. Kenya is committed to the achievement of the Millennium Development Goals on water and sanitation as elaborated in the country's development blueprint, Vision 2030. The Ministries responsible for water, irrigation, public health and sanitation are spearheading the drive towards attaining these targets through a devolved structure.

Recognizing the magnitude of the challenges, the "Water Act 2002" introduced a new legal and institutional framework that brought about the separation of policy, regulation, and service provision, as well as decentralization of functions in the sector. The new institutional and legal opportunities arising from the promulgation of the new Kenyan Constitution in 2010 (CoK, 2010) have now led to the formulation of the "Water Act 2012".

In 2010, the Ministry of Public Health and Sanitation (MoPHS) embarked on a pilot sanitation initiative that saw more than half a million people gain new access. This initiative led to the development of a roadmap to eradicate open defecation in Kenya. The campaign dubbed "Open Defecation Free Rural Kenya 2013" is currently underway with an estimated budget of US\$ 37.55 million and targets to reach over 13 million Kenyans. This commitment seeks to ensure that the related behaviour of hand-washing with soap and safe water at point of use is encouraged. The specific objectives of the campaign are to develop capacities of key stakeholders and an effective Planning, Monitoring and Evaluation Research (PM&ER) system for more effective evidence based

approaches. The campaign also targets mobilization of resources to support the initiative.

The programmes in the ministries responsible for water and irrigation are targeted at ensuring availability of adequate water for the various competing demands with a strong specific focus on providing services to the underserved urban and rural poor. The programme contributes to the attainment of the Vision 2030 objectives and milestones, Medium Term Plan (MTP) flagship projects and the MDG goals. In 2010/11, Ksh 32.8 billion was committed which was a 31.7% increment from Ksh 24.7 billion in 2009/10. To meet the water targets as per Vision 2030, a growth in the budget of 40% annually is required.

The reforms have been underpinned on the targets of the Millennium Development Goals (MDGs) and have resulted in commendable progress towards improvement of water resources management and water services delivery. The reforms are in tandem with Vision 2030, the country's development blueprint that seeks to transform the economy into a rapidly industrializing middle-income nation. Water and water-related issues play a significant part in the roadmap to successful achievement of Vision 2030, and in this respect the Vision has elaborated on the role of the water sector under the social pillar.

Since the commencement of reforms, the growth of the water sector budget has been encouraging with the development budget component recording the highest upward progression. This substantial increase in the sector's budget and particularly the development vote confirms the confidence that the government and development partners (DPs) have in the water sector reform agenda.

As mentioned earlier, the overall budgetary allocations to the water sector have increased by more than 200% in the last five years (2006/07 to 2010/11), with the development allocation increasing by 252%, while the recurrent budget has maintained a lower growth rate of 93%. The importance of water and sanitation has also been reflected in the government development budget with allocations to the water subsector increasing from US\$ 227 to US\$ 423 million over a 5 year period. The water budget's compound growth rate for the last 10 years was 20.7%.

The net result is that about 1.6 million additional people living in urban areas are being reached with water supply, and an additional 854,212 urban residents are being reached with sanitation/sewerage services. For the rural population, about 1.3 million additional people were reached with water supply and about 965,807 with sanitation services.

A well-coordinated and aligned sector is critical for achieving the desired results and thus the Sector Wide Approach (SWAp) to planning has been adopted. The Ministry responsible for water has established various instruments with which to achieve the SWAp agenda. In the year under review, the sector launched the Water Sector Strategic Plan, an instrument which rallies all sector stakeholders behind a common agenda, and with which intra- and inter-ministerial collaboration will be strengthened. In addition, the sector carries on strengthening its monitoring and evaluation through the establishment of various monitoring and evaluation information systems.

6.5 Water Resources in Kenya

The future water resources of Kenya have been evaluated considering the climate change effect. According to multi-model analysis, increase of the surface air temperature seems to be unavoidable in the future, estimated at around 1°C by 2030 and 2°C by 2050 uniformly from the current climate. The mean annual rainfall and evapo-transpiration are expected to increase for 2030 and 2050 as shown in Table 6.2a.

Table 6.2a: Projected increase in mean annual rainfall and potential evapotranspiration

Year	2010	2030	2050
Mean annual rainfall (mm/year)	672	742	794
Mean annual potential evapotranspiration (mm/year)	544	608	655

Source: Water Sector Strategic Plan 2012-2015/Draft National Water Master Plan 2030

Based on the projected future climate, the water resources were estimated using Similar Hydrologic Element Response (SHER) model. Renewable water resources, defined as theoretically maximum usable freshwater resources, were estimated as shown in tables 6.2b and 6.2c.

Table 6.2b: Estimated renewable water, surface water and ground recharge using SHER model

Year	2010	2030	2050
Renewable water resources (MCM/year)	76,610	80,474	83,583
Surface water (MCM/year)	20,637	24,894	26,709
Ground water recharge (MCM/year)	55,973	55,580	56,874

Source: Water Sector Strategic Plan 2012-2015/Draft National Water Master Plan 2030

Table 6.2c: Renewable surface water estimates per catchment

Catchment	Catchment area (km ²)	2010	2030	2050
Lake Victoria North (MCM/year)	18,374	4,626	4,969	5,455
Lake Victoria South (MCM/year)	31,734	4,773	5,749	7,005
Rift Valley (MCM/year)	130,452	2,457	3,045	3,794
Athi (MCM/year)	58,639	1,198	1,334	1,711
Tana (MCM/year)	126,026	5,858	7,261	7,383
Ewaso Ng'iro North (MCM/year)	210,226	1,725	2,536	1,361
Total (MCM/year)	575,451	20,637	24,894	26,709

Source: Water Sector Strategic Plan 2012-2015/Draft National Water Master Plan 2030

Table 6.2d: Renewable surface water estimates per catchment

Catchment	Catchment area (km ²)	2010	2030	2050
Lake Victoria North (MCM/year)	18,374	708	703	720
Lake Victoria South (MCM/year)	31,734	874	868	888
Rift Valley (MCM/year)	130,452	1,402	1,392	1,425
Athi (MCM/year)	58,639	333	330	338
Tana (MCM/year)	126,026	879	873	893
Ewaso Ng'iro North (MCM/year)	210,226	1,401	1,391	1,424
Total (MCM/year)	575,451	5,597	5,558	5,687

Source: Water Sector Strategic Plan 2012-2015/Draft National Water Master Plan 2030

Based on the available data such as Census 2009, Kenya Vision 2030, and other sources of statistical data, water demands for domestic, industrial, irrigation, livestock, wildlife and inland fisheries were estimated for 2010 and projected for 2030 as shown in tables 6.2e and 6.2f.

Table 6.2e: Water demand by various sub-sectors

Water demand by sub-sector (MCM/year)	2010	2030
Domestic	681	2,556
Industrial	54	250
Irrigation	2,026	7,550
Livestock	351	715
Wildlife	8	8
Fisheries	15	26
Total	3,136	11,105

Source: Water Sector Strategic Plan 2012-2015/Draft National Water Master Plan 2030

Table 6.2f: Water demand by catchment and sub-sector by the target year 2030

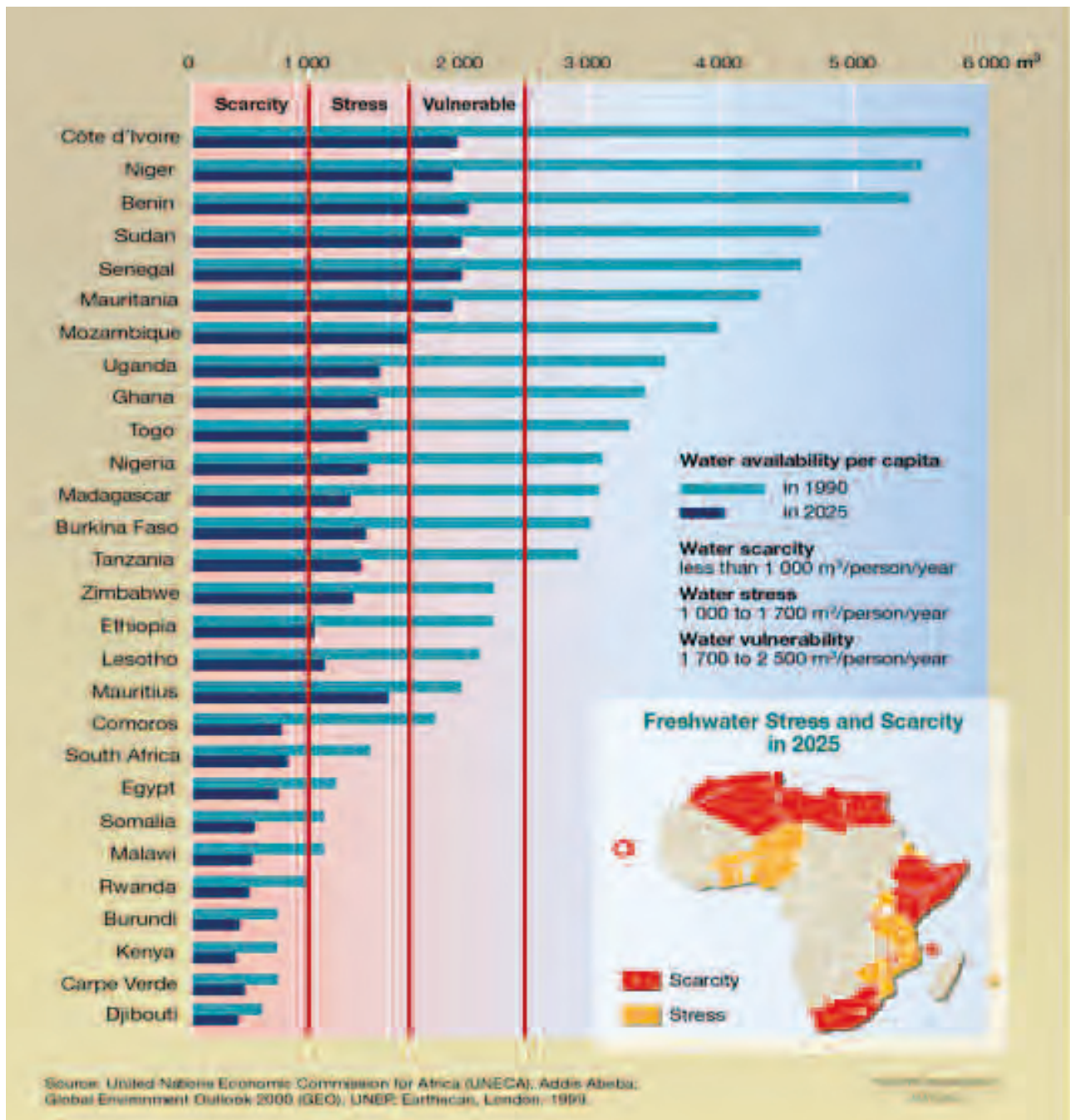
Sub-sector	Domestic	Industrial	Irrigation	Livestock	Wildlife	Fisheries	Total
Catchment							
L. Victoria North	428	19	733	146	0	5	1,331
L. Victoria South	472	20	1,505	212	2	5	2,216
Rift Valley	259	17	459	137	3	2	877
Athi	899	179	754	91	2	4	1,929
Tana	297	14	3,987	105	0	5	4,408
Ewaso Ng'iro North	201	1	112	24	1	5	344
Total	2,556	250	7,550	715	8	26	11,105

Source: Water Sector Strategic Plan 2012-2015/Draft National Water Master Plan 2030

Kenya's per capita water storage capacity stands at 5 m³. This storage capacity is obtained from the country's 4,330 small dams and 17 large dams which store about 180 million cubic meters of water (Water Sector

Strategic Plan 2012-2015/Draft National Water Master Plan 2030). Figure 6.7 clearly illustrates the precarious water situation in Kenya compared to other African countries.

Figure 6.7: Freshwater stress and scarcity in selected African countries by the year 2025



6.6 Adjusted Human Water Security (HWS) Threat Indicator

Recent research by Vörösmarty et al. (2010) presents an 'Adjusted Human Water Security Threat' (HWS) indicator. The indicator is a function of the cumulative impacts of 23 biophysical and chemical drivers simulated globally across 46,517 grid cells representing 99.2 million km². With a digital terrain model at its base, the calculations in each of the grid boxes of this model take account of the multiple pressures on the environment, and the

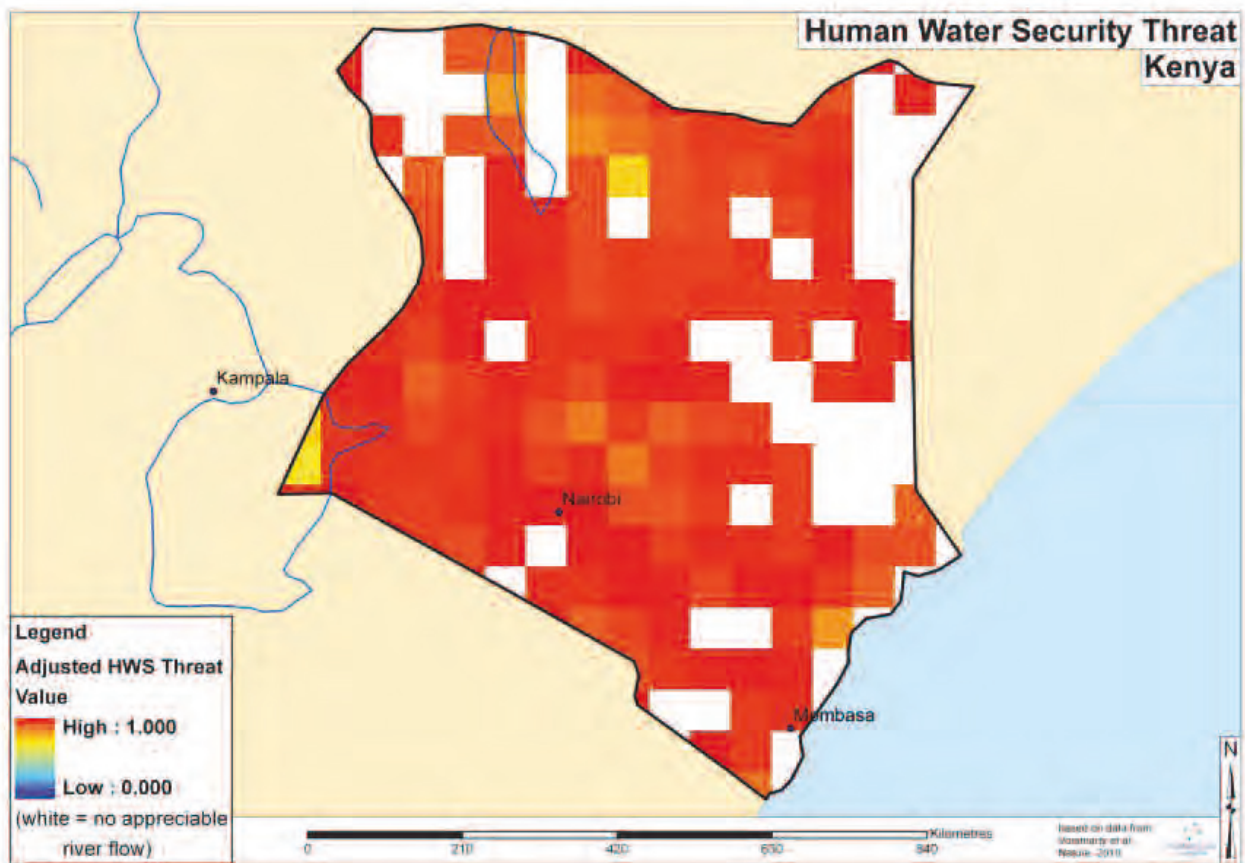
way these combine with each other, as water flows in river basins. The level of investment in water infrastructure is also considered. This infrastructure measure (the investment benefits factor) is based on actual existing built infrastructure, rather than on the financial value of investments made in the water sector, which is a very unreliable and incomplete dataset.

The analysis represents the current state-of-the-art methodology of indicating the level of human water stress. It is based on what is known from all verified peer reviewed sources about surface water resources as

generated by natural ecosystem processes and modified by river and other hydraulic infrastructure (Vörösmarty et al., 2010). However, it does not provide assessment in places where there is 'no appreciable flow', where rivers do not flow, or only do so for such short periods that they cannot be reliably measured. This method does not also address places where water supplies depend wholly on groundwater or desalination, being piped in, or based on wastewater reuse.

Figure 6.8 presents the present day HWS estimates for Kenya, using the model that operates at 50km resolution. The only areas where water stress is not recorded in Kenya are the areas excluded from the analysis due to lack appreciable flow. High human population pressure and its associated impacts, such as pollution and land degradation, have led to a severe lack of human water security, and high water stress (World Water Assessment Programme, 2006). This analysis provides additional evidence that Kenya is suffering water stress.

Figure 6.8: Human water security threat for Kenya



6.7 Drinking Water and Sanitation

Until the post-election violence of 2007/2008, Kenya appeared to be on track to achieve the Millennium Development Goal (MDG) of 90% water access, though it was off-track to meet its 90% target for sanitation access (USAID, 2009). There are 1800 municipal water supply schemes, out of which 700 are managed by the Ministry of Water Resource Management and Development while communities manage the rest. There are 9000 boreholes, most of which require rehabilitation. The data presented in Table 6.3 summarises the improvements to water and sanitation in urban and rural Kenya (JMP/WHO & UNICEF, 2009).



Pic: www.academia-engelberg.ch

Table 6.3: Trend in water and sanitation access in urban and rural Kenya, 1990-2010

Year	Urban Population (millions)	Rural Population (millions)	Improved Water Supply (%)		Total	Improved Sanitation (%)		Total
			Urban Population	Rural Population		Urban Population	Rural Population	
1990	4.3	19.1	92	33	44	27	25	26
1995	5.2	22.2	89	38	48	28	27	27
2000	6.2	25.2	87	43	52	30	28	29
2005	7.4	28.2	84	47	55	31	30	30
2008	8.3	30.4	85	50	57	31	31	31
2010	9.0	31.5	82	52	59	32	32	32

Source: JMP/WHO & UNICEF (2009)

6.8 Kenya's Vision 2030 for Water and Sanitation

Kenya's Vision 2030 for the water and sanitation sector is "to ensure water and improved sanitation availability and access to all by 2030" (GoK, 2007). Kenya is a water-scarce country with renewable fresh water per capita at 647 m³ against the United Nations recommended minimum of 1,000 m³ (Jacobsen et al., 2012; Ngigi, 2009; Maitima et al., 2009). This compares unfavourably with neighbouring countries of Uganda and Tanzania, which have per capita levels of 2,940 m³ and 2,696 m³, respectively (Maitima et al., 2009).

Due to continued population growth, it is estimated that by the year 2025, Kenya's per capita water availability will be 235 m³/year, about two-thirds less than the current 647m³/year²⁷. Additional supply and more efficient management of scarce water resources in Kenya for household and commercial enterprises will therefore be necessary to achieve the

economic, social and political priority projects suggested by Vision 2030 (GoK, 2007). Thus, all the flagship projects –in tourism, agriculture, industry etc. – will consume additional water. So will the measures envisioned under education, health, urban development and housing in the social sector (GoK, 2007). Conflict management and resolution under the political pillar also has a water dimension since many conflicts in rural Kenya tend to be resource-based with a bias towards shared water sources. Efficient water management will, therefore, not only contribute to sustainable long-term economic growth, but also to poverty reduction, health and security (GoK, 2007).

The poor and most vulnerable groups will gain directly from access to water and sanitation through improved health, reduced health costs and time saved. An improved water source together with better sanitation (which includes disposal of effluents and excreta) is one of the most important contributors to human development. It is estimated that 80 per cent of all communicable diseases are water-related and hence constitute a major

27. Wafula, P. 2010. Lack of investment in water sector leaves Kenyan towns parched. Business Daily (Nairobi, Kenya: Nation Media Group), p.2. Available at: <http://www.businessdailyafrica.com/-/539546/-/item/1/-/w05d3ez/-/index.html>

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 as a whole (GoK, 2007).

The main consumers of water in Kenya have been industries, agriculture (horticulture and livestock), energy production and domestic consumption, in that order. It is projected that the use and demand for water will increase at an unprecedented level with the expected 10 per cent annual growth rate, high levels of urbanisation and population growth (GoK, 2007).

6.9 Water, Climate Change and Human Development in Kenya

The world is on the verge of the greatest crisis it has ever faced. Worsening water security will have irreversible consequences on ecosystems, livelihoods and the global economic system. The ever-expanding water

demand by the world's growing population and economy has made water scarcity a reality in many parts of the world. We are witnessing severe damage to livelihoods, human health, and ecosystems. It is predicted by most accounts that by 2030, global water requirements would increase by 40% above current accessible and reliable supply. In the next two decades, global demand for fresh water will vastly outstrip reliable supply in many parts of the world, especially in the developing world and Kenya is no exception. We are exerting heavy pressure on river basins and underground aquifers. Moreover, climate change is predicted to escalate scarcity in water-stressed regions like Kenya. Global warming is expected to accelerate melting of glaciers and snow cover upon which over a billion people depend for their water.

The links between climate change, water, sanitation and human development in Kenya are well illustrated by the experiences presented in Boxes 6.2 and 6.3 and Plates 6.1a.

Box 6.2: Climate change water crisis impacts hospital maternal care

Kakamega, Kenya: At the Kakamega Provincial District General Hospital, located in Western Kenya, access to adequate and clean water still remains a pipe dream. Even though the need is critical the hospital, which works with maternity medicine and birthing procedures for women, still lacks an adequate plumbing system for water. These conditions and others are only made worse by frequent and severe water shortages in Kenya.

Kakamega's hospital staff members admit that problems of water shortages are common. Because of this, women and children are especially vulnerable as they face the destructive effects of unsafe water. "As women constitute the largest percentage of the world's poorest people, they are most affected by these changes. Children and youth – especially girls – and elderly women, are often the most vulnerable," says BRIDGE, a research and information program that is part of (IDS) the Institute of Development Studies – Knowledge Services. With the negative effects of climate change rising, experts predict that the biggest challenge in the coming years for a majority of the world's people will be the ability to access clean, healthy and safe water. Should access to clean water be considered a human right? Rights defenders worldwide answer with a strong, "Yes!" Yet, water figures show that resources and water supplies are declining quickly as global temperatures continue to rise and water sources are literally beginning to "evaporate."

Twenty year old HellenWasiili, from the western part of Kenya, had her baby in a public hospital only one month ago. She went to the hospital so her birthing process would be monitored by medical staff for safety and assurance. But things didn't work out that way. After giving birth she quickly developed typhoid fever, an often fatal waterborne disease, as a result of her exposure while she was in the hospital to untreated and unsafe water.

Kenya is currently unable to provide safe drinkable water in many of its hospitals. Three fourths of all Kenyan hospitals have inadequate and/or below standard facilities for both drinking water and water used for sanitation and medical needs. Out of 160 medical centers across the country, a staggering 120 currently do not have consistently working plumbing systems. Why? The reasons are varied. Those who face the greatest impact in Kenya's shortage of water are children and pregnant women, whose health conditions are usually compromised during pregnancy and severely compromised during childbirth. More than 2.5 billion people and almost one billion children worldwide live today without any basic sanitation.

Experts in Kenya now warn that common regional water shortages are a serious threat to the health of expectant mothers. Ranked 50th in the world in maternal and child mortality, UNDP statistics show that Kenya has more than 400 infant deaths per 100,000 births. The facts are clear. Climate change, water supply and sanitation play a responsible role in many of these deaths.

Source: Njeru, G. (2012); WNN Features

Box 6.3: Water shortages in Kenya responsible for growing thefts and conflicts

As droughts become more frequent and water shortages worsen, Kenya is seeing an increase in water thefts and other water-related crime, police records show. The most common crimes are theft, muggings and illegal disconnections of water pipes by thieves who collect and sell the water. Many of the crimes occur in urban slums, which lack sufficient piped water. "Since 2003, we have made piped water available to at least half of the slum residents in the entire country, but we are faced with severe hurdles as populations continue to grow and demand for the commodity continues to increase," said Peter Mangich, acting director of water services in the Ministry of Water.

Police statistics show that in Kibera - Nairobi's largest slum with over one and a half million inhabitants - there are as many as 75 reported incidences of water-related theft daily. Police say they believe many other cases go unreported since residents fear reprisals. In Nairobi's Kawangware slum, the problems are the same but the reported thefts are half those in Kibera. The reason? Kawangware borders Lavington, one of Nairobi's most affluent suburbs. Police say slum residents, instead of stealing from others in the slum, sneak into Lavington to steal water. Affected Lavington residents have asked the government to intervene. Studies currently being conducted by the University of Nairobi suggest that water scarcity may drive worsening domestic and international conflict.

A time bomb?

"What we are witnessing in the slums is very serious. Some think that water theft is petty, but we are living with a time bomb," said MakumiMwagiru, a professor at the Institute of Diplomacy and International Studies at the University of Nairobi. Most cases involving water crimes rarely make it to court, he said, largely because Kenyan police view water theft as a petty offense. But "there have been incidents where people have been killed that relate to water," he said. In July, 2012, a Kenyan newspaper, the Daily Nation, reported that an old man living in Kenya's Rift Valley killed another man with his walking stick after being refused permission to jump to the head of a long queue of people waiting for water at a community well. Because the man with the walking stick was over 80, the court ordered him to pay the family of the victim a camel as a fine and did not seek a jail sentence.

Gladys Murimi, who lives in Korogocho slum in Nairobi, says home break-ins and water thefts are an ongoing problem in her neighborhood. She regularly has her window panes broken and three times has had thieves steal plastic containers of water from her home. "I am currently looking for a better place to stay since my job is well paying and do not want to reside in the slum anymore. My immediate neighbors have also been affected," she said. Kenya police reported that in that very year 2012, more than 16,000 water crimes were reported to police!

Source: various



Plate 6.1a: Destruction of cropland by floods (a threat to food security) in Budalangi, Kenya in 2012 Source: Shisanya (2012).



Plate 6.1b: Destruction of houses by floods (a threat to human shelter) in Budalangi, Kenya in 2012 Source: Shisanya (2012)



Plate 6.1c: Livestock death (a threat to livelihoods) due to drought in Garissa, Kenya. Source: Shisanya (2012)

6.10 Adaptation Strategies in Water and Sanitation Sector

As pointed out *inter alia*, Kenya is a water scarce country, which essentially means that its annual per capita renewable water resource is less than the conventional universal minimum of 1000 cubic metres. Climate change will aggravate the situation as it affects precipitation. For this reason, certain adaptation interventions that need to be made in this sector include the following (GoK, 2010a):

- Constructing inter-basin and intra-basin water transfers to channel water from areas with excess water to areas with water deficit,
- Investing in decentralised municipal water recycling facilities for both domestic and Industrial use to reduce wastage,
- Enforcement and/or enactment of laws and regulations required for efficient water resource management,
- Increasing capture and retention of rainwater through the construction of waterways, strategic boreholes and other water harvesting structures to ensure availability of water during dry seasons,
- Developing and maintaining an appropriate stock of water infrastructure (dams, water pans, supply lines),
- Building capacity for water quality monitoring including training personnel to protect watersheds and monitor water quality,
- Having a strategic fund to purchase water purification chemicals for disinfection of community wells and shallow boreholes during floods and drought episodes when water quality is most threatened,
- De-silting rivers and dams to improve carrying capacity, water storage, and water quality,
- Protecting and conserving water catchment areas, river- banks, and water bodies from degradation and contamination, e.g. by imposing a water levy to generate funds for investment in conservation of water catchment areas, heightened awareness campaigns to underscore the importance of sustainable use of water resources, e.g. through the promotion of water harvesting techniques such as harvesting water from roof catchment at household level,
- Developing artificial re-charging of groundwater for threatened aquifers,
- Protecting flood plains through construction of dykes and river dredging,
- Putting in place adequate hydrometric network to monitor river flows and flood warning telemetric systems, and
- Introducing financial instruments such as subsidies to promote technologies that use water efficiently.

The above mentioned interventions must, however, take into consideration the importance of integrated water resources development and management, which has as its core the following principles:

- **Water is a finite resource:** essential to life, human development, and ecological functions. It should therefore be managed in a holistic manner by linking the need for socioeconomic development and protection of the natural resource,
- **Water has an economic value:** failure to recognise the economic value of water has led to its unsustainable use and degradation of its natural base in many regions of the world, and

- **Participatory approach:** involving different water users including gender groups, socioeconomic groups, planners, and policymakers in water resource management.

Improved agricultural water management (AWM) is one of the 'best bets' for adapting agricultural production to climate change and variability. The Blue Revolution must be designed to complement a Green Revolution in Africa and particularly Kenya. However, accomplishing this Blue Revolution is a significant challenge. At present, only about 6 per cent of African agricultural land is under irrigation, and according to the Intergovernmental Panel on Climate Change (IPCC), by 2020 rain-fed crop yields in some countries will decrease by half, with as many as 250 million Africans facing critical water stress. The impact of climate change on farmers and their livelihoods could be catastrophic.

Among the adaptation strategies recommended is smallholder irrigation development. Studies have shown that the performance of smallholder irrigation schemes – in terms of improved water management, food security, and income – is encouraging, with net earnings ranging between USD 200 and 1200 per month for single-crop enterprises in Kenya. Rainwater harvesting complements smallholder irrigation and enhances farmers' profitability.

Smallholder AWM is emphasized for a number of reasons. The performance of large public irrigation schemes in Africa is associated with poor governance and insecure land tenure, leading to low farmer investment and exploitation by government agencies. This partly explains the low cost recovery, poor performance, low water use efficiency, poor crop yields, low water productivity, and weak sustainability that typify public irrigation schemes. A key policy change would be to support increased investment in smallholder irrigation as opposed to large-scale irrigation projects. Apart from the obvious lower start-up cost and high economic impact, smallholder irrigation systems often have strong local community governance, are relatively free of political intervention, and have lower operation and maintenance costs.

Water management is also improved by having a greater diversity of options for water sources, such as small streams, shallow wells, boreholes, and rainwater storage. Other irrigation options also exist. These include surface irrigation methods (furrows and small basins), pressurized systems (sprinkler surface irrigation methods (furrows and small basins), pressurized systems (sprinkler and both high- and low-head drip) and water lifting technologies (gravity, manual and both high- and low-head drip) and water lifting technologies (gravity, manual and pumps – motorized, wind-driven and solar).

Another management strategy is the upgrading of rain-fed agriculture through integrated rainwater harvesting systems and complementary technologies such as low-cost pumps and water application methods, such as low-head drip irrigation kits. Rainwater harvesting systems include two broad categories:

- In-situ soil moisture conservation – technologies that increase rainwater infiltration and storage in the soil for crop use.
- Run-off storage for supplemental irrigation using storage structures such as farm ponds, earth dams, water pans and underground tanks

To realize the benefits of proposed interventions, necessary steps must be taken to ensure adoption, replication, up-scaling and sustainability. The necessary steps to enhance adoption and sustainability of proposed AWM strategies include:

- capacity building at various levels,
- research and technology development,
- appropriate policy and institutional reforms and,
- the provision of farmers' support services such as micro-credit, revolving grants, crop insurance, marketing infrastructure, and value addition.

The above would form the basis of increased investment (including grants) to promote improved agriculture water management as a climate change adaptation for smallholder farmers in Kenya.

6.11 Harnessing Opportunities in the Water and Sanitation Sector

Recent droughts in Kenya have created good investment opportunities in the water sector. All over the world, policy makers and investors are trying to find ways to mitigate the effects of such events. China, for example, has announced targets for investments of up to \$300 million in water conservation that Kenya could benefit from. These events are driving demand for companies and technologies working in the water infrastructure and treatment sectors. The World Bank estimates that \$180 billion of water infrastructure investment is needed each year until 2030 to meet freshwater demand and this urgent need for vast amounts of capital investment is quickly gaining recognition. Investment opportunities are found in three main areas: water infrastructure offers high growth, especially in the emerging markets due to mass urbanisation; water treatment; and water utilities.

A Kenya national climate fund has been established with the purpose of receiving all international finance. This body has served to simplify the former fragmentary climate finance landscape, providing finance for both adaptation and mitigation efforts. This Fund is governed by representatives of its main stakeholders: the government of Kenya, civil society, the private sector, and development partners. The government of Kenya continues to receive support to improve its capacity to absorb, manage, and disburse climate finance.

For many millions of smallholder farmers in Kenya, reliable access to water is the difference between plenty and famine. It is therefore essential to find ways to cope with existing and increasing variability in rainfall, as well as other effects of climate change like changes in temperature patterns. An opportunity to adapt to these climate-related challenges is through smart agriculture. Achieving water-smart agriculture in the context of climate change is providing an opportunity for Kenya to improve management of water resources from the national level down to the local level as enshrined in the Water Act 2002. Budget limitations often restrict efforts to strengthen institutions and gather high quality data needed to inform management decisions. Local water users and improved technologies can play greater roles in water management through improvements in data collection, analysis, and forecasting. These are cardinal tenets of Kenya's Water Act. Balancing Multiple Uses and Climate Change is another foreseen

opportunity of climate change in the water sector in Kenya. Balancing multiple uses in the face of climate change will require using stakeholder processes to arrive at strategies that cope with variability in water availability. These processes would benefit from clear and accessible information on tradeoffs associated with different allocations of water to different uses. Further, risks and opportunities associated with predicted changes in rainfall amounts and distributions should be evaluated.

Production of high valued and niche crops for domestic and export markets can be important sources of income for farmers operating as out-growers, contract farmers, or as individuals. Commercial agriculture, especially as conducted by smallholders in Kenya, will require access to a predictable water supply to ensure success, particularly as climate change scenarios predict increased variability in rainfall in many areas of sub-Saharan Africa. Irrigation, either through supplemental or full-scale systems, will be an important component of this success. Smallholders engaged in rain-fed agriculture may be able to access irrigation infrastructure through private investment associated with commercial out-grower opportunities. Currently only 6% of cultivated land in sub-Saharan Africa is irrigated (Ngigi, 2009).

Payment for Environmental Services (PES) is a market-based mechanism where land owners are rewarded by service beneficiaries. It is based on the premise that land owners undertake land use transformations that provide agreed ecosystem services. For these services, they are rewarded financially by the beneficiaries and the recipients are obliged to undertake land use practices that will ensure continued supply of ecosystem services.

Climate compatible development has been defined by Climate and Development Knowledge Network (CDKN) as 'development that minimizes the harm caused by climate impacts, while maximizing the many human development opportunities presented by low emissions, more resilient, future'. In the context of climate change and the conservation of natural carbon stores, such as forests, PES schemes are commonly seen as the 'silver-bullet' for achieving climate compatible development –that is benefits in climate change adaptation, mitigation and sustainable development. In Kenya, carbon markets, biodiversity premiums, and other PES schemes have created new opportunities for achieving climate compatible development–climate change adaptation, mitigation and sustainable development. As the number and diversity of PES projects continue to increase, there remains scant evidence on the fiscal and regulatory mechanisms required to deliver the incentives. The governance conditions needed to support the establishment and operation of these emerging markets for PES, or indeed the expected benefits for both climate change (adaptation and mitigation) and development are also lacking or vague. Already, Kenya has a number of policies and programmes to ensure the health and wellbeing of its citizens and the environment. The policies that specifically touch on coastal zones are contained in the National Climate Change Response Strategy (NCCRS), Vision 2030, Fisheries Policy, Forest Act 2005 and the Water Act 2002. In most of these policy documents, the limitations of knowledge, capacity, and financing mechanisms have been noted.

7 INFRASTRUCTURE SECTOR

Key messages

1. Infrastructure quantity and quality are key determinants of human development by spurring economic growth, reducing poverty, and empowering people to make choices.
2. Infrastructure is also a key determinant of a country's vulnerability to climate change.
3. In spite of notable progress in some areas such as roads and ICT, there are major infrastructure deficits in Kenya, especially in the electricity and transportation sectors. Inadequate supply and high cost of electricity, and inefficient and expensive port and related logistics services, feature as the main impediments to the county's competitiveness. About 25% of the country's infrastructure assets require rehabilitation.
4. There are wide disparities (along regional, income, gender lines, among others) with respect to infrastructure services.
5. Infrastructure is one of the sectors that is highly impacted and vulnerable to climate variability and change.
6. The main climate change impacts, vulnerabilities, and risks to the country's infrastructure come from flooding and range from destruction of different types of physical infrastructure from inundation, siltation of dams, and the resultant reduction of water storage and hydroelectricity generation capacity. The replacement cost of infrastructure damaged during the 1997-1998 El-Niño floods, for example, was estimated at Kshs. 62 billion (US\$ 777 million).
7. The impacts, vulnerabilities, and risks vary across various cleavages, especially regional or location with ASAL areas; the Coast, Nyanza, and Western provinces, and generally in low lying areas; people living in urban slums; and people living along steep slopes facing the greatest risk to drought and/or floods.
8. The country has already made significant progress towards adaptation to and mitigation of climate change, for example, through



the development of national adaptation and mitigation strategies, and initiation of the process of establishing a Climate Change Authority through an Act of Parliament, and increasing investment and reliance on green or clean energy, among many others.

9. Obstacles to adaptation and mitigation efforts in the Kenyan infrastructure sector mainly revolve around technology challenges such as awareness, cost, and poor quality enforcement; data challenges; and lack of credit to access the technology.
10. The increasing global attention to climate change and Kenya's richness in renewable resources, especially green energy resources, present considerable opportunities for the country to tap into the international financial resources and expertise to develop unique technologies for adapting to or mitigating climate change, and to create employment opportunities.
11. For the country to effectively exploit these opportunities, a specific department in government should be tasked with the responsibility.

7.1 Introduction and Sector Overview

Infrastructure plays a central role in human development by spurring economic growth and reducing poverty. It achieves this by reducing the cost of doing business and therefore enhancing competitiveness of a country's products and services. Infrastructure is also an important means of empowerment, as it determines the freedom and choices people have, and provides the means for delivery of social and economic rights enshrined in the Bill of Rights of the Kenyan 2010 Constitution. Access to essential services such as water, sanitation, education, health, and housing crucially depends on the availability and quality of infrastructure.

Moreover, infrastructure is a major indicator of vulnerability to climate

change, with areas endowed with better infrastructure expected to have higher capacity to adapt to climate change (O'Brien et al., 2004). Areas with all-weather roads, for instance, have better access to modern agricultural inputs and other technologies, while areas with irrigation infrastructure are less dependent on rain-fed agriculture, and are thus more resilient to climate change.

Not surprising, therefore, Kenya Vision 2030 positions the infrastructure sector as a leading enabler and accords it unprecedented priority. The Vision seeks firm interconnection of the country through an efficient, effective, and reliable system of roads, railways, airports, ports, water ways, and telecommunications. Table 7.1 shows the sector's targets and priorities for Vision 2030's first medium-term plan (MTP, 2008-2012).

Table 7.1: Infrastructure sector targets and priorities, 2008-2012

Infrastructure Sub-sector	Targets and Priorities for 2008-2012
Transport	<ol style="list-style-type: none"> 1. Rehabilitation of main road corridors 2. Development of a National Spatial Plan 3. Development and implementation of a National Integrated Transport Master Plan 4. Construction of a new transport corridor linking Lamu to Southern Sudan and Ethiopia 5. Fast tracking implementation of National Road Safety Action Plan 6. Development of a roads maintenance and management system 7. Construction of a light rail for Nairobi and its suburbs 8. Dredging, expansion, and modernization of Mombasa port 9. Formulation of a mass rapid transit programme for Nairobi Metropolitan region
Energy	<ol style="list-style-type: none"> 1. Increasing installed power generation 2. Enhancing access to electricity 3. Strengthening energy sector regulatory framework 4. Improving operational efficiency of power utilities 5. Encouraging private investment in power generation 6. Delinking power generation from its distribution 7. Building infrastructure to connect Kenya to energy-surplus countries 8. Exploration and development of new energy sources and tapping geothermal, coal and other renewable energy sources
Information Communication Technologies (ICT)	<ol style="list-style-type: none"> 1. Improvement of ICT infrastructure 2. Formulation of appropriate public policy and regulations 3. Development of requisite skills 4. Improvement of collection, storage and dissemination of national statistics 5. Acceleration of growth of ICT industries through public private partnership (PPP) 6. Equity in and universal access to ICT services
Water & Sanitation	<ol style="list-style-type: none"> 1. Expansion of water coverage 2. Expansion of sewerage facilities 3. Scaling up of water storage to improve water security 4. Water catchment conservation targeting the main water towers

Source: GoK (2012d).

Major achievements have been recorded over the last decade especially in the roads and ICT sub-sectors. These include, among others, the recently completed Nairobi-Thika Superhighway and the fibre optic telecommunication infrastructure, both of which have given Kenyans new optimism and spurred private investment.

Challenges

However, key challenges remain. These include:²⁸

- (i) Low infrastructure stock and services, even by African standards, due to many years of inadequate investment.
- (ii) Inadequate contribution of the sector to the country's per capita income growth. The contribution between 1991-95 and 2001-05, for example, was less than in other leading African countries (Briceño-Garmendia & Shkaratan, 2010). It contributed only about 0.5 percentage points to the country's growth in per capita GDP over the last decade compared to slightly more than 1.5 percentage points in Mauritius (Briceño-Garmendia & Shkaratan, 2010). Past surveys, moreover, have attributed about 30% of the productivity deficit in

Kenya's firms to infrastructure constraints, mainly in the electricity and transportation sub-sectors (Escribano et al., 2010)²⁹.

- (iii) Inadequate power generation capacity that requires at least doubling within the next decade; major power outages that cost the country up to 2% of GDP and that have led to about 70% of the country's firms investing in their own generation compared to only 10% of firms in South Africa; and high electricity costs.
- (iv) Low and declining access rates to household services such as water and sanitation; and high dependence on surface water and open defecation.
- (v) Inadequate terminal capacity at the port of Mombasa and poor interface between the port and surface (road and rail) transport.
- (vi) High distribution losses in power and water sub-sectors, totalling to about 0.4% of GDP, and a similar loss due to under-pricing in the two sub-sectors.
- (vii) Inequitable access to power and water.
- (viii) Weak integration of the country's major infrastructure backbones with those of neighbouring countries especially with Ethiopia, Tanzania, and Somalia.

²⁸ For more details on the challenges, see Briceño-Garmendia&Shkaratan(2010) and IDLO (2012).

²⁹ The relative contribution of the various infrastructure sub-sectors to the productivity deficit faced by the Kenyan firms were electricity (45%), transport (30%), water (19%), and ICT (6%) (Escribano et al., 2010).

- (ix) High rehabilitation requirement, with 25% of the country's infrastructure assets requiring rehabilitation compared with 15% in South Africa.
- (x) Infrastructure financing gap of about 5% of GDP, mainly in power investment and water maintenance; and low overall spending on roads and a huge unfunded road rehabilitation backlog, with spending being only 20% of the required amount.
- (xi) Exceptionally low capital budget execution ratios, and high implementation and cost overruns.

Out of these challenges, perhaps the most serious are the inadequate supply and high cost of electricity, and the inefficient and expensive logistics services at the port of Mombasa and the interfacing surface transport systems.

Infrastructure deficit

The importance of addressing these infrastructure challenges in the country's endeavour to raise productivity and therefore enhance human development cannot be overemphasized. Indeed, simulations suggest that if Kenya's infrastructure could be improved to that of Mauritius³⁰, per capita GDP growth would be 3.3 percentage points higher, with the bulk of the boost emanating from the power sector (Briceño-Garmendia & Shkaratan, 2010). The same authors have estimated that the country requires US\$ 4 billion annual spending for a decade in order to close its infrastructure deficit, with almost half of this being spent in water and sanitation, and about a quarter of the amount in electricity. The same could be achieved, however, without additional funding over annual spending levels in 2006, within 18 years, if inefficiencies are eliminated

through the use of more efficient technologies especially in the water & sanitation and transport sectors (Briceño-Garmendia & Shkaratan, 2010).

The 2010 Constitution has charged County governments with heavy infrastructure development responsibilities. These include county roads, storm water drains, water supply, sewerage, solid waste dumps, hazardous waste disposal facilities, security and street lighting, telecommunication utilities, ferries and harbours, public road transport, markets, county abattoirs and slaughter houses, livestock sale yards, county assembly halls, county offices and buildings, fire stations, county hospitals, health centres and dispensaries, cemeteries, conference and social halls, cinemas, museums, electricity and gas reticulation infrastructure, libraries, county stadia and parks, vehicle parking yards and silos, housing development, village polytechnics, home craft centres, nursery schools, and child care facilities.

Organization of the chapter

The rest of this chapter is organized as follows: the remainder of this section provides brief descriptions of the current status, prospects, and finally plans for the different infrastructure sub-sectors, with the exception of water and sanitation which is the subject of chapter six. This includes brief reviews of the sub-sector's contribution to GHG emissions where data is available. This is followed up with a brief discussion of equity issues in infrastructure in section 7.2. Section 7.3 assesses climate change impacts, vulnerabilities, and risks associated with the various sub-sectors, presenting as much evidence as possible, while section 7.4 reviews the country's climate change adaptation and mitigation efforts and challenges in the infrastructure sector. Opportunities arising from climate change and



30 Africa's leading country with respect to infrastructure.

7.1.1 The transport sector

Transport is intricately associated with human development, as it is central to people's lives. On the one hand, it contributes to poverty reduction by facilitating access to markets and other essential services, and provides mobility to people thereby enabling them to make choices according to the lives they desire. Transport also drives economic activity by moving goods, services, and labour. On the other hand, transportation is responsible for the stress and loss of productivity associated with traffic congestion, more than 80% of air pollution in developing country cities, consumption of more than half of liquid fossil fuels globally, almost a quarter of global energy-related CO₂ emissions, and for more than 1.27 million annual fatal accidents globally (UNEP, 2011). The totality of these societal costs, including adverse health effects of air pollution, noise, and vibration³¹, and loss of biodiversity from land taken by transport infrastructure can add up to more than 10% of a country's GDP annually (UNEP, 2011). Congestion has been found to hinder access to jobs, markets, and essential facilities, particularly for the poorest and most vulnerable members of society. About half of the people who die from road accidents are pedestrians, cyclists, and motorcyclists who are mainly the poor usually left out of infrastructure provision.

The transport sector is a major source of CO₂ emissions and therefore a leading contributor to climate change. Globally, CO₂ emissions from transport are distributed as follows: land transport (73%)³², aviation (11%), and shipping (9%) (UNEP, 2011). Passenger transport accounts for 73% of the total land transport emissions while freight transport accounts for 27%, mainly from trucks.

Kenya's transport sector is mainly composed of air, road, railway, and maritime sub-sectors. Moreover, the non-motorized transport sub-sector is large and growing, and is increasingly receiving policy attention. Infrastructure in the sector includes roads, bridges, railways, airports, ports and harbours, and such supporting infrastructure as parking facilities and fuelling stations.

Air transport

Kenya's air transport infrastructure comprises of 3 international airports and about 300 other airfields, most of which are unpaved (Cameron et al., 2012). Jomo Kenyatta International Airport (JKIA) in Nairobi has become one of SSA's three main international gateways and the national carrier, Kenya Airways, is one of Africa's three largest international airlines. Moreover, Kenya has the fourth largest domestic air transport market in SSA (Briceño-Garmendia & Shkaratan, 2010). The air transport services have played a key role in supporting two of Kenya's leading productive sectors, namely tourism and horticulture.

Growth of air transport industry in the country over the last decade is demonstrated by the steady growth of passengers from about 1.6 million in 2000 to about 3.3 million by 2010³³. Kenya's share of total passengers carried in Sub-Saharan Africa (including countries of all income levels)

increased from 8.4% to 10.2% over the period. This is also evident in freight where Kenya's share of total air freight in SSA rose from 4.5% in 2000 to 13.4% by 2006 before declining to 10.6% by 2010. Total air freight in the country grew from 77 million ton-km in 2000 to 301 million in 2006 before gradually declining to 258 million by 2010.

There are a number of challenges to the sector's further development. First, the terminal capacity at the JKIA is very limited, as is airside infrastructure such as taxiways and aprons (Briceño-Garmendia & Shkaratan, 2010). Current passenger traffic at JKIA has exceeded terminal capacity by a factor of about 3. The growth plans of Kenya Airways, moreover, are currently seriously constrained by the limited parking space at the airport. The other challenge is inadequate security provisions that have stood in the way of JKIA obtaining U.S. Category 1 Security Clearance that would pave the way for direct flights to the USA (Briceño-Garmendia & Shkaratan, 2010).

Encouragingly, expansion, upgrade, modernization, and rehabilitation of airports and airstrips has been one of the key priorities of the first 5-year medium term plan (MTP 2008-2012) of the Kenya Vision 2030. The Annual Progress Reports of the plan show that a considerable amount of work in this direction has been done in the Kisumu International, Jomo Kenyatta International, and Wilson airports. Moreover, 6 airstrips were rehabilitated in 2010/11 while another 6 were under rehabilitation in 2011/12.

Aviation is an important source of greenhouse gas (GHG) emissions, especially from jet kerosene consumption.

Current passenger traffic at JKIA has exceeded terminal capacity by a factor of about 3. The growth plans of Kenya Airways, moreover, are currently seriously constrained by the limited parking space at the airport.



³¹ Air pollution from exhaust emissions is associated with cardiovascular/pulmonary and respiratory diseases. Lead pollution especially is associated with multiple and serious diseases and children are particularly vulnerable to IQ and attention span reductions, among other ailments. In addition, a recent study has estimated that improvement of oil refineries to reduce sulphur content of fuels used for transport could save about US\$ 340 million in health costs per year in East Sub-Saharan Africa (ICF International, 2009).

³² Moreover, more than 80% of the projected increase in emissions in the future is expected to come from road transport. However, emissions from maritime and aviation are projected to grow very rapidly.

³³ World Bank Open Source Data, accessed in December 2012

Maritime transport

Maritime transport is an important component of transportation in Kenya, with the country being the outlet for several landlocked neighbouring countries. While the sector continues to face serious challenges, it has improved over time with the port's container traffic growing from 240,000 twenty foot equivalent (TEUs) in 2000 to 587,367 in 2007, and to 771,000 TEUs by 2011. Total port freight reached 19.95 million tons in 2011 and is growing rapidly. The liner shipping connectivity index³⁴ also improved considerably from 9 between 2004 and 2006 to 13 by 2010. Moreover, the quality of port infrastructure in the country improved from 3³⁵ in 2007 and 2008 to 4 between 2009 and 2011.

A perpetual challenge with respect to maritime transport has been long delays, occasionally accompanied by cost escalation, due to systemic weaknesses ranging from inadequate container handling capacity, facilities, and equipment; and governance problems; to poor interface with hinterland road and railway transport services. The total container handling capacity, for example, stood at 600,000 TEUs against traffic of 771,000 TEUs in 2011. By 2006, moreover, Mombasa port's container crane productivity³⁶ was only 10 containers per hour compared to 15 at the port of Durban and 20 at the port of Dar es Salaam (Briceño-Garmendia & Shkaratan, 2010).

Inability of vessels of large size to dock and navigate at the port was another major challenge until April 2012 when dredging (to -15 metres) and widening of the Kilindini Harbour was completed. This was one of the priorities in the first 5-year plan under Kenya Vision 2030. The dredging work started in July 2011. Completion of this work has enabled vessels with capacities of even 6,000 TEUs to dock and navigate at the port, thereby aligning the port with the global trend of increasing vessel size³⁷ and enhancing the port's international competitiveness.

Several other large projects are under various stages of implementation as part of Kenya Vision 2030. First, construction of berth No. 19 at the port was expected to be completed by March 2013 thereby increasing container handling capacity to 800,000 TEUs. Second, construction of the second container terminal at the port has commenced and is expected to be completed in 2015. This is expected to boost annual capacity by 1.2 million TEUs to reach 2 million TEUs.

Third, a new access road and railway line are planned to link the second terminal to existing port network and to a proposed road by-pass at

Dongo-Kundu and the Mombasa-Nairobi highway. Fourth, a contract has been awarded to prepare a master plan and develop Kenya's first free port at Dongo-Kundu in Mombasa. Fifth, automation of major operations at the port is being implemented with the aim of enhancing operational speed and efficiency. Sixth, the country is investing in the expansion of cargo handling capacity and is also exploring the feasibility of developing small ports along the coastline.

In addition to efforts to improve the port of Mombasa, feasibility studies, preliminary designs, development of master plan, and detailed designs of the first three berths and associated infrastructure with respect to the development of Kenya's second (and larger) port in Lamu (as part of the planned Lamu Port – Southern Sudan – Ethiopia Transport, LAPSSSET corridor) were completed in July 2011.

Maritime transport contributes only marginally to GHG emissions, mainly from gasoline consumption.

Road transport

Like in many other countries, road transport infrastructure is very important for movement of goods and passengers, and therefore, growth. The country's total road network was estimated at 61,945 km in 2009³⁸, down from 63,942 km in 2000. Road density in the country is rather low, at 11km of road per 100 sq.km of the land area³⁹, compared to the world average of 30-33. Besides the low density, only about 14% of the Kenyan roads were paved by 2009, compared with Sub-Saharan Africa and World averages of 19% and 65%, respectively.

About 30% of Kenya's population has access to an all-weather road within 2 km of their residence (Briceño-Garmendia & Shkaratan, 2010). However, there are large regional differences in access (Fig. 7.27).

Intensity of road usage in Kenya is increasing fast but remains lower than SSA and World averages. Thus, the number of motor vehicles for every 1,000 people rose from 17 in 2003 to 20 by 2007 and 23 by 2009 (Fig. 7.1). The number of passenger cars per 1,000 people followed a similar pattern, increasing from 9 in 2003 to 11 in 2007 and to 13 in 2009 (Fig. 7.1). By 2011, Kenya had about 1.4 million registered vehicles and 400,000 motorcycles, with about 60% being used around Nairobi, and about 200,000 new vehicles being registered annually (Cameron et al., 2012a).

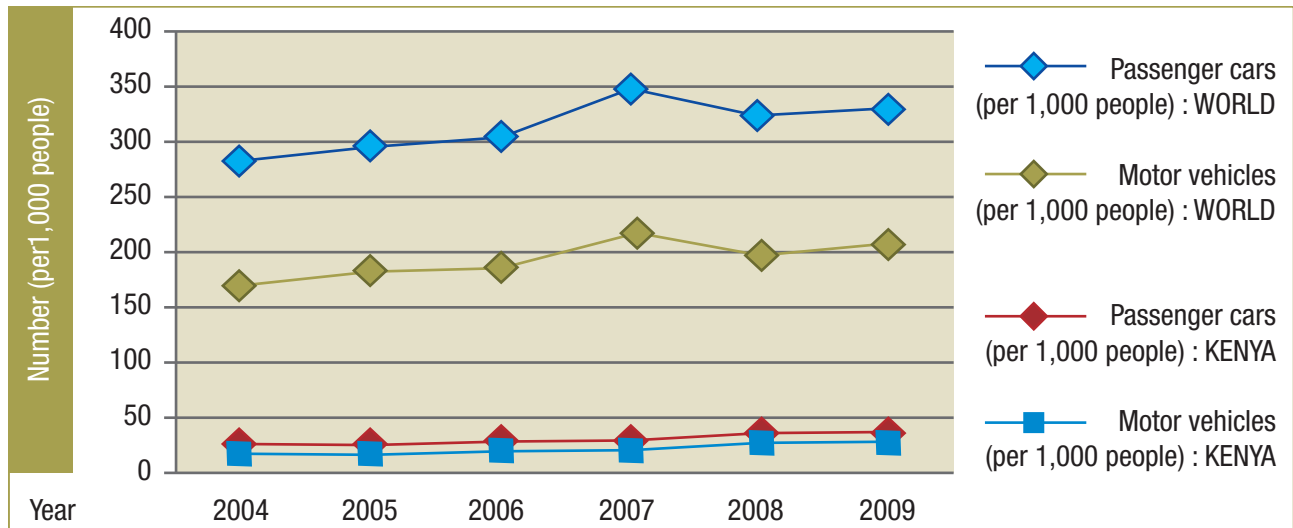
Road density in the country is rather low, at 11km of road per 100 sq.km of the land area³⁹, compared to the world average of 30-33.



38 World Bank Open Source Data, accessed in December 2012.

39 The same estimate is reported for 2004, 2008 and 2009 (World Bank Open Source Data, accessed in December 2012), suggesting that data availability and quality are challenges.

Figure 7.1: Number of motor vehicles and passenger cars, Kenya versus World



Source: Data from World Bank Open Source, accessed in December 2012.

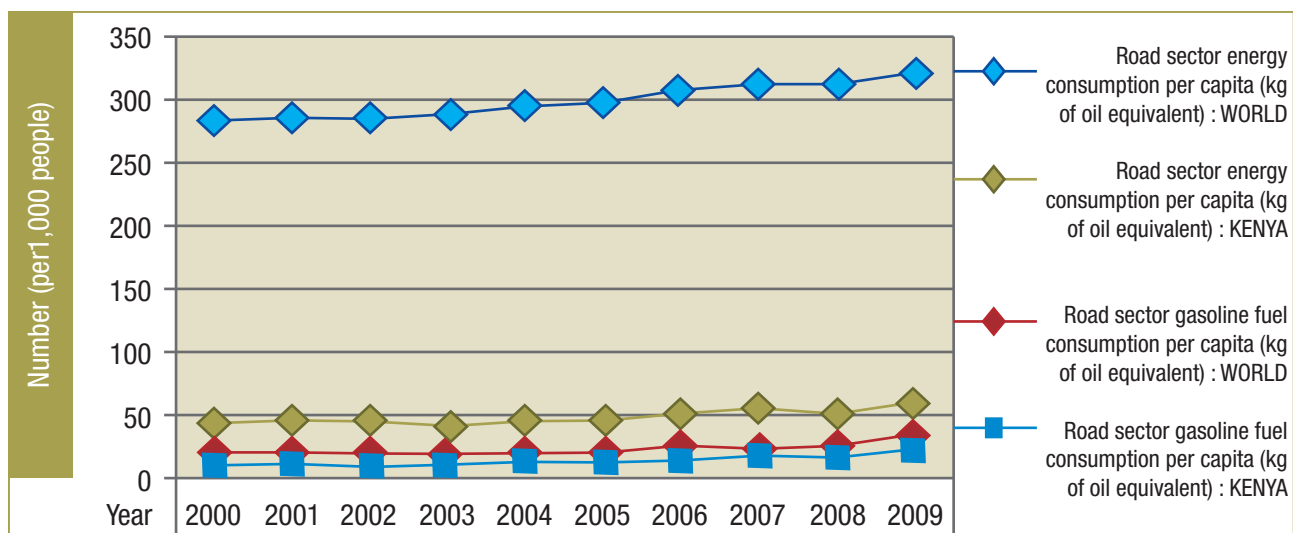
The number of vehicles for every km of road in the country also increased from 10 in 2004 to 13 by 2008 when the global average was 30, implying that Kenya’s roads can be utilized more efficiently.

Data on the volume of goods and passengers transported on the country’s roads is not up to date, with the latest data showing that 22 million ton-km of goods were transported in the 2000-2001 period.

The road sector is the main source of air pollution especially in the urban areas of the country. It is estimated, for instance, that the mean daytime concentration of particulate matter in Nairobi ranges from 10.7 mg/m³

in the edges of the city to 98.1 mg/m³ in the Central Business District (CBD), which is about 5 times higher than the global standards (WHO, 2006). The roads sector is also the main source of GHG emissions in Kenya’s transport sector, accounting for 99% of the non-aviation transport emissions and projected to account for 91% of the total emissions from the transport sector by 2030 (Cameron et al., 2012a). The situation would be significantly worse if the intensity of energy use in the Kenyan roads sector were to increase towards the global average (Fig. 7.2).

Figure 7.2: Intensity of energy use in the roads sector



Source: Data from World Bank Open Source, accessed in December 2012.

The main factors accounting for the high emissions include severe traffic congestion in the urban areas, a large number of private vehicles that ferry only 22% of the travellers but are responsible for 64% of the traffic volume, and heavy reliance on imported second hand vehicles that account for about 56% of the total number of vehicles registered every year.

Several policy measures recently undertaken or under consideration in the roads transport sector are expected to reduce GHG emissions significantly. These include barring importation of vehicles older than 8 years, re-introduction of a 10% bio-ethanol blending (E_{10}) policy albeit on a pilot basis in Kisumu and Nakuru, exemption of import duty for battery operated vehicles, road improvements, and railway system improvements. In addition, the planned Mass Rapid Transit (MRT) system for the Nairobi Metropolitan region⁴⁰ can considerably reduce traffic congestion and thus GHG emissions.

Besides general pollution and GHG emissions, other challenges in the roads sector include the low roads density, limited connectivity due to many neglected areas in the country, poor condition of many roads in the country partly caused by a high volume of high density vehicles (HDVs), the low life expectancy of roads in the country (8 years compared to about 40 years in Europe) (Kolossa, 2006), and low safety record as demonstrated by the high rate of accidents⁴¹. In addition, there is a huge rehabilitation backlog, low rates of budget execution (for example, only 60% of the 2006 budget), cost overruns of up to 80% over engineering estimates, lengthy implementation delays, and inadequate supervision of construction contracts (Briceño-Garmendia & Shkaratan, 2010). Moreover, planning and management of the road transport is hampered by lack of important data such as the number of vehicles on roads, the number of vehicles de-registered or retired from the roads, usage patterns, infrastructure and vehicle stock characteristics, and fuel economy by type of vehicle (Cameron et al., 2012a). Low investment rates in roads infrastructure and high dependence on government funding, slow disbursement of donor funds, and encroachment on road reserves are additional bottlenecks.⁴²

Not surprising, therefore, 37% of firms in the country identified roads as a major business constraint compared to 23% of the firms in low-income African countries and 7% of firms in middle-income African countries (Gwilliam et al., 2008).

Rail transport

The railway system does not only play a marginal role in the transportation of goods and passengers in Kenya but has also declined over time. Thus, the volume of rail lines has declined from about 2,634 route-km in 2001-2004 to 1,917 route-km in 2005-06, the last period for which data are available.⁴³ Moreover, the volume and number of goods and passengers ferried by the system dropped from 1,492 million ton-km in 2000 to 1,399 in 2006 (for goods) and from 350 million passenger-km in 2000 to 226 in 2006 (in the case of passengers). Rail transport accounts for

less than 6% of cargo ferried on the northern corridor that links Kenya, Uganda, Rwanda, Burundi, Democratic Republic of Congo (DRC), parts of Tanzania, South Sudan, and Ethiopia (Briceño-Garmendia & Shkaratan, 2010).

The country's single-track railway system is managed by Kenya Railways Corporation, a public agency. Kenya has rail links Uganda and Tanzania although the track is characterized by disrepair, low capacity, and slow speeds (Cameron et al., 2012). In addition, the system is characterized by low efficiency levels, lack of operational expertise by the concessionaire resulting in failure to finance the anticipated track rehabilitation, and weak multimodal transfers between the port and the rail corridor (Briceño-Garmendia & Shkaratan, 2010).

Weaknesses of the railway system have seen a gradual shift of cargo to road transport and contributed to considerable road damage and traffic congestion, and high freight costs that have impeded trade competitiveness in the region. Nevertheless, railway transport retains a key positioning in the Kenya Vision 2030 as part of the 50-year integrated national transport master plan.

Railway freight is expected to increase six-fold by 2030 when the vision is fully realized, and could account for more than 30% of transit freight by 2020 (Cameron et al., 2012a). Moreover, recent reforms and projects including granting of a 25-year concession to a private consortium (Rift Valley Railways) in 2006, and the on-going/planned flagship projects of developing a light rail system in Nairobi Metropolitan region with capacity to ferry at least 150,000 people (about 5% of projected public transport demand in the metropolis) per day, and developing a new transport corridor linking the Kenyan coast with South Sudan and Ethiopia, are enough evidence that the stagnation and decline always associated with the railway transport system will be reversed (see also Box 7.1). Moreover, the government has allocated some funds for the commencement of a standard gauge railway linking Mombasa and Uganda in the 2013/14 budget.



Syokimau Railway is the first station to be completed under the Nairobi Commuter rail project

www.vision2030.go.ke

40 This comprises of 9 MRT corridors incorporating Bus Rapid Transit (BRT) and Light Rail Transit (LRT) systems, and an additional BRT recently approved by the World Bank on the elevated Uhuru Highway overpass (Cameron et al., 2012a).

41 It is estimated that about 68 people die per 1,000 registered vehicles in Kenya, which is 30-40 times higher than in highly motorized countries (Cameron et al., 2012a). Moreover, the cost of accidents is very high, estimated at 2-5% of GNP (GOK, 2008, Kenya Vision 2030).

42 GoK, 2012a.

43 World Bank Open Source Data, accessed in December 2012.

Box 7.1: Kenya opens its first Railway Station in more than 80 years!

Kenya's recent unprecedented focus on infrastructure development as part of her Vision 2030 was demonstrated by the official launch, by the President, of the first phase of Nairobi Commuter Rail Service project on 13th November 2012, barely a week after the commissioning of the 8 lane Nairobi-Thika superhighway. This phase involved construction of the first railway station in more than 80 years at Syokimau and laying of 2.2km of new railway tracks to link the station with the Nairobi-Mombasa line, at a cost of Kshs 400 million. The new service links Syokimau with Nairobi's Central Business District (CBD), and provides a comfortable, fast, and cheaper alternative means of transport to the heavily congested Mombasa-Nairobi highway. The project is part of the Nairobi Urban Transport Master Plan that includes rail, road, rapid transit bus, and metro. It will cut travel time from about 90 minutes by road to only about 30 minutes. The NCR project consists of 4 phases (linking the CBD to Syokimau, Ngong, Kiserian, Kikuyu and Jomo Kenyatta International Airport (JKIA) estimated to cost about Kshs 24 billion. Two other railway stations are already under construction at ImaraDaima and Makadara.

Source: Ministry of Transport Source: Ministry of Transport

Railway transport contributes minimally to GHG emissions in Kenya. It is estimated to be about 4 times more fuel efficient than road transport, and to account for less than 1% of the total emissions from the transport sector by 2030 (Cameron et al., 2012a). Thus, modernization and extension of the current railway system will not only enhance climate change mitigation, but also shift freight transport from roads, and therefore, raise life expectancy of the roads, improve road safety, and also facilitate regional trade.

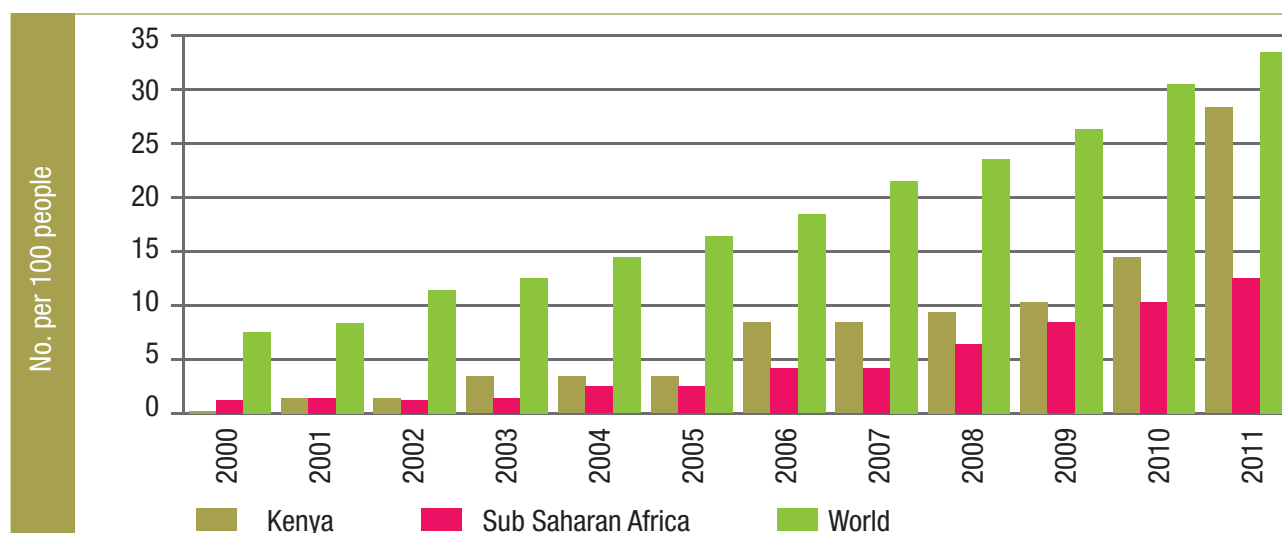
7.1.2 Information Communication Technology (ICT) sector

Information communication technologies are transforming human lives in many ways around the world. Not only do they enhance the choices

people have to live according to their desired lives, but they also enhance productivity and economic growth, and create the type of jobs preferred by the youth. These technologies are also empowering poor people and helping them to move out of poverty. An exciting example of this is the mobile telephone money transfer innovation in Kenya, M-Pesa, which has provided financial services to millions who were not banked and therefore lacked access to financial services. The human development impact of M-Pesa has been lauded by no less than the global leader in ICT innovation and investment, Bill Gates.⁴⁴

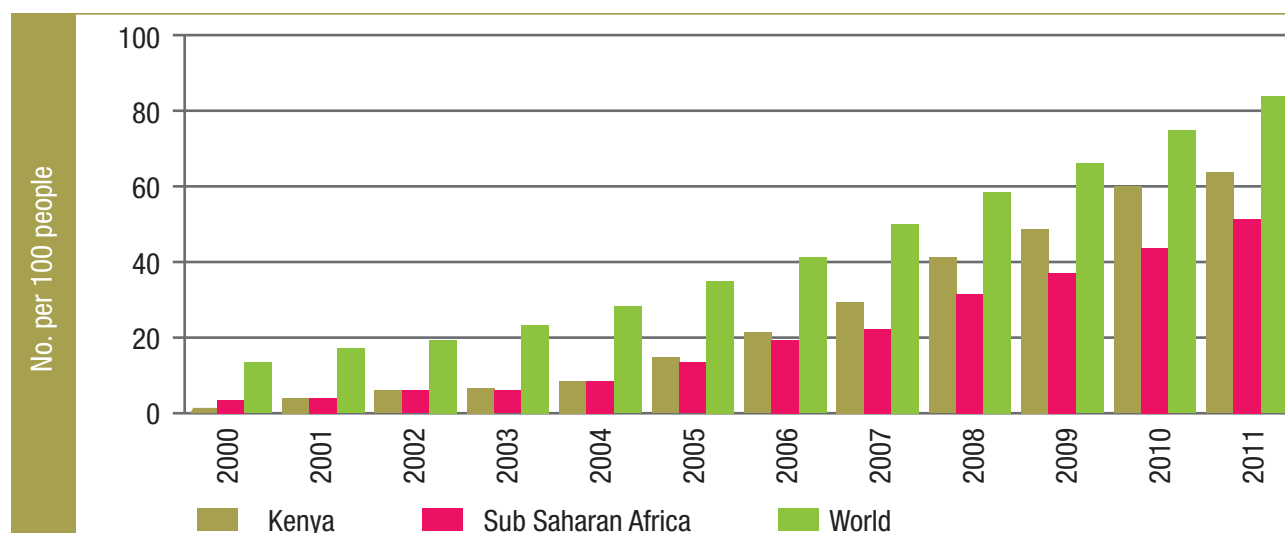
Kenya has made great strides in the ICT sector especially in the 2000s when unprecedented reforms were implemented. Over the last decade or so, the country has dramatically narrowed her gap with the global average and surpassed the sub-Saharan Africa average especially in the proportion of the population using or subscribing to the Internet and mobile cellular services (Figs. 7.3 and 7.4).

Figure 7.3: Internet users (per 100 people)



Source: Data from World Bank Open Source, accessed in December 2012.

⁴⁴ Gates, Bill. 2013. "How digital technology is improving the lives of the world's poorest people", article published in the Daily Nation of January 1, 2013, page 13.

Figure 7.4: Mobile cellular subscriptions (per 100 people)

Source: Data from World Bank Open Source, accessed in December 2012.

Regrettably, the pace of catch up with respect to the infrastructure such as the number of secure Internet Servers and telephone lines is much slower. For every 100 people in the country, there is only 1 telephone line and this has remained so for more than a decade. This compares with about 2 telephone lines in Sub-Saharan Africa and about 18 globally. Kenya's share of the total number of secure Internet servers in SSA rose from 0.79% in 2004 to 2.65% in 2011, while her share of the servers in the world increased from 0.0025% to 0.01% over the same period.

Data is not available about GHG emissions in Kenya's ICT sector although they are insignificant if they exist at all. The key challenges in the sector include inadequate infrastructure network coverage in some parts of the country, inadequate levels of rural electrification, and high rate of illiteracy.

7.1.3 Energy sector

The centrality of energy in human development, which is the goal and process of expanding people's capabilities, freedoms, and choices in order for them to live the lives they desire, is best captured by the response that India's Prime Minister gave to a question on what he considered as his country's main priority: "If you asked me that question 15 years ago, I would have said 'food'. Today, it is energy. We can do anything – become whatever we wish to be."⁴⁵ All of modern life activities (including work, travel and communication, cooking, running hospitals and schools, security systems, and entertainment, among others) are driven by energy, and it is the lifeblood of development. Access to adequate and affordable energy to all segments of society translates into wealth, power, and resilience against climate change and other shocks.

The key challenges in the sector include inadequate infrastructure network coverage in some parts of the country, inadequate levels of rural electrification, and high rate of illiteracy.

Key concerns in the sector include a high level of energy insecurity, which is worsening due to rising fossil fuel prices and having serious implications on the balance of payments; high risk of pollution and other health hazards especially to the poor who rely on traditional and dirty forms of energy; the increasing climate change vulnerabilities, impacts, and risks; and the high energy poverty especially among the poor.

On account of its importance in fuelling growth and development, provision of adequate and affordable energy supply is the central focus of Sessional Paper No. 4 of 2004 on Energy Policy and the Kenya Vision 2030. Energy is also critical for the achievement of Millennium Development Goals (MDGs) (Table 7.2). The country spends more than half of its export earnings in energy imports, mainly oil.



45 Versi, Anver. 2012. "Power to the people: Can Africa's vast energy sources be the key to the continent's future affluence?". Msafiri, Kenya Airways Magazine, Edition 84, November-December 2012, pp.92-100.

Table 7.2: Role of energy access in the achievement of MDGs

Millennium Development Goal (MDG)	How Modern Energy will help attain the MDG
1 Eradicate extreme poverty and hunger by reducing the proportion of people whose income is less than US\$ 1 per day (in US\$ PPP)	Increases household incomes by improving productivity in terms of time saving, increasing output, and value addition, and diversifying economic activity. Energy for irrigation increases food production and access to nutrition.
2, 3 Achieve universal primary education and promote gender equality	Provides time for education, facilitating teaching and learning by empowering especially women and children to become educated on health and productive activities, instead of traditional energy related activities.
4, 5, 6 Reduce child and maternal mortality and reduce disease	Improved health through access to clean water, cleaner cooking fuels, heat for boiling water, and better agricultural yields. Health clinics with modern fuels and electricity can refrigerate vaccines, sterilise equipment, and provide lighting.
7 Ensure environmental sustainability	Cleaner fuels, renewable energy technologies, and energy efficiency can help mitigate environmental impacts at the local, regional and global levels. Agricultural productivity and land-use can be improved to run machinery and irrigation systems.

Source: UNEP, 2011.

The energy sector in Kenya comprises of a large biomass sub-sector; an import-based petroleum sub-sector that, however, stands on the verge of transformation following recent discovery of oil resources in the country; low but rapidly growing electricity access rates; and dominance of renewable⁴⁶ sources of electricity. The institutional infrastructure in the sector comprises of:

- Public hydroelectric, geothermal, and 1 wind power plants;
- Public transmission and distribution lines;
- A public-private owned oil refinery in Mombasa which has some capacity to produce LPG;
- A public oil pipeline company;
- Several private and one public oil distribution companies;
- Independent power producers (IPPs) that have focused on thermal generation in the past but are now venturing into renewable sources such as wind; and
- Private agencies generating power from various sources including mini-small hydros, solar, and co-generation with sugar production. This includes multinationals such as the General Electric (GE) which is investing in wind power generation.

For the vast majority of households, however, the infrastructure comprises of the biomass sources and the various forms of ovens used for cooking, and lamps used for kerosene lighting. A LPG import handling, storage and distribution facility is also expected at the port of Mombasa. The sector is also set for further transformation following discovery of coal deposits and pursuit of nuclear energy capacity.

Biomass from wood sources and agricultural residues accounts for about 89% of the country's primary energy demand (KIPPRA, 2010)⁴⁷. The main forms of biomass energy include fuel wood (43%), charcoal (30%), and others (4%). Liquefied Petroleum Gas (LPG) use is insignificant.

Use of biomass fuel is a major contributor to indoor air pollution and therefore disease. It has been estimated, for instance, that pollution from burning solid fuel accounted for 2.7 per cent of the global burden of disease in 2000 and is ranked next to unsafe drinking water and lack of sanitation as the leading environmental contributors to health problems (WHO, 2006; UNEP, 2011).

Use of fossil fuel also has considerable adverse impacts on human development. Air pollution from motor vehicle use, for example, is a growing problem, especially due to traffic congestion in the large urban centres. The World Health Organization estimated that external environmental risks were responsible for up to 10% of global death and disease burden in 2009, and that fossil fuel use accounted for over half of this (WHO, 2009).

The use of fossil fuels and traditional forms of energy compromise human development in several other ways, including accelerating deforestation and thus affecting ecosystems and biodiversity, decreased water supply and quality, acidification of water bodies, and introduction of hazardous substances into the biosphere, thereby affecting the capability of the planet to respond to climate change (UNEP, 2011).

Fossil fuel consumption as a share of the total energy consumed in Kenya is quite low (averaging about 15% between 2000 and 2009) compared to the SSA and global averages (about 40% and 80% respectively) over the same period.

Kenya is rich in renewable energy sources (Table 7.3) and its consumption is high and rising (Fig. 7.5), which demonstrates the high potential of alternative energy as a mitigation strategy.

⁴⁶ Renewable energy is derived from natural processes that are replenished constantly. It includes energy generated from solar, wind, biomass, geothermal, hydropower and ocean resources, and bio-fuels and hydrogen derived from renewable resources (IEA, 2008).

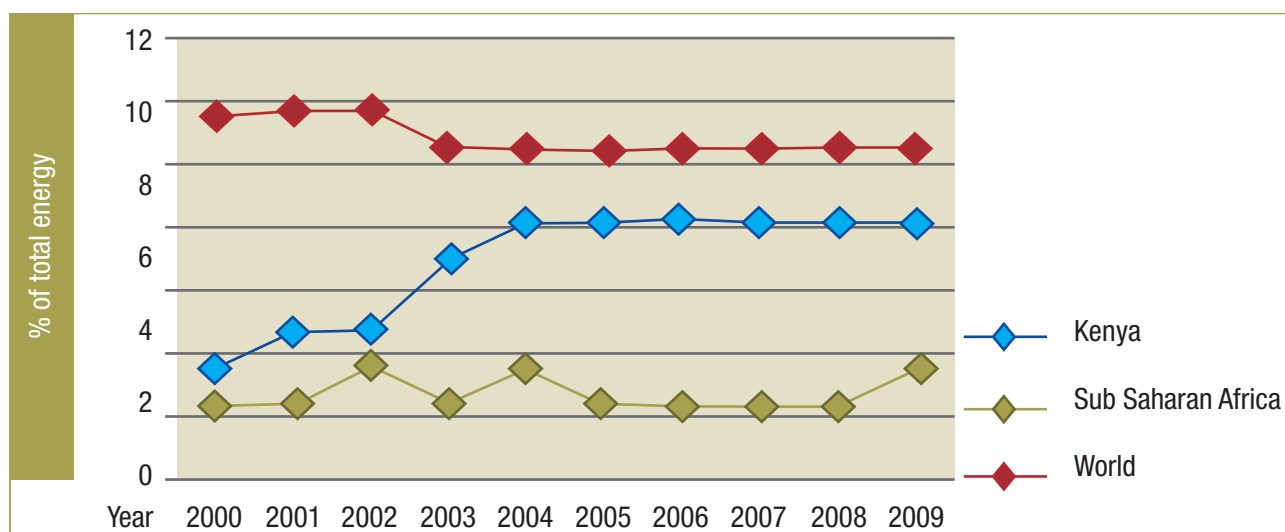
⁴⁷ This refers to total energy demand excluding electricity and transport fuels.

⁴⁸ World Bank Open Source Data, accessed in December 2012.

Table 7.3: Kenya's energy resources

Resource type	Estimated Potential	Current Installed Capacity
Hydroelectricity	3,000-6,000 MW, at least half of the potential from small hydro potential, although the International Energy Agency (IAE) estimates technically feasible potential at 1,100 MW (Cameron et al., 2012b).	88 MW
Geothermal	10,000 MW	208 MW by July 2012
Petroleum	Assessment still in progress	Nil. However, there is a refinery that refines imported crude oil.
Wind	90,000 km ² with wind speeds of at least 6 metres/second (Cameron et al., 2012b). Wind generation by 2030 is estimated at 2 GW within the Updated Least Cost Power Development Plan.	5.1 MW wind farm in Ngong owned by KenGen, which was installed in 2009.
Solar	In many parts of the country, solar resources are about one and half times better than in Germany, one of the world's largest markets for solar PVs (Cameron et al., 2012b). Average solar radiance at constant temperatures is 4.5 KWh/m ² /day (Saidi et al., 2012).	No solar-generated electricity in the national grid yet. However, it is estimated that Kenya could produce 250 MW in the near term (Hille et al., 2011).
Coal	Sufficient deposits in the Mui Basin (Kitui) for commercial exploitation (MoE, 2012a).	Nil but there are plans to generate 620 MW of electricity by 2018 and 2,400-4,490 by 2030.
Biomass	Large potential, largely unknown but has been conservatively estimated at 50MW by Fisher et al. (2010).	Currently, several sugar companies have installed capacity for electricity co-generation but most of this is used locally and not reported. However, one sugar company (Mumias) is exporting about 17.7 GWh annually to the national grid (Cameron et al., 2012b).
Bio-diesel	2 million to 40 million litres p.a. (Cameron et al., 2012a)	Insignificant
Bio-ethanol	49 million to 45,000 million litres p.a. (Cameron et al., 2012a). By 2008, the country was producing only 125,000 annually. In the 1980s, Kenya used to blend ethanol with petrol (E10) to produce gasohol but this stopped because of inadequate production.	125,000 litres by 2008

Source: Various

Figure 7.5: Alternative and nuclear energy (% of total energy)

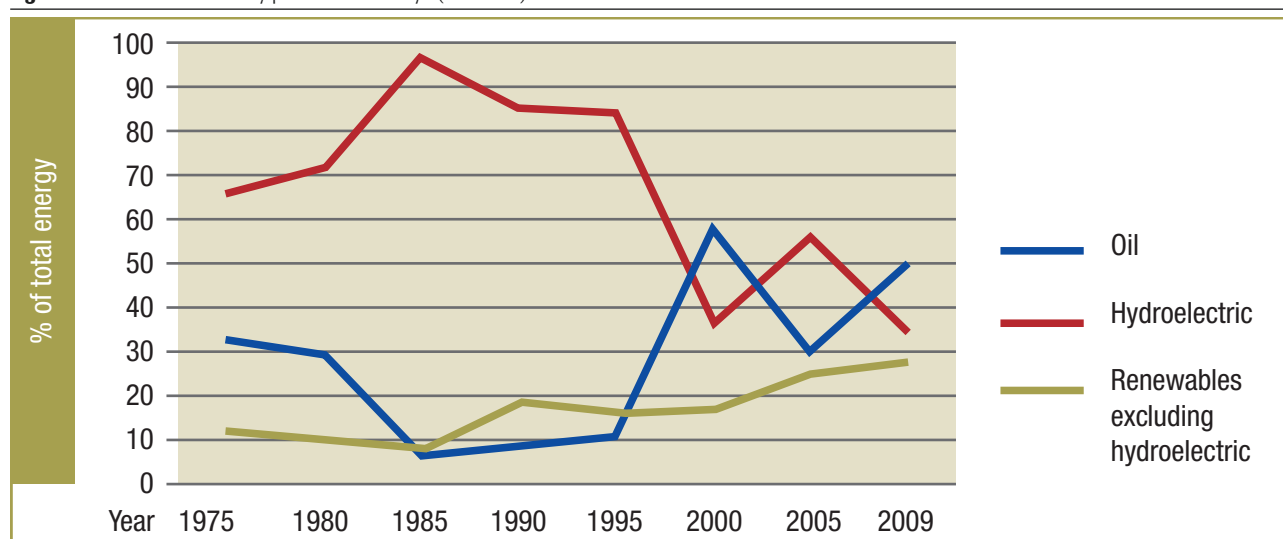
Source: Data from World Bank Open Source, accessed in December 2012.

Electricity accounts for only about 10% of final energy consumption, distributed as follows: 60% to the commercial and industrial sector; 24% to households; and 16% to small commercial enterprises (Saidi et al., 2012). This is likely to change, however, as demand for electricity is increasing at a fast rate. Between 2005 and 2010, for instance, overall demand for electricity increased by 27% while demand in the household sub-sector grew by 35% over the same period (Saidi et al., 2012).

Currently, the main source of electricity is hydroelectricity followed by thermal sources and geothermal, although the relative contribution of hydroelectric sources has declined considerably since the 1970s (Fig.

7.6). The electricity mix is projected to change drastically in order to drive the achievement of Kenya Vision 2030 and in light of recent resource discoveries and long-term plans⁴⁹ (Fig. 7.7 and Box 7.2). As a way of adaptation to climate change, for example, the relative dependence on hydroelectricity is projected to decline considerably further. Dependence on thermal generation is also projected to decline considerably in efforts aimed at reducing not only the cost of electricity but also abatement of CO₂ emissions. Investment in solar energy generation is expected to increase after revision of the energy policy, effective January 2013, to improve the feed in tariffs for suppliers of solar energy.

Figure 7.6: Sources of electricity production in Kenya (% of total)



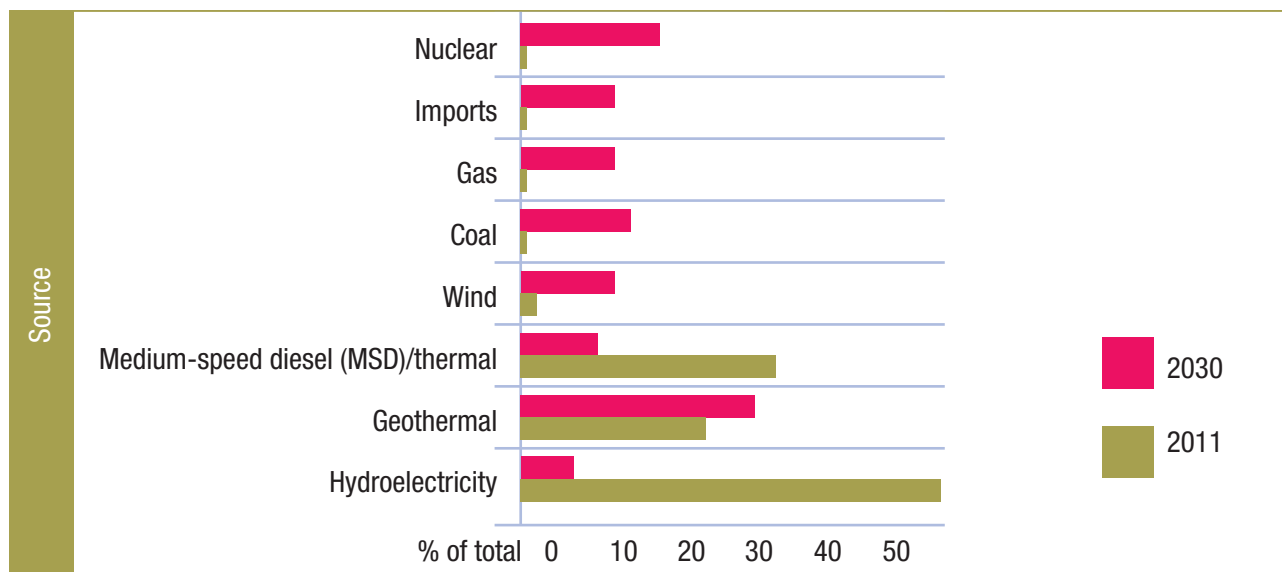
Source: Data from World Bank Open Source, accessed in December 2012.

Box 7.2: Kenya's largest wind power project underway

The first of its kind in Kenya, the Lake Turkana Wind Power Project (LTWP) is expected to produce 300MW of reliable low cost power to the national grid by mid-2015. This is equivalent to 20% of the current national installed electricity generation capacity, and signals the government's drive in diversifying renewable power sources from hydroelectric sources due to climate variability and change.

Source: Data from MoE (2011).

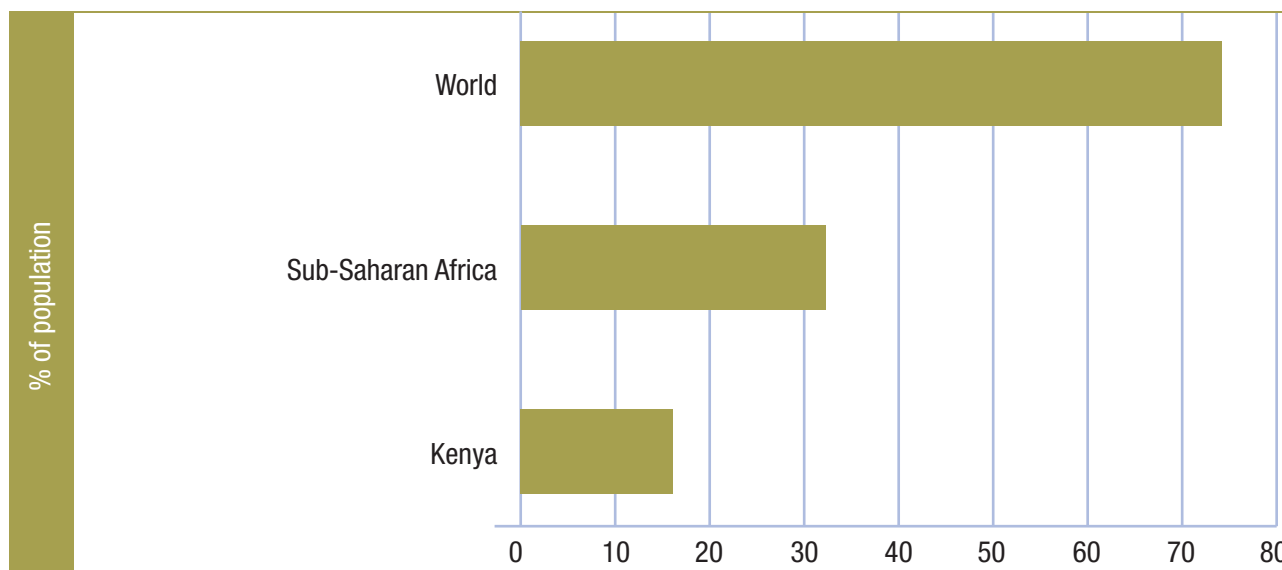
⁴⁹ The figures for 2030 are based on the Updated Least Cost Power Development Plan (ULCPDP). The figure for wind source in 2011 includes other sources such as biomass. Electricity generated and consumed on site by sugar processing factories and other producers is not included in the data.

Figure 7.7: Sources of electricity in Kenya in %, 2011 and 2030

Source: Data from MoE (2011).

Access to energy has increased considerably in Kenya since 2003, in both rural and urban areas. However, only about 20%⁵⁰ of households have access to grid electricity, with more than 60% of the households still dependent on biomass energy sources (GOK, 2012d). In the rural areas, the connection rate is only 12%. Moreover, even though access rates have improved, they are still considerably lower than the SSA and world averages (Fig. 7.8). Kenya's total annual energy consumption is very

low, at about 57 trillion British Thermal Units (BTUs), compared with the largest consumer globally, China, at 77,807 trillion BTUs. The per capita energy consumption in the country has averaged about 400 kg of oil equivalent between 2000 and 2009, compared with the SSA average of about 700 kg and world average of about 1,700 kg over the same period.⁵¹

Figure 7.8: Population (%) with access to electricity, 2009

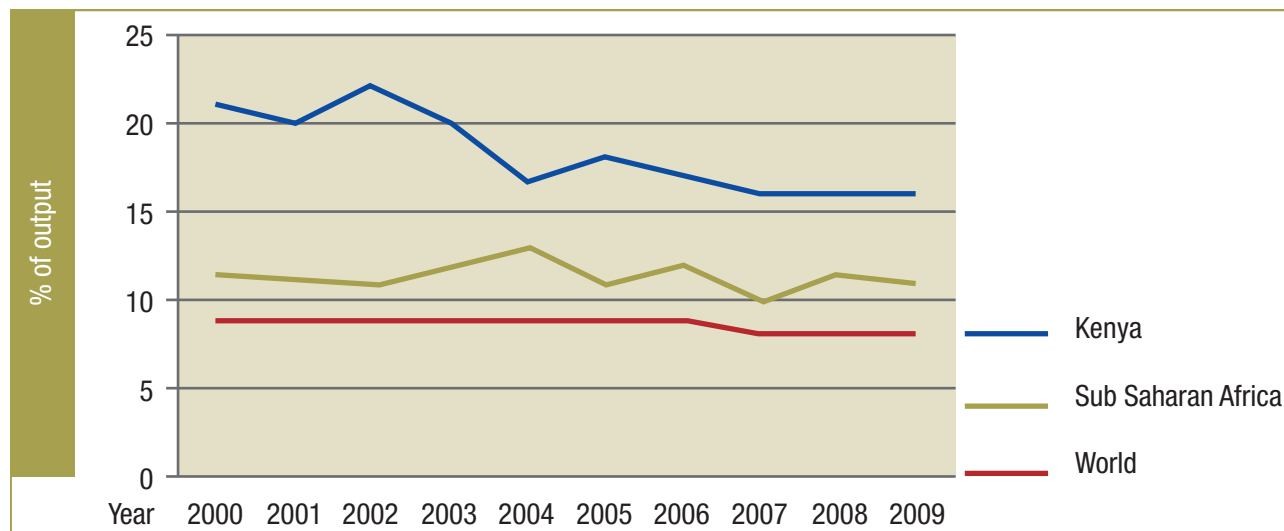
Source: Data from World Bank Open Source, accessed in December 2012.

The challenges associated with high dependence on hydroelectricity are supply and distribution instability, power rationing during drought periods, and price volatility- due to exchange rate movements and the switch to thermal generated power during dry periods. The country loses

about 16% of the power generated during transmission and distribution, compared to much lower rates in SSA and rest of the world (Fig. 7.9), and high cost of power continues to pose significant obstacles to trade competitiveness of the country.

⁵⁰ However, according to the 2011 Annual Report of Kenya Power, 29% of the total population receives electricity although other estimates are that only about 17% of the country's population can access electricity from the national grid.

⁵¹ Data from World Bank Open Source, accessed in December 2012.

Figure 7.9: Electric power transmission and distribution losses (% of output)

Source: Data from World Bank Open Source, accessed in December 2012.

CO₂ intensity, that is kg of CO₂ generated per kg of oil equivalent energy used, for Kenya has been constant at 1 kg between 2000 and 2009, compared with 2 kg for SSA and a global average of 3 kg over the same period. However, energy productivity in Kenya and SSA is significantly lower than the global average, with a GDP of US\$ 3 (in constant 2005 PPP terms) per kg of oil equivalent energy used in Kenya and SSA (over the 2000-2009 periods) compared with the global average of \$5.

Electricity generation and consumption was estimated to account for 23% of GHG emissions in the energy sector in 2010, but this is projected to rise significantly by 2030 due to the rapid expansion in demand and the planned development of gas, coal, and diesel plants (Saidi et al., 2012). CO₂ emissions from fossil fuel consumption contribute to climate change and ocean acidification.

7.2 Equity and Infrastructure in Kenya

Equity is central to the concept of human development and is an important target for Kenya in Vision 2030. Kenya is one of the countries with a significant inequality problem, not only with respect to income, but also along gender (and head of household status), education level, location (including the rural-urban divide, region and slum versus non-slum dwelling), ethnicity, and other cleavages such as age, disability, physical and mental ability, and current versus future generations. The magnitudes of differences along these cleavages indicate the categories of Kenya's society that are most vulnerable to climate change impacts, vulnerabilities, and risks.

Inequality in access to infrastructure services is important in its own right and also as a determinant of other important inequities such as those on income and education level. In turn, these inequities determine climate change impacts, vulnerabilities, and risks.

7.2.1 Location/regional disparities

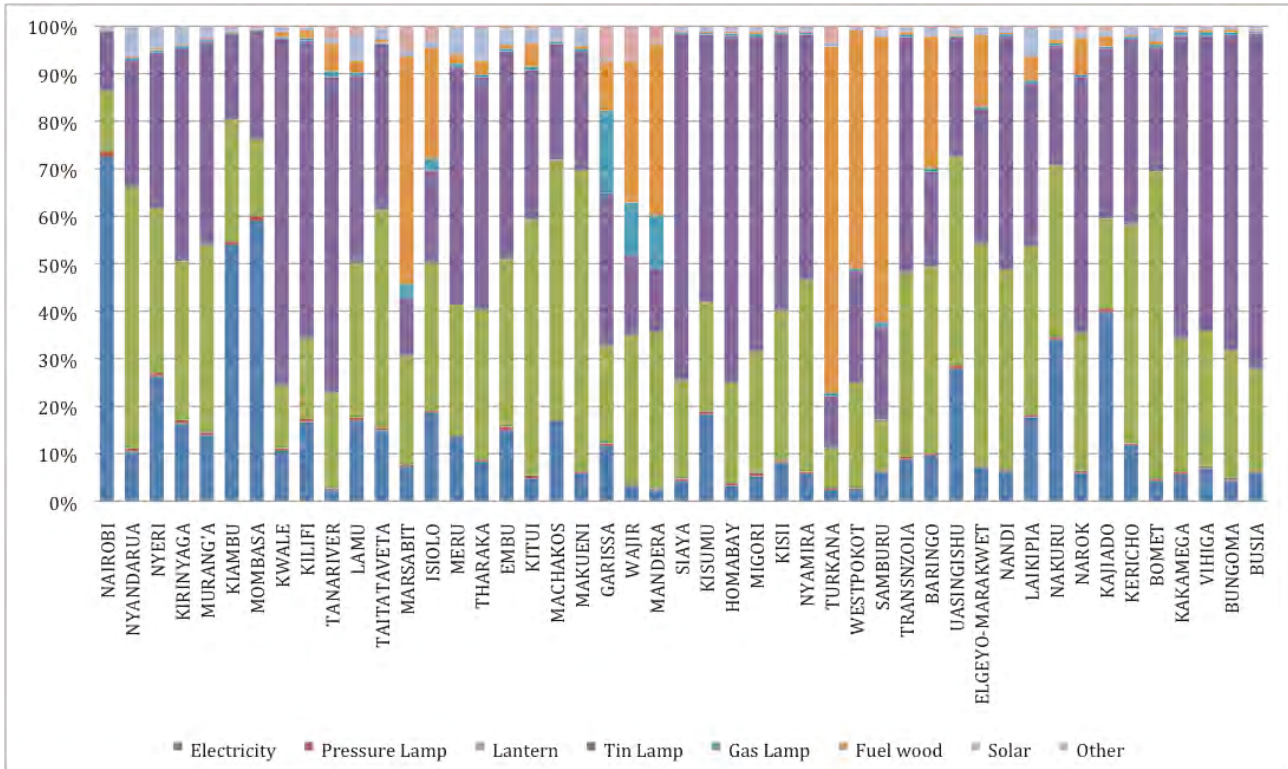
There are major location or regional inequalities in access to almost all infrastructure services in Kenya. The country's infrastructure backbones such as the main roads, the railway line, and key power transmission and fibre optic lines are concentrated in the southern half of the country, mainly along the main corridor linking Mombasa, Nairobi, Kisumu, and Uganda (Briceño-Garmendia & Shkaratan, 2010). Population and agricultural activity are also high in this part of the country. The northern part of the country is sparsely populated and has fragmentary infrastructure coverage (Briceño-Garmendia & Shkaratan, 2010).

Figures 7.10-7.14 show the wide disparity in various infrastructure services across the country. For example, electricity use is above 50% in only three counties (Nairobi, Mombasa, and Kiambu) and the use of tin lamps and lanterns for household lighting is widespread in the country (Fig. 7.10).

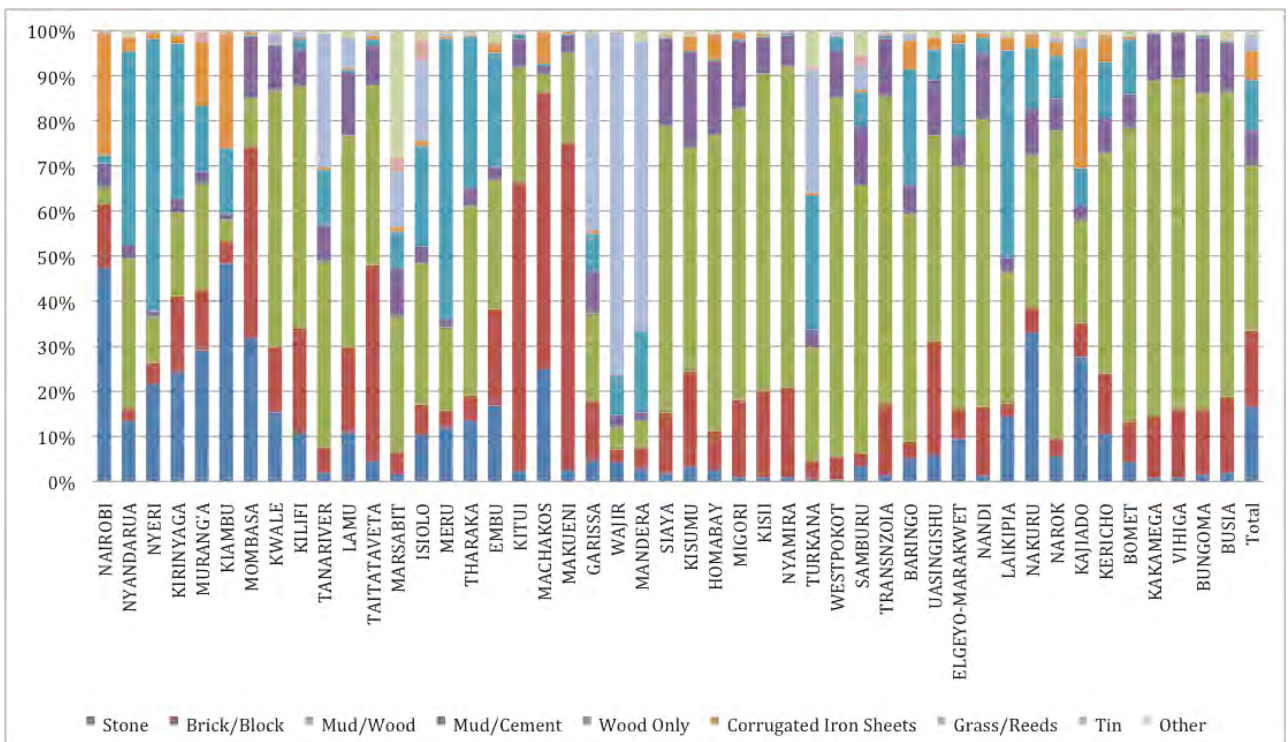
It is only in nine (9) counties or 19% of all counties that at least 40% of the houses have walls built using either stone, brick, or block (Fig. 7.11). There is thus heavy reliance on weaker construction materials such as mud, wood, and grass. There is appreciable progress with respect to the type of roofing material. In 5 counties at the coast and North Eastern parts of the country, less than 70% of the households live in dwellings that do not have roofs made of either corrugated iron sheets, tiles, or concrete (Fig. 7.12).

The general condition of the roads is poor. However, inequality across the counties is evident. Thus, it is in only 3 counties (Nairobi, Mombasa, and Kiambu) where paved roads constitute more than 10% of all roads (Fig. 7.13). Moreover, in about 66% of the counties, earth roads constitute at least 70% of all roads. In addition, the quantity and quality of roads is much higher in urban areas compared to rural areas. This is despite the fact that rural roads have been found to reduce poverty and to be pro-poor (UNEP, 2011).

The proportion of the population using mobile telephone ranges from as low as 19.3% in North Eastern province to 58.7% in Nairobi, while that using Internet ranges from as low as 0.4% in Western province to 10.5% in Nairobi (Fig. 7.14).

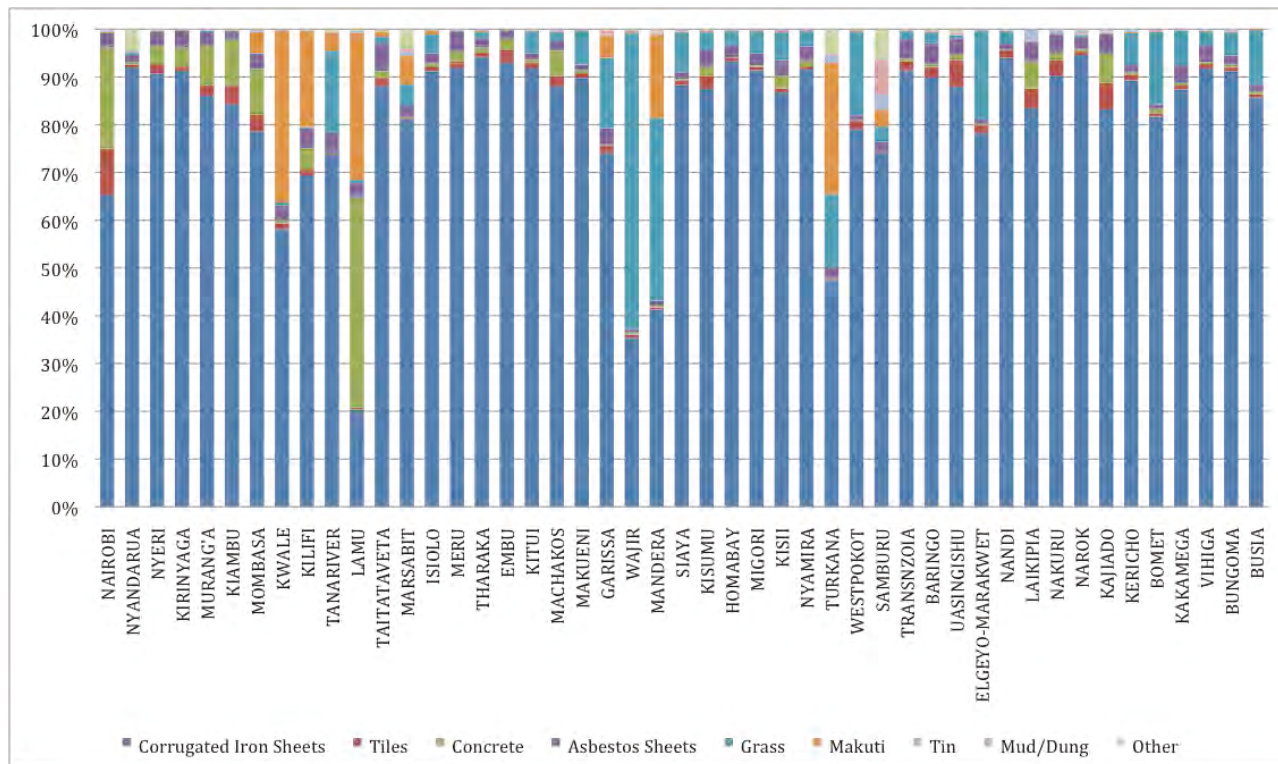
Figure 7.10: Source of energy for household lighting at County level (%)

Source: KNBS (2009), Kenya Population and Housing Census Data. Obtained from KNBS website in March 2013.

Figure 7.11: Type of walls used for housing by County (%)

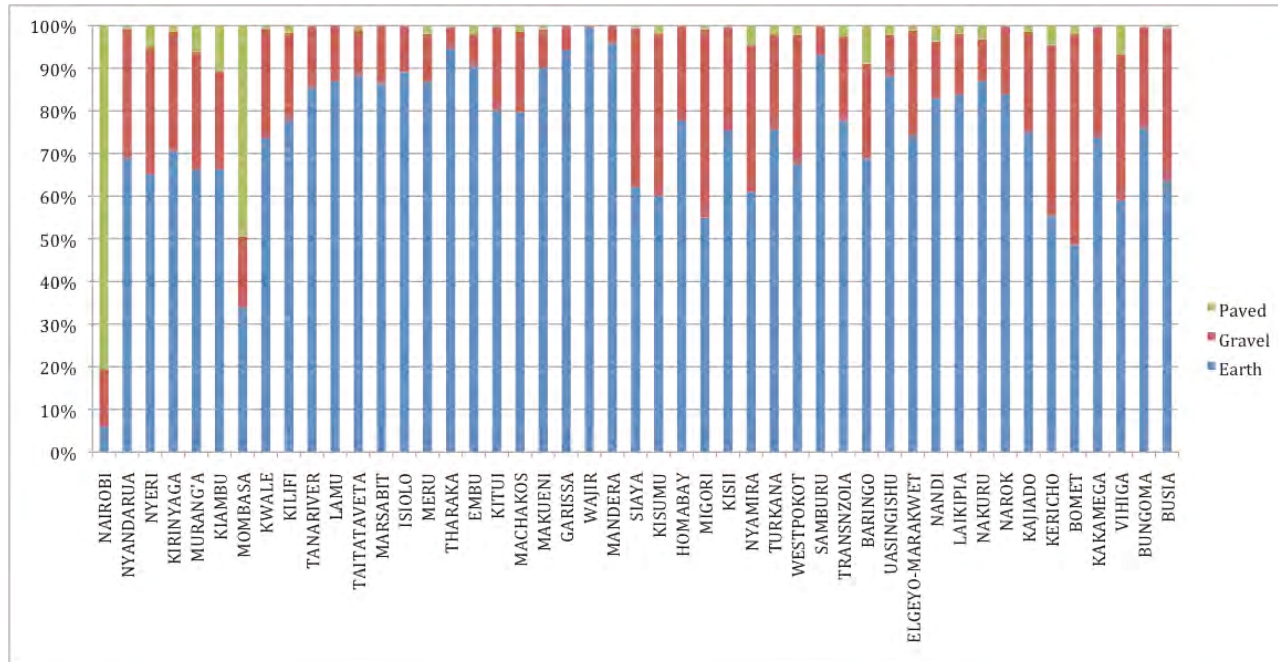
Source: KNBS (2009), Kenya Population and Housing Census Data. Obtained from KNBS Website in March 2013.

Figure 7.12: Type of roofing used for housing by County (%)

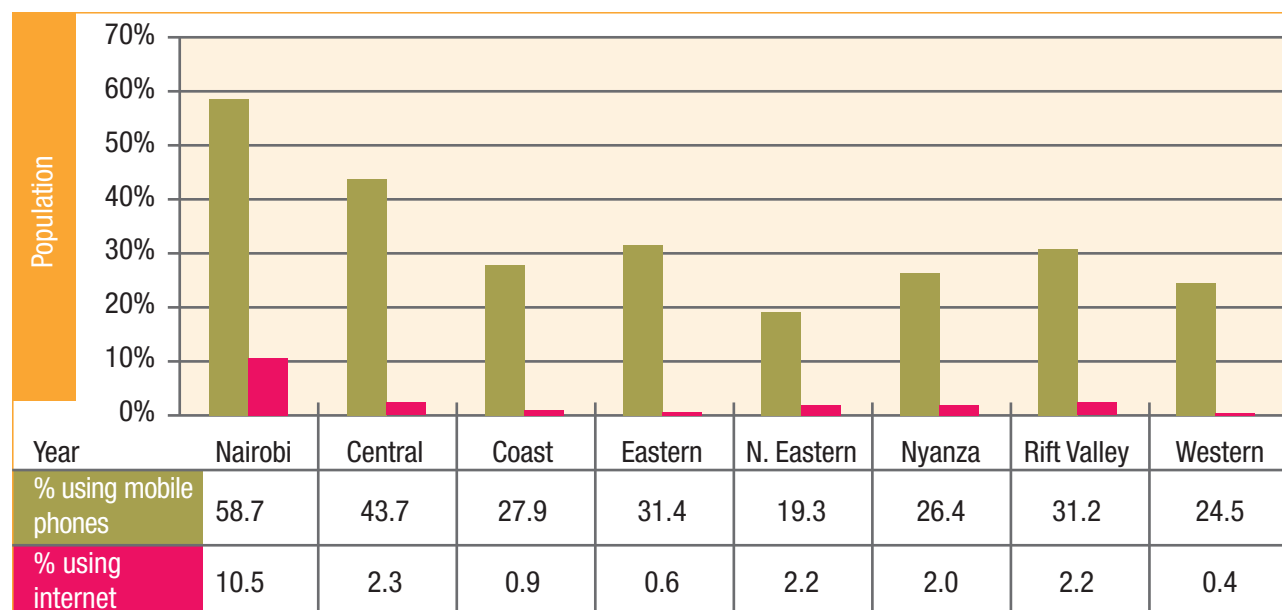


Source: KNBS (2009), Kenya Population and Housing Census Data. Obtained from KNBS Website in March 2013.

Figure 7.13: Road type by County (%)



Source: KENHA (2013), Kenya National Highways Authority.

Figure 7.14: Access to Mobile Telephone and Internet Services (%), by Region

Source: KNBS (2009), Kenya Population and Housing Census Data. Obtained from KNBS Website in March 2013.

7.2.2 Income disparities

Richer people in Kenya have much better access to infrastructure services and are therefore more equipped to cope with climate variability and change compared with the poor. By 2006, for instance, about 69.4% and 87.6% of households with access to piped water and power grid, respectively, were in the richest quintile (Briceño-Garmendia & Shkaratan, 2010). The current transport system, moreover, is heavily tilted in favour of private car use, and therefore the richer population segment. Inadequate infrastructure in support of public transport, walking, cycling, and other non-motorized modes not only impedes poverty reduction but also exposes the poor to high risk of fatal road accidents.

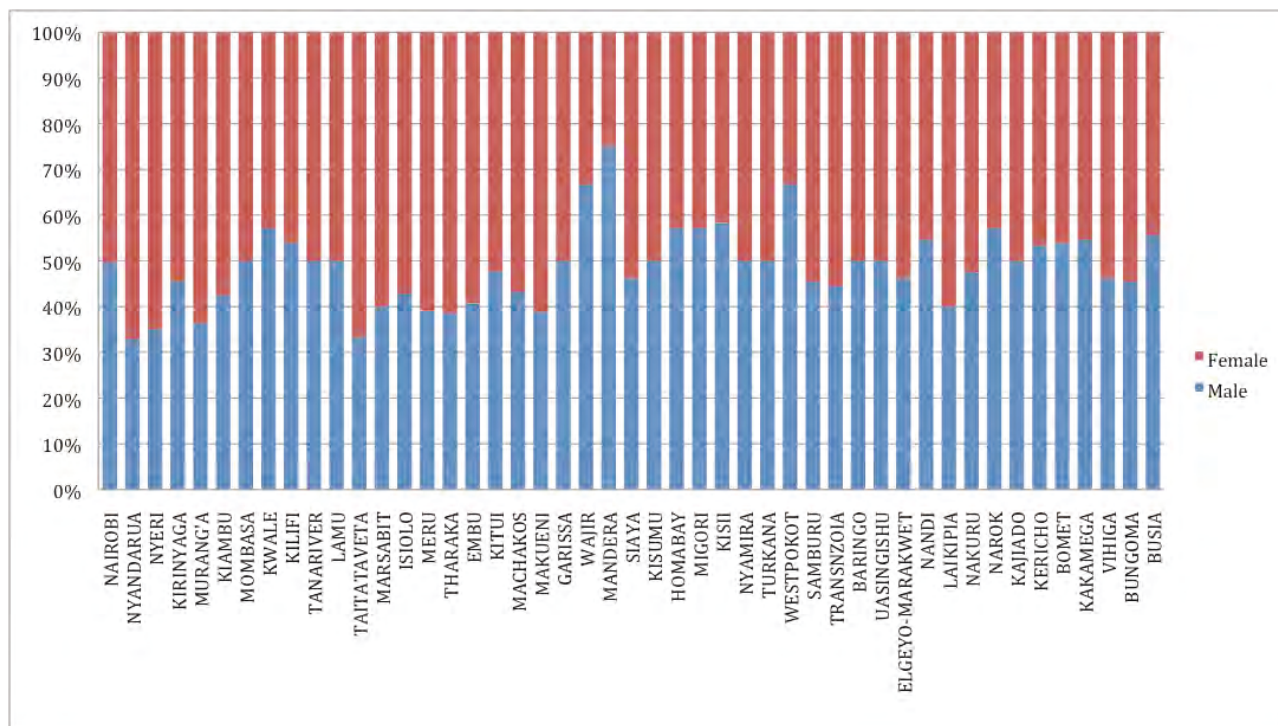
7.2.3 Gender disparities

While there may be no obvious gender differences in access to water, sanitation, and energy services, women are more vulnerable to climate variability and change impacts, and vulnerabilities and risks on account of gender differentiated roles. Women play the roles of fetching water, household cleaning chores, and fetching firewood especially in the case of poor households. Climate change and vulnerability threats on these infrastructure services therefore have a disproportionately larger effect on women who will have to invest additional time and other resources in order to cope with the threats. The relative disadvantage of women with respect to literacy in 40 of the counties (Fig. 7.15), moreover, make them more vulnerable to climate change risks and impacts due to lower income and reduced access to other opportunities. As the figure shows, the counties with the highest levels of female disadvantage with respect to literacy (Mandera, Wajir, and West Pokot) are in the ASAL areas, although Nyanza region stands out though it is not in these areas.

Use of biomass energy has major gender impacts. It is estimated, for example, that illnesses from cooking and lighting fuel cause the death of more women in rural Kenya than those caused by both malaria and tuberculosis (Global Alliance for Clean Cookstoves, 2011).



Figure 7.15: Gender disparity in literacy rates, by County



Source: KNBS (2009), Kenya Population and Housing Census Data. Obtained from KNBS Website in March 2013.

7.3 Impact of Climate Change on Infrastructure in Kenya

There is inadequate data on climate change impacts, vulnerabilities, and risks with respect to Kenya’s infrastructure. However, it is evident that hydroelectricity, freshwater availability, physical infrastructure - especially roads and other infrastructure more so in low lying areas of the country such as the Coast province- are not only highly vulnerable to climate change and variability, but also already suffer adverse impacts (Table 7.4). In recent stakeholder consultations, evidence of the adverse impact of climate change and vulnerability on the infrastructure sector was cited in half of the counties in the country (LTS International & Acclimatise, 2012).

7.3.1 Main drivers

The main climate change impacts, vulnerabilities, and risks to the country’s infrastructure come from flooding and range from destruction of different types of physical infrastructure from inundation, and siltation of dams and the resultant reduction of water storage and hydroelectricity generation capacity. The replacement cost of infrastructure (roads, communication, buildings, and water systems) damaged during the 1997-1998 El-Niño floods, for example, was estimated at Kshs 62 billion (US\$ 777 million) (World Bank, 2006).

Table 7.4: Impact of climate change on infrastructure in Kenya

Climate Variable & projected change	Transport (Roads, Rail, Air & Maritime)	Energy	ICT & Other Infrastructure
<p>Mean temperature: general warming in Kenya over time</p> <p>Mean annual temperature in Kenya has increased by 10C since the 1960s and is projected to increase further by 10C - 2.80C by the 2060s and 1.3-4.50C by the 2090s (McSweeney et al., 2009).</p>	<p>Affects construction, maintenance and operation of transport infrastructure, and vehicles as some materials and type of infrastructure deteriorate faster above 32.2°C.</p> <p>Increased vehicular and aircraft fuel consumption due to reduced fuel efficiency.</p> <p>Increased refrigeration and cooling at ports, maintenance facilities, and terminals.</p> <p>Affects ship navigation and other port operations due to stronger winds and storms.</p> <p>Corrosion of steel port facilities.</p>	<p>Increase in energy demand for refrigeration and cooling. In Mombasa alone, cooling demand is expected to increase by 240-340% by 2050s due to increase in incomes (SEI, 2009).</p>	
<p>Higher frequency & severity of hot temperature/ extreme heat</p>	<p>Affects construction, maintenance and operation of transport infrastructure and vehicles as some materials and type of infrastructure deteriorate faster above 32.2°C.</p> <p>Increased refrigeration and cooling at ports, maintenance facilities and terminals. It has been estimated, for example, that demand for cooling in Mombasa could increase by 300% by 2050s (SEI, 2009).</p> <p>Increased vehicular and aircraft fuel consumption due to reduced fuel efficiency</p> <p>Pavement softening</p> <p>Asphalt rutting, flushing and bleeding</p> <p>Warping of rail tracks</p>	<p>Together with cloud cover, higher temperatures may affect solar power generation (Cameron et al., 2012b).</p> <p>Reduction of cooling capacity for river-cooled clean coal and small efficiency losses (Urban & Mitchell, 2011)</p>	<p>Higher temperatures combined with high humidity leads to increase in internal temperatures in buildings, thereby affecting performance of ICT equipment or damaging it (LTS International & Acclimatise, 2012). This includes, for example, overheating of equipment in data centres, exchanges and base stations. Failure of ICT infrastructure in one region can affect data distribution in other countries and regions (LTS International & Acclimatise, 2012).</p>

<p>Extreme and intense precipitation, storms & floods</p> <p>Kenya experienced flooding in the following years: 1937, 1947, 1951, 1957-1958, 1961, 1978, 1998 & 2012.</p>	<p>Destruction of roads especially unpaved ones ; structural instability of coastal roads due to weakening of underlying foundation.</p> <p>Washing away of bridges. Floods in 1993, for example, washed away bridges and led to one of the worst rail accidents when 114 Kenyans lost their lives after a train plunged into a river following the destruction of the NgaiNdehya bridge near Voi, Coast province.</p> <p>Coast province and other low lying areas highly vulnerable: sea ports, low-lying airports, highways, railroads, bridges, subways and tunnels.</p> <p>Severe storm can damage port facilities. It also disrupts international shipping and supply chains (ITS International & Acclimatise, 2012).</p> <p>Unplanned urban settlements are especially at risk because they are generally densely populated, as are settlements on deforested steeply sloping areas to risk of landslides (ITS International, 2012).</p>	<p>Siltation of dams, thereby affecting hydroelectricity generation. In 2002, for instance, hydro power generation was affected by siltation of dams following ElNiño rains of 1998 (UNESCO, 2006).</p> <p>Changing wind regimes and extreme weather events may also affect wind power generation (Cameron et al., 2012b).</p> <p>Juja power sub-station and the associated power lines were reportedly destroyed by floods in April 2012 (ITS International & Acclimatise, 2012).</p>	<p>Damage and destruction to ICT infrastructure, including telephone lines, thereby disrupting service (ITS International & Acclimatise, 2012).</p> <p>Infrastructure below the ground is susceptible to flooding, rising water table, water ingress, and subsidence from flooding or drought (ITS International & Acclimatise, 2012). Moreover, infrastructure above the ground (such as masts, antennae, switch boxes, aerials, and overhead wires and cables) is vulnerable to precipitation, wind and landslides (ITS International & Acclimatise, 2012).</p> <p>Infrastructure such as houses in informal settlements and schools where flooding is frequent are exposed and are vulnerable to floods (IPC, 2012). In River Nyando catchment, for example, a survey has found 40% of the schools vulnerable and another 48% marginally vulnerable due to lack of funds, poor building standards, topography, soil types and inadequate drainage (Ochola et al., 2010).</p>
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<p>Drought</p> <p>Kenya has so far experienced drought in the following years: 1928, 1933-34, 1942-44, 1952-55, 1960, 1965, 1971-75, 1984-85 and 1998-2000 (UNESCO, 2006), 2004-2005 and also 2008-2011 (CoK, 2006; CoK, 2012). The severest of these were 1971-75, 1984-85 and 1998-2000 in that order.</p>		<p>Reduces river flow and runoff, thereby affecting hydroelectricity generation, which Kenya relies upon to a large extent. World Bank (2005), for instance, estimates that the 1998-2000 droughts cost Kenya Kshs 51.8 billion (US\$ 642 million) due to reduced hydroelectricity generation and the associated rise in generation costs and cost of imported substitute. World Bank (2006) further estimated that the country lost Kshs 110 billion (US\$1.4 million) in lost industrial production arising from power shortages. It is also estimated that in 2000, hydropower generation dropped by 25-30% (Kiva, 2008). Between April 2008 and April 2010, hydroelectricity generation reduced significantly leading to 37% and 45% increase in thermal electricity production in 2009 and 2010, respectively, which is much more expensive than hydroelectricity (GOK, 2012b). This led to revenue loss of Kshs 2.6 billion from lost hydroelectricity production and higher production cost of Kshs 29.8 billion due to the shift to thermal power generation (GOK, 2012b).</p>	
<p>Sea level rise: by 17-59cm by turn of 21st century</p>	<p>Inundation of low-lying coastal areas, cities, and transport systems leading to erosion and deposition.</p> <p>Coastal flooding and erosion leading to infrastructure damage and destruction (IIS International & Acclimatise, 2012).</p>		
<p>Ocean acidification</p>	<p>Corrosion of port facilities</p>		

Source: Various

Drought is also associated with considerable impact on Kenya's infrastructure services, especially water availability and hydropower generation. World Bank (2005), for instance, estimated that the 1998-2000 droughts cost Kenya Kshs 51.8 billion (US\$ 642 million) due to reduced hydroelectricity generation. It was further estimated that the country incurred a cost of Kshs 110 billion (US\$1.4 million) in lost industrial production arising from power shortages (World Bank, 2006). Moreover, the cost of reduced water availability in Tana River alone has been estimated at US\$ 66 million in terms of lost hydroelectricity and irrigation opportunity (SEI, 2009). Other estimates show that increased water supply costs associated with drought in the country amount to Kshs 31.5 billion (US\$ 389 million) (World Bank, 2006); and that drought-related damage to water infrastructure between 2008 and 2011 was about Kshs 7.7 billion (GOK, 2012b).

Temperature rise is also associated with such risks as performance deterioration of some infrastructure material at temperatures above 32.2°C, deterioration of performance of solar panels at temperatures above 32°C (with optimal temperature being 25-26°C), reduced performance of ICT equipment due to overheating, corrosion of steel materials, warping of rail tracks, warming of water beyond operational levels, and increased energy use for cooling especially in Mombasa where demand is projected to rise by between 24°C and 34°C by the 2050s, and also due to reduced vehicular and aviation fuel efficiency.

The projected rise in the sea level is also associated with high risks to Kenya, especially in the second largest city and seat of the tourism industry, Mombasa, mainly through inundation and destruction of infrastructure and water quality deterioration from salt intrusion. Overall, annual economic cost of sea level rise to Mombasa has been estimated at US\$7-58 million by year 2030 and 31-313 million by 2050 (SEI, 2009).

From a sectoral perspective, most of the projected impacts, vulnerabilities, and risks are related to water. Thus, according to UNEP (2011), 25 of the 32 examples of major projected impacts of climate change by the IPCC Fourth Assessment Report include primary links to hydrological changes. Of the other seven, water is implicated in four and two are general; one of which refers to main impacts (coral bleaching) not obviously linked to the hydrological cycle.

7.3.2 Equity considerations

The impacts, vulnerabilities, and risks vary across various cleavages, especially regional or location with ASAL areas; the Coast, Nyanza, and Western provinces, and generally in low lying areas; people living in urban slums; and people living along steep slopes facing the greatest risk to drought and/or floods. For example, the 1961 floods considered as perhaps the worst in the country to date, led to about 1.3 meters rise in the level of Lake Victoria, inundation of about 250km² in that region (excluding permanent swampy areas), and about 500km² in Tana River region, around Garissa (UNESCO, 2006). Inundation leads to heavy damage on infrastructure. It is estimated, for instance, that the 1997-98 El Niño floods cost the country about \$1 billion in damaged transport and telecommunication infrastructure, and 36 lives, over a period of 8 months (Ngecu & Mathu, 1999).

Women and children are more exposed to risk especially in sub-sectors like water and energy on account of their responsibility for fetching water and cooking. Women are also disproportionately affected by drought because of higher poverty and insecurity levels caused by existing discrimination, and because of the extra socio-economic burden they have of caring for households, children, the vulnerable, and the elderly (GOK, 2012b).

7.4 Adaptation and Mitigation Efforts

Kenya has already made significant progress towards adaptation to and mitigation of climate change. This is in the development of national adaptation and mitigation strategies through a highly consultative process, and through the initiation of a process of establishing a Climate Change Authority through an Act of Parliament. The country's increasing investment and reliance on green or clean energy is perhaps the most visible demonstration of commitment towards better management of climate change. Table 7.5 below summarizes the country's efforts in climate change adaptation and mitigation. It also borrows from experiences in other countries in order to identify additional adaptation and mitigation measures with potential for consideration in Kenya's infrastructure sector. Global experience, with respect to investment in green transport, for instance, shows that there are considerable net benefits (Table 7.6), thereby supporting the measures Kenya is taking or planning to reform its transport sector.



Table 7.5: Adaptation and mitigation efforts and potential in Kenya's infrastructure sector

Sub-sector	
Transport	Adaptation efforts & potential
	<p>Upgrading and rehabilitation of the main road corridors, the most visible being the Nairobi-Thika Superhighway and the 3 bypasses (Eastern, Southern and Northern) that are expected to considerably reduce traffic congestion in Nairobi and its environs. A Road Sector Investment Plan (RSIP) covering over 40 priority road maintenance and rehabilitation projects over a 20 year period and expected to cost Kshs 63 billion was developed.</p> <p>Improvement of rural access roads through Roads 2000 programme, whose coverage has been expanded from 37 to 150 districts. Between July 2010 and June 2011, 1,097 km of roads were rehabilitated against the target of 1,369.⁵⁴</p>
	Mitigation efforts & potential
	<p>Interventions that have been found, from a global perspective, to improve transport efficiency and reduce CO₂ emissions from the sector and some of which have been implemented or are being considered in Kenya include the following:</p> <ul style="list-style-type: none"> (i) Good planning at the urban, regional and national levels aimed at reducing the need or distance to travel by bringing people, services and activities close together. (ii) Regulations on fuel economy, vehicle emission levels, fuel quality, vehicle inspection, and on vehicle use and/or vehicle occupancy rates. (iii) Providing information through public awareness on the socio-economic and environmental implications of alternative modes and methods of travel, labelling of new and cleaner vehicles, and driver education and training programs such as eco-driving. (iv) Setting the right financial conditions and economic incentives, including adequate public funding for infrastructure, national subsidies, fuel and vehicle taxes, parking charges and land-related taxes/charges, road pricing, grants, loans, private investment through PPPs and other modes, international green transport funding mechanisms, and multilateral & bilateral funds. (v) Reforming transport pricing to capture the various socio-economic and environmental impacts of transport and the subsidies often provided to roads, fuel and sometimes to vehicles. This should include congestion tax and vehicle use tax. <p>Cameron et al. (2012a) estimate that an extensive MRT system for Nairobi Metropolitan, in the form of BRT corridors and limited LRT corridors, outcompetes other transport options in terms of abatement potential and development. It can abate about 2.8 MtCo₂e (million tonnes of carbon dioxide equivalent) annually by 2030. This is followed by a 10% biodiesel blending (B10) with potential to abate 1.2MtCo₂e annually. The other options have potential to abate 0.5-0.8 MtCo₂e.</p> <p>Shift of 30% transit freight to rail transport by 2030 is estimated to abate about 0.83 MtCo₂e (4.7% of total transport emissions) per year. A feasibility study has been carried out and a MOU signed between the governments of Kenya and Uganda towards the development of a standard gauge railway line linking the two countries.</p> <p>Cost effective mitigation options include development of non-motorized transport (NMT) infrastructure and providing incentives or its use; efficiency improvement of the existing stock of heavy duty vehicles (HDVs); bio-ethanol blending (E10); discounted customs duty for imported new and used vehicles with low Co₂ emissions ratings; reduced taxes on locally blended bio-fuels; road pricing or congestion charges; and carbon tax (Cameron et al., 2012a).</p> <p>Planned phasing out of the 14-seater public service vehicles ("matatus") that currently dominate public passenger transport in favour of larger buses and coaches is expected to abate a considerable amount of carbon. The potential of this is demonstrated by the 87% decline in the registration of new 14-seater vehicles (and 31.5% increase in the registration of new buses and coaches) in 2011 following earlier notice by the government of matatu phase out by January 2011.⁵⁵</p> <p>Globally, this movement towards green transport has been found to have a huge potential in mitigating climate change and yielding other considerable benefits (Table 7.6). Indeed, models of International Energy Agency (IEA) and European Environment Agency (EEA) suggest that reductions in transport CO₂ emissions of up to 70% are possible with an intervention package consisting of two-thirds of 'improve' measures (such as improved engine and vehicle design, electric cards, low-carbon fuels and technologies encouraging behavioural change) and one-third of 'avoid' and 'shift' measures (such as road pricing, car clubs, increasing population density in cities and travel planning) (UNEP, 2011). Further modelling work using the T21 model finds reductions of up to 68% and an employment increase of about 10% (UNEP, 2011).</p>

54 GoK, 2012d.

55 The notice was not enforced due to strong lobby from the matatu industry but, according to the Minister in charge of Transport, the government is still committed to the phase out.

Continued)

Sub-sector	
Energy	Adaptation efforts & potential
	<p>Diversification of energy mix to reduce dependence on hydroelectricity.</p> <p>Energy efficiency measures by government, private sector and development partners. These include setting up of a Division of Energy Efficiency at the Ministry of Energy, Department of Renewable Energy & Energy Efficiency at Energy Regulatory Commission, and Demand Side Management (DSM) unit at Kenya Power; distribution of free compact fluorescent lamps (CFLs) to consumers by Kenya Power⁵⁶; development of The Energy (Solar Water Heating) Regulations 2012 requiring use of solar water heating systems for all buildings that require more than 100 litres of hot water per day; drafting of a Kenya Energy Management Regulation that makes energy audits mandatory for facilities and encourages them to attain at least 50% of the identified energy efficiency potential; establishment of Centre for Energy Efficiency & Conservation at the Kenya Association of Manufacturers with the support of development partners, to conduct energy audits; and initiatives by international organizations (such as IFC, AFD & GIZ) targeting different end user groups and energy carriers.</p> <p>Consolidated Energy Fund proposed in the National Energy Policy and a hydroelectricity risk mitigation fund being considered under it.</p>
	Mitigation efforts & potential
	<p>Diversification of energy mix to reduce dependence on diesel or thermal electricity generation.</p> <p>Grid expansion at the national level and planned expansion at the regional level to facilitate import of hydropower. The national grid expansion reduces the use of dirty forms of energy.</p> <p>Off-grid and decentralized mini-grids options are being explored/developed at the local levels, with great potential to reduce use of dirty energy. Renewable off-grid solutions such as small hydros, mini-wind, bio-energy, and solar household systems (SHSs) are increasingly widespread in the country.</p> <p>Existence of feed-in-tariff scheme has attracted investment in renewable forms of electricity. These were introduced in 2008 for wind, biomass and small-hydros, and extended in 2010 to cover geothermal, biogas and solar-generated electricity.⁵⁷</p> <p>Adoption of carbon credit scheme by the national electricity generating company has provided incentives for greater investment and focus on renewable forms of electricity.</p> <p>Clean biomass technologies such as improved cook stoves and biogas systems are increasingly important in reducing use of firewood and air pollution. Although constrained by prevalence of free ranging mode of cattle production in the country biogas generation is playing a significant role in replacing firewood in regions such as Nyeri where dairy farming is large.</p> <p>Assuming 35% unsustainable wood fuel use between 2010 and 2030, Saidi et al. (2012) identify the following energy technologies as having relatively larger potential in abatement: improved cook stoves with potential to abate 5.6 MtCo₂e and to improve health of women; replacement of kerosene lamps with renewable ones (such as LED lanterns and PV sources) can abate 1.8 MtCo₂e; switching to the use of LPG instead of wood fuel for cooking with potential to abate 1.7 MtCo₂e⁵⁸; co-generation of biogas in agriculture can abate 1.6 MtCo₂e in addition to considerable benefits to women; use of energy efficient bulbs can abate 1 MtCo₂e; and energy efficiency improvements in industry can abate 0.9 MtCo₂e.</p> <p>Expansion of low-carbon electricity generation options has the potential to attain the amount of power targeted by 2030 with enormous abatement potential. Cameron et. al (2012b) estimates the abatement potentials of the various options as follows: geothermal (14.1 MtCo₂e); wind (1.4); hydroelectricity (1.1); clean coal (1.1); solar PV (1.0); and landfill gas (0.5).</p> <p>Reduction of electricity transmission and distribution losses from the current level of 16.3% to 10% can reduce energy supply requirement and emissions by 6.8% (Cameron et al., 2012b).</p>

Source: Various

⁵⁶ Estimated at 5.25 million pieces by end of 2012 (Saidi et al., 2012).

⁵⁷ The feed in tariff for suppliers of solar energy, for example, is Ksh 10.25 per kilo watt hour for generators of 0.5-40MW of power.

⁵⁸ The 2012 draft Energy Policy has one of its targets the encouragement of LPG use through removal of taxes. This is aimed at reducing overreliance on wood fuel and eliminating kerosene use in households.

Table 7.6: Costs and benefits of investing in green transport – global evidence

Green Transport Mode	Investment cost		Benefits				
	Direct investment	Long-term costs	Air quality	GHG emissions	Congestion	Transport accessibility	Road safety
Bus Rapid Transit (BRT)	++	+	++	++	++++	++++	++
Light Rail	+++	++	++	++	++++	+++	++
Rail	++++	++	+	++	+++	++	+
Cleaner & more Efficient Vehicles	++	+	++++	+++	+/-	+/-	+/-
NMT Infrastructure	++	+	++	+	+++	+++	+++
City Planning / Design	++	++	+++	++	++++	++++	+++

Source: UNEP (2011). The more the pluses the higher the size/cost of investment or benefit of investing in the mode

7.4.1 Obstacles to adaptation and mitigation

Obstacles to adaptation and mitigation efforts in the Kenyan infrastructure sector mainly revolve around technology challenges such as awareness, cost, and poor quality enforcement; data challenges; and lack of credit

to access the technology (Table 7.7). Moreover, the cost of retiring old inefficient infrastructure and retrofitting with modern and more efficient alternatives is high (UNEP, 2011).

Table 7.7: Obstacles to adaptation and mitigation in Kenya's infrastructure sector

Infrastructure sub-sector	Challenges to Adaptation and Mitigation
Transport	<ol style="list-style-type: none"> 1. Lack of space for such technologies as BRTs in urban areas. 2. Lack of data on such variables as infrastructure stock characteristics, vehicle stock characteristics, fuel consumption by different vehicle types, fuel efficiency, transport mode usage rate before and after improvements, vehicle retirement and deregistration, 3. Reluctance or opposition by vested interests.
ICT	<ol style="list-style-type: none"> 1. Inadequate network coverage or infrastructure that has not reached all parts of the country. 2. Inadequate rural electrification rates in many parts of the country. 3. Low usage rates that serve as a disincentive to investors. 4. High rate of illiteracy in the country.
Water and Sanitation	<ol style="list-style-type: none"> 1. Inadequate legal backing and enforcement capacity to prevent problems like clogging of floodways (ICLEI, Undated). 2. Long and inefficient transfer infrastructure. 3. Lack of enough public resources for capital investment, challenges confronting full cost recovery, low rates of revenue collection, and high proportion of poor people who cannot afford to pay for water and sanitation services. 4. Degradation of ecosystems and water catchment areas. 5. Reluctance or opposition by vested interests.

Energy	<ol style="list-style-type: none"> 1. High upfront costs required for many renewable energy technologies and barriers to capital access (including high interest rates, ignorance of renewable energy sector by financial institutions, and uncertainty about power purchase agreements) especially during and immediately after the global financial crisis of 2008. 2. High cost of retiring/retrofitting power assets (UNEP, 2011). 3. High project risk including exploration risk, resource risk especially in light of climate change, and securing power purchase agreements. 4. Low rates of return to investment and long payback periods especially where incentives are missing or are inadequate. 5. Presence of fake, sub-standard or older second-hand products and technologies in the market. These include LED lanterns, PV technologies, CFLs, household appliances (such as refrigerators, air conditioners and TVs) 6. Wind and solar-generated electricity is characterized by variable and unpredictable supply and this poses a challenge to existing electricity transmission and distribution infrastructure. 7. Adoption of solar water heating technologies is constrained in buildings with shared roofs. 8. Regulatory risk in terms of country and political risk, in addition to regulatory and institutional weaknesses including lack of standardization and labelling schemes, and lack of clear and transparent regulations on PPAs and a regulatory framework and physical metering system that does not allow sale of extra power to the national grid. 9. Inadequate capacity in terms of low public awareness levels, collection of municipal solid waste, technical expertise, poor distribution of transmission infrastructure around the country thereby posing an obstacle to power generation in remote areas (e.g. wind in Turkana), data availability to aid planning⁵⁹, and weak institutional capacity. This also includes inadequate capacity to enforce energy standards, product quality and other regulations. 10. Adverse impacts of some renewable energy forms. Biofuels, for example, compete with food production and can affect biodiversity and ecosystems while large scale hydropower can have major social and environmental impacts (UNEP, 2011). Moreover, renewable forms of energy requiring use of rare minerals have impacts arising from the requisite mining and deforestation (UNEP, 2011). 11. Inadequate transmission and distribution infrastructure. 12. Reluctance or opposition by vested interests.
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Ngong Hills wind farm

⁵⁹ Data lacking includes end-user information on energy consumption behavior, appliance use, and type of technologies used by industries (especially micro and small enterprises) and their energy use characteristics (Saidi et al., 2012). It also includes various data types for the renewable energy sources (Cameron et al., 2012b).



7.5 Harnessing Emerging Opportunities

Some literature suggests that there are no opportunities from climate change in physical infrastructure (LTS International & Acclimatise, 2012). Nevertheless, several opportunities come to mind. The first and most important is the establishment of global support mechanisms that Kenya could tap into, in her effort to adapt to and mitigate climate change. These mechanisms include the Copenhagen Green Climate Fund established at the 2009 UNFCCC conference, Climate Investment Fund (CIF) and its Clean Technology Fund (CTF), Climate Technology Mechanism, agreed upon during the 2020 UNFCCC conference in Mexico to accelerate development and transfer of climate change adaptation and mitigation technologies to developing countries, International Renewable Energy Agency (IRENA) created in 2011 to facilitate collaborative work by governments towards promotion of renewable energy, Global Environment Facility (GEF), Fast Start Financing, and multilateral and bilateral funds. Kenya can also sell carbon credits or green certificates, obtained by producing renewable energy, through the Clean Development Mechanism (CDM). Indeed, the country is already doing so through companies such as KenGen, the electricity generation public company. In addition, the accreditation of the National Environment Management Authority (NEMA), among only four other organisations in Africa, under the Kyoto Protocol enhances this opportunity.

Kenya's richness in green energy resources (ranging from geothermal, wind, solar, and co-generation), combined with availability of global funds for adaptation and mitigation provides huge opportunities for the country to exploit these resources and in the process, create employment, diversify development into traditionally neglected regions of the country (especially northern Kenya) that are rich in some of these resources, save foreign exchange that would have gone to thermal power generation, and reduce the high level of energy poverty where more than 80% of the population still rely on traditional biomass energy. Modelling work

suggests that increased investment in renewable energy, which is more labour intensive than conventional power generation, yields more employment at least in the short term (UNEP, 2011).

A related opportunity is tapping of global resources and expertise for R&D aimed at developing appropriate technologies for exploitation of green energy resources. Moreover, collaborative R&D between Kenyan and foreign experts could also benefit the country through capacity development and technology transfer.

Rapid improvement in the cost competitiveness of renewable energy technologies relative to fossil fuel technologies presents an important opportunity for Kenya to improve her balance of payments position. The global price of PV modules, for example, dropped from US\$ 22 per watt in 1980 to less than US\$ 1.5 in 2010 (IPCC, 2011). This opportunity could be enhanced by leveraging upon global resources and expertise to reduce distribution losses in electricity to levels closer to global average.

Since the bulk of infrastructure is still largely undeveloped in Kenya, there is opportunity to learn from knowledge developed elsewhere to develop infrastructure that is resilient or adaptive to current climate variability and future climate change. In other words, a big portion of the planned infrastructure could be climate proof without the cost of destroying existing infrastructure. Thus, for example, there is an opportunity to leapfrog into green transport and avoid mistakes made by developed countries since cities are still emerging and have not been locked into private car dominated systems (UNEP, 2011). International funding mechanisms for climate change adaptation and mitigation could be leveraged upon to develop public transport and non-motorized transport infrastructure. Table 7.8 shows an example of the green transport technologies available globally that Kenya can tap into through technology transfer, investment in adaptation capacity, capability development, and other measures.

Table 7.7: Green transport technologies

Green Transport Goals	Technologies	Level of importance in 2010 & 2030	
		2010	2030
• Improvement in energy efficiency	Improved internal combustion engines (ICEs)	+++	+
	Vehicle technology improvements (e.g. material substitution, aerodynamics)	++	+++
• Reduction in air pollution and greenhouse gases	Retrofitting technologies	+++	+
	Hybrid and Plug-in hybrid electric vehicles	+++	++
• Increased use of renewable resources	Battery electric vehicles	++	++
	Solar electric vehicles	+	+
• Reduced use of non-renewable Resources	Fuel cell vehicles	+	+++
	Flex-fuel vehicles	++	+++
	Alternative fuel technologies – Biofuels, Compressed natural gas (CNG); Liquefied natural gas (LNG); Liquefied petroleum gas (LPG) and hydrogen	+	+++
	Non-motorised transport vehicles	+++	+++
	Public transport systems	+++	+++
	Intelligent transport systems	++	+++
	Use of Information technologies for traffic management (smart infrastructure)	++	+++
	e/tele-technologies for travel demand reduction	++	+++
	Integrated ticketing	+++	+++
	Eco-driving and speed control	++	+++
• Waste minimization	Material substitution, use of composite materials	++	+++
• Reduction in land pollution	Recycling technologies	++	+++
• Reduced noise pollution	Electric vehicles, hybrids	++	+++
	Silencers, etc.	+	++
• Safety	Vehicle safety technologies such as tyre-pressure monitoring, Adaptive cruise control/collision mitigation, Emergency brake assist/collision mitigation, etc.	+	++
		++	+++

Source: UNEP (2011). +++: Central; ++: Highly Relevant; +: Relevant

Investment in multi-purpose dams for hydropower generation provides the opportunity for enhanced water storage and therefore water security. Thus, it is recommended for project appraisals of hydropower proposals to incorporate non-power-related benefits (Briceño-Garmendia & Shkaratan, 2010).

Global attention on climate change provides another opportunity for Kenya and the neighbouring countries that share water resources to seek

international support towards the design and negotiation of cooperative water management instruments.

The rapid development of the ICT sector provides an opportunity for climate change mitigation through telecommuting, teleconferencing, and related services that contribute to reduction of traffic congestion and thus GHG emissions.

7.6 Conclusion and Policy Recommendations

7.6.1 Conclusion

Access to quality infrastructure services is central to achievement of higher levels of human development not only through enhanced per capita income growth, but also direct consumption of such essential services as water, sanitation, clean energy, transportation, and communication. While Kenya has made significant strides in the development of various services such as ICT, transportation, and energy, considerable challenges remain. The country needs to spend about Ksh 4 billion annually for a decade to close the existing infrastructure deficit or maintain current spending rates and eliminate inefficiencies, which would enable the country to achieve the same target in 18 years.

Even though data on climate change impacts, vulnerabilities, and risks for the country's infrastructure sector is scanty, it is evident that these are substantial especially because of infrastructure damage arising from floods. Droughts too are increasingly costing the country large amounts of money in terms of worsening water scarcity, reduction of hydropower production and greater reliance on thermal power, and rising costs of these services. These higher costs not only reduce access to the essential services especially for the poor and other vulnerable segments of the Kenyan society, they also curtail economic growth and therefore growth

in employment and incomes. The projected sea level rise, moreover, threatens the very existence of large parts of Mombasa, the country's second largest city, home of the port that serves the country and its land locked neighbours, and seat of the tourism industry that is one of the productive sectors targeted to drive achievement of Vision 2030.

Kenya has made considerable efforts towards adaptation to and mitigation against climate change, as strongly demonstrated by her increasing investment and reliance on green energy. It is worth noting first and foremost that the quantity and quality of existing infrastructure is one of the main adaptive capacities. In the infrastructure sector, moreover, incentives to stimulate investment in green energy such as introduction of feed-in-tariffs, public investments in the improvement of roads and railway system, reforms and public investments in the water sector aimed at enhancing storage capacity, and reducing use inefficiency, are some of the key efforts.

The increasing global attention to climate change and Kenya's richness in renewable resources especially green energy resources present considerable opportunity for the country to tap into the international financial resources and expertise to develop unique technologies for adapting to or mitigating climate change, and to create employment opportunities.



Kenya has made considerable efforts towards adaptation to and mitigation against climate change, as strongly demonstrated by her increasing investment and reliance on green energy.

7.6.2 Policy recommendations

Several interventions could be considered in order to accelerate and deepen climate change adaptation and mitigation efforts in Kenya. These can be grouped into the following broad areas:

- (i) Improved management of climate change impacts, vulnerabilities, and risks in the infrastructure sector;
- (ii) Exploitation of the potential presented by green energy;
- (iii) Enhancing infrastructure role in providing adaptation avenues to productive sectors; and,
- (iv) Harnessing emerging opportunities.

7.6.3 Improved management of climate change impacts, vulnerabilities, and risks

Management of climate change impacts, vulnerabilities, and risks in Kenya's infrastructure sector can be improved substantially through judicious adoption and application of best practices in adaptation and mitigation.

The first step is to entrench adaptation and mitigation planning.

Kenya has already developed comprehensive and highly consultative national adaptation and mitigation plans. However, these did not have the benefit of sufficient research and data. Studies on climate change impacts, vulnerabilities, and risks in different infrastructure sub-sectors are therefore important and urgent, especially in the sub-sectors where this is seriously lacking, including ICT and storm water infrastructure. This should entail systematic review of localized climate trends, projections, and likely impacts; assessment of local vulnerabilities and potential costs of impacts; identification of the most cost effective options of reducing vulnerabilities; and review and implementation of adaptation and mitigation strategies. This type of research would also entail valuation of ecosystem goods and services⁶⁰ through interdisciplinary teams.

Secondly, **infrastructure policies and laws ought to be reviewed to incorporate climate change and adaptation**, and ensure that any traditional infrastructure regulatory and health standards that may impede innovation are reviewed. For instance, the Sessional Paper on national integrated transport policy before the Parliamentary Committee on Transport, Housing and Communication should be climate proofed before completion. Moreover, the medium term plan (MTP, 2013-17) provides an opportunity for climate proofing of infrastructure.

Thirdly, **infrastructure should be progressively redesigned** informed by the systematic analysis recommended in the first step, especially projected climate variability and change. This may require relocation of roads, power lines, and other infrastructure to higher elevations or further inland in some areas. Related to this is enhanced investment in R&D to develop more heat tolerant materials for construction, maintenance, and operation of transport and other infrastructure. Infrastructure technologies that are more tolerant to inundation and that absorb rainwater should also be developed.

Effective land use planning and enforcement (including prohibition of development in highly vulnerable areas and providing land for periodic inundation), integration of land use and transport planning in order to avoid or reduce transport trips by localizing production and consumption, enforcement of building codes, maintenance of drains, and effective solid waste management to avoid clogging of drains are important.

Land tenure, poor planning, and other challenges that constrain adaptation in informal areas should also be addressed.

Fourthly, **the deficit in infrastructure should be closed as a top priority through increased public and private investment.** Thus, private participation should be promoted through enabling policy and incentives where possible. It should be noted, however, that it is almost impossible for infrastructure investments to keep pace with population growth. Subsidies should **therefore be reduced and externality charges introduced in order to promote judicious use.** Prices should cover the higher cost between marginal cost and average cost of providing the infrastructure service, including all external costs such as congestion, infrastructure wear and tear, health and other impacts of air pollution, accidents, noise, and climate change, among others. This should be supported by income transfer mechanisms targeting the vulnerable members of society who would be adversely affected by optimal pricing.

Moreover, as the infrastructure deficit is being closed **more investment should be directed towards public transport; infrastructure suited to walking, cycling, and other forms of non-motorized transport; and rail and maritime infrastructure** as these not only contribute significantly to wellbeing but also create jobs, and reduce emissions.

Creation of a Green Infrastructure Fund to help the country cope with and mitigate climate change is essential. Funds can be sourced from fuel and vehicle taxes, public funds, and global climate change adaptation and mitigation resources.

Fifthly, **restoration of ecosystems such as forests and river basins, tree planting, and other conservation measures** are critical in enhancing climate change mitigation, regulating floods, and supplying direct ecosystem services such as clean water (UNEP, 2011). Incentives and other measures such as payment for ecosystem services (PES), optimal charge rates and financing mechanisms, entitlements and allocation mechanisms, specification of property rights (for example, through well-defined land tenure systems), and strong governance structures to enforce these rights, are important in this respect.

Six, **access to the infrastructure by all segments of society and their empowerment to exercise some control over it**, are essential. The Constitutional provision for minimum political and employment participation of women provides an opportunity for addressing unique vulnerabilities of women to climate change. In a randomized study in India, for example, Chattopadhyay and Duflo (2004) found that village councils led by women were more likely to increase investment in infrastructure for drinking water. In Kenya, however, Kremer et al. (2008) did not find such support for affirmative action for women although women leadership (empowerment) did not compromise maintenance of protected springs. Assuring members of the public that they are owners of

⁶⁰ This kind of research is required, for example, in the determination of how much groundwater could be extracted annually without compromising sustainability (UNEP, 2011).

infrastructure, moreover, through effective public participation can reduce vandalism and save resources for funding other infrastructure projects.

The poor should also be empowered by being enabled to **access micro insurance schemes against natural disasters and catastrophes.**

Finally, **strong and elaborate early warning systems and community disaster preparedness plans should be developed and resourced adequately for effectiveness.** The draft national disaster preparedness strategy should be reviewed to ensure that localized climate change projections are taken into consideration and that roles are clearly defined for the different agencies involved. Moreover, **capacity building of relevant institutions** including local governments should constitute a major component of the plans and strategy.

7.6.4 Exploiting green energy potential

As noted earlier, Kenya is already on the learning curve with respect to development and utilization of the large green energy resources the country is endowed with. As a result, not only has the share of green energy in the total national production risen significantly, it is also planned to increase much more by year 2030. For this to be hastened and expanded, the country should continue fine-tuning, on the basis of emerging best practice knowledge, and implementing strategy and action plans to scale up the existing alternative energy initiatives including solar systems; biogas; mini, micro, and small hydros; wind; sustainable charcoal and related fuel; bio-fuels; geothermal; and use of LPG as a substitute for biomass. Such fine-tuning should consider such measures as:

- (i) Clear long-term policy commitment and, preferably, signalled through public investment through economic stimulus packages and other avenues;

- (ii) Feed-in-tariffs that are guaranteed for 15-20 years;
- (iii) Public concessional credit schemes or credit guarantees to facilitate adoption of renewable technologies;
- (iv) Subsidies (in the form of investment support, grants to reduce capital cost, and operating support) and fiscal incentives such as investment tax deduction, production tax deduction, preferential depreciation schemes and tax credits or rebates;
- (v) Looking out for emerging better technologies and supporting R&D to generate and adapt alternative technologies;
- (vi) Regulatory frameworks protected from short-term changes and supported by improved enforcement systems and capacity;
- (v) Legislating mandatory energy audits;
- (vi) Technical training and broader institutional capacity development;
- (vii) Public awareness about the benefits of renewable energy;
- (viii) Introduction of standardization and labelling schemes to lock out fake and sub-standard products and technologies; and,
- (ix) Improvement of data collection and packaging including resource assessments such as wind speeds, seasonal river flow rates, average insolation levels, and assessments of biomass feed stocks.

Likewise, the country should consider fine-tuning strategies and action plans for scaling up existing energy efficiency initiatives, using emerging know how and best practice. In particular, the country should adopt aggressive energy-efficient innovation policies and incentives like Japan and South Korea did in the 1970s.



7.6.5 Enhancing infrastructure role of providing adaptation avenues to productive sectors

Existing infrastructure is one of a country's adaptive capacities besides the information base, quality of institutions and governance, financial resources, and technical resources or human capacity. Improvement of infrastructure, therefore, could enable productive sectors to better adapt to climate change and variability. Efficient infrastructure and communication systems, for example, can enhance access to food from surplus areas, and also help to build resilience by stimulating growth and rise in incomes.

Besides elimination of energy subsidies and strengthening of property rights, investment in robust and safer physical infrastructure is a win-win policy that can yield development, equity, sustainability, and strengthen resilience to climate change. In this respect, ICT is a critical infrastructure subsector with respect to building stakeholder capacity and awareness creation about climate change and variability. Secondly, land zoning and planning can play a big role in reducing exposure to natural disasters, thereby protecting productive sectors. Thirdly, the importance of flood prevention infrastructure cannot be overemphasized for the same purpose.

The country could also exploit resources that have been set aside globally to support adaptation and mitigation efforts by tasking a specific department in government to pursue this opportunity.

For infrastructure to play this role effectively, climate proofing or integration of climate change risks and opportunities into the design, operation, and management of infrastructure is imperative. This can be done, for example, through underground cabling, use of concrete electric poles, erection of buildings or shelters to curb mud slides and other climate change problems, construction of flood walls around infrastructure in low lying areas, nesting self-contained infrastructure systems into the centralized or regional systems to enhance system robustness, construction of increased redundancy in the supply infrastructure, and engendering participatory community action. Moreover, the productivity of infrastructure such as dams can be maximized by utilization of all its uses including capturing and controlling river flows, avoiding flood damage, electricity generation, and agriculture.

7.6.6 Harnessing emerging opportunities

While there are not many climate change opportunities evident in infrastructure, Kenya can benefit from the stock of knowledge and technology already existing in the area of adaptation and mitigation. The country can therefore avoid the development path characterized by high emissions by leapfrogging with the assistance of existing knowledge and technology. The country could also exploit resources that have been set aside globally to support adaptation and mitigation efforts by tasking a specific department in government to pursue this opportunity. This presents an opportunity for the country to minimize emissions while simultaneously generating employment, reducing poverty, and improving development in general by tapping on international knowledge, technology, and financial resources to exploit the country's rich resources.



8

INTEGRATION OF HUMAN DEVELOPMENT AND CLIMATE CHANGE IN DEVELOPMENT PLANNING

Key messages

1. Climate change is having impacts across the key sectors and actors of Kenya's economy and society. The use of a systemic approach to policy formulation and evaluation can support the creation of synergies while avoiding the creation of side effects that would have negative consequences across sectors.
2. The integration and mainstreaming of climate change adaptation into core development policies, strategies, and plans requires the adoption of an Integrated Policymaking approach (IP), taking into consideration economic, social, and environmental variables that influence the achievement of policy objectives.
3. Climate change policy work should consider the three layers of policy development (structure, scenarios, and policies). Clear and reliable indicators for policy formulation and evaluation should also be established, along with clear responsibilities.
4. Adequate planning (physical, socio-economic etc.) needs to be undertaken on a continual basis in order to address the impacts of climate change. Such planning should be undertaken not in isolation, but in the wider context of sustainable development.
5. A multi-stakeholder approach should be employed to ensure coordination of all actors on mitigating and adapting to climate change. Such involvement and participation should occur on an appropriately coordinated basis which minimises duplication of effort and conflict, and which ensures efficient use of resources and the creation of positive synergies.
6. Eighteen policy priorities are selected across sectors. These include, among others, efforts to improve agricultural productivity and resilience, investments in ecosystem restoration to curb climate change impacts on infrastructure, improvement of the accessibility and affordability of health care, acceleration of sanitation coverage, and preservation of tourism environmental attractiveness.
7. Given the impacts of climate change on human development, which directly impacts sustainable development, national human and institutional capacity should be developed in all aspects of climate change research, response, planning, and implementation.
8. Funding is necessary to improve climate resilience and support human development. Efforts should be made to procure and allocate financial and other resources, as appropriate and feasible, to ensure that climate change is addressed in the manner required.



8.1 Introduction

The concept of Human Development provides an innovative paradigm to understand the multiple variables influencing people's ability to live the lives they value. It is linked with healthy living conditions, material consumption, education, access to economic resources, and environmental protection. Economic, social, and environmental variables are deeply interconnected in the definition of human development indicators and the identification of the most suitable policies for its achievement.

It is now undeniable that the impact of climate change on livelihoods

and ecosystems constitutes a threat to human development, especially for the most vulnerable communities, which still lack the capacity and technology to properly address such challenges. Previous chapters have analysed the adverse impacts of climate change on human development goals and objectives in Kenya, including food security, access to clean drinking water, health, among others. By exacerbating famine, energy shortages, desertification, forced mass migration, diseases, and overall economic, environmental, and human degradation, climate change has the potential to severely affect lives and livelihoods,

21 Estimate by the Ministry of Agriculture, 2009.

and thus human development of the Kenyan population.

This chapter seeks to explore the complex interconnection between climate change and human development, and suggests the adoption of an integrated policymaking approach for the alignment of goals and objectives in view of climate resilient human development. First, it builds on the sectoral analysis of previous chapters to introduce the steps to mainstream climate change response into national development planning (in particular Kenya Vision 2030) through the adoption of an integrated policymaking approach.

Secondly, Kenya's development objectives have been analysed against current and projected climate change impacts on the key sectors identified in Vision 2030. These sectors include agriculture, trade, manufacturing, business process offshoring, tourism, water, environment, health, housing, and education. Climate change response actions suggested in national policies and strategies have then been classified against the sectoral development objectives, to highlight synergies and complementarities. Based on the analysis of current strategies, a number of policy options have been suggested, which would help create the enabling conditions for the transition to climate resilient human development.

Thirdly, this report addresses the implementation of suggested policies and strategies, and further suggests institutional arrangements for a coherent distribution of roles and responsibilities across all relevant stakeholders. In particular, Multi-Stakeholder Processes are recommended in order to include all actors in the decision-making process.

Finally, the report makes specific (cross-sectoral) recommendations, focusing on climate change adaptation and mitigation priorities. The rationale behind the suggested actions is that if approached under a systemic perspective, climate change presents an opportunity to put in place policies, management structures, and human and institutional capacities to pursue development that is resilient to climate risks and vulnerabilities.

8.2 Climate Change Adaptation and Mitigation in the Context of National Planning

As early as in the first National Human Development Report, a "sustainable environment" was considered as one of the main conditions and goals to achieve human development (KNHDR, 1999). Nowadays, the evolution of climate science and the increased accuracy in the quantification of climate change impacts allow for an evidence-based analysis of climate-related threats to human development in Kenya. As examined in the previous chapters, climate change is already having negative impacts on the Kenyan economy, society, and environment, including on key sectors such as agriculture, water and sanitation, health, and infrastructure, among others. The Kenyan population is increasingly vulnerable to extreme weather events, sea level rise, and higher temperatures, whose consequences are challenging the achievement of the Millennium Development Goals and other long-term national objectives.

The overall cost of climate change impacts on the Kenyan economy might be close to 3% of GDP by 2030 (SEI Report, 2009). Such economic losses would have a disproportionate effect on vulnerable groups, especially economically vulnerable women (Heinrich Boll Stiftung, 2010). These projections need to be taken into account for the realization of 'Vision 2030', the national economic and social development strategy. If climate change adaptation and mitigation options are appropriately included into short and long-term development plans, possible economic losses can be transformed into opportunities for sustainable growth and climate resilient human development.

As presented in Chapter 3, the agricultural sector in Kenya is increasingly vulnerable due to phenomena that are exacerbated by climate change, such as shifts in rainfall patterns, harsher droughts in arid and semi-arid lands, floods, and erosion along the coast. Livestock and fisheries are also threatened by higher temperatures, ecosystem degradation, and extreme weather events. As a result, food security, one of the basic conditions for human development, is constantly threatened, with consequences especially on the poor and on vulnerable groups, in particular, rural women. The introduction of innovative adaptive techniques and technologies represents an opportunity for the creation of a modern agricultural sector, which would strengthen food security and reduce current and future climate change impacts, in line with international environmental standards.

Climate change is also threatening the national health sector, one of the pillars of Vision 2030 social strategy (Chapter 5). Natural disasters such as storms and floods are causing injuries and deaths, in particular among vulnerable sectors of society. More frequent droughts in arid and semi-arid lands result in famine and contribute to malnutrition, especially among children and the poorest communities. Other illnesses directly or indirectly related to climate change, such as malaria, diarrhoea, cholera, bilharzia, respiratory, and cardio-vascular diseases are expected to increasingly affect health conditions of the Kenyan population. In particular, as a result of higher temperatures, malaria is affecting the population in the highlands, which are not prepared to respond to such disease. Finally, extreme weather events are causing damage to health facilities across the country. The mainstreaming of climate change adaptation and disaster risk management into national policies is thus an essential step to ensure healthy living conditions to Kenyans.

Higher temperatures are contributing to the drying up of lakes and therefore to the reduction of the overall water supply (chapter 6). Moreover, water siltation and salinization are compromising the quality of freshwater, with serious consequences for human development. Water efficiency standards and regulations, combined with incentives for the responsible use of water resources and investments in water catchments would improve water security, thus creating conditions for sustainable development of the Kenyan economy and people.

Weather changes are affecting tourism demand (chapter 4), and consequently the national economy (tourism accounts for 10% of GDP). Ecosystem deterioration and harsher climatic conditions could lead to a considerable reduction in tourism revenues, also impacting connected sectors such as agriculture, manufacturing, banking,

handicrafts, etc. Vulnerable groups and communities, many of whom derive their livelihoods from tourism-related activities, are likely to suffer from climate change impacts on the sector.

Roads, ports, dams, energy plants, and ICT infrastructure are affected by climate instability (chapter 7). Such infrastructure constitutes a fundamental condition for the development of key economic sectors under Vision 2030, including tourism, manufacturing, and trade. A prompt intervention through climate change adaptation initiatives (for example, adaptation of ports to sea level rise, and building of climate-proof roads and buildings) could prevent future economic losses, and allow for budget reallocation to other priority sectors for human development.

It is undeniable that reduction of climate vulnerability is an essential priority for Kenya in order for human development to improve. In particular, the national framework to respond to climate related disasters such as floods, droughts, landslides, lightning, and earthquakes should be strengthened in light of current and projected climate change impacts. Disaster risk management requires better coordination across all relevant stakeholders, including national and local government, NGOs, CBOs, local leaders, media, etc. The prioritization of climate change issues in urban planning, agricultural, and other practices would provide an opportunity to reduce the vulnerability of communities to natural disasters.

The Government of Kenya has demonstrated its commitment to the achievement of climate-resilient development. Indeed, the country is active in international forums and debates as well as in the establishment of a dedicated institutional and policy framework. The Ministry of

Environment and Mineral Resources (MEMR) has the mandate to deal with climate change and environmental issues and supervises a number of institutions, including Climate Change Secretariat; Directorate of Environment; National Climate Change Activities Coordinating Committee; National Environment Management Authority; and Kenya Meteorological Department. In addition, a Climate Change Coordination Unit, hosted by the Office of the Prime Minister⁶¹, provides high-level political support to climate change activities in Kenya (NCCRS, 2012).

Kenya also has a number of policy and regulatory instruments to guide actions related to climate change and human development, including, among others: National Climate Change Action Plan (2013 – 2017); National Climate Change Response Strategy; National Environmental Policy; National Environment Action Plan Framework (2009-2013); Kenya Vision 2030, the national economic and social development strategy; Environmental Management and Coordination Act; National Disaster Management Policy; and Sector specific policies including, agriculture, energy, forestry, industrialization, population, and water.

Mainstreaming climate change mitigation and adaptation into national development planning constitutes an invaluable opportunity for Kenya to respond to the threats of climate variability and change. It also helps to build a sustainable environment conducive to human development that is resilient and respectful of natural resource constraints. This section explores the steps to the incorporation of climate change into national development planning, with an emphasis on human development impacts, using an Integrated Policymaking (IP) approach.



Ecosystem deterioration and harsher climatic conditions could lead to a considerable reduction in tourism revenues, also impacting connected sectors such as agriculture, manufacturing, banking, handicrafts

61 The Office of Prime Minister was abolished following conclusion of elections in March 2013.

8.2.1 Incorporating climate change into national development planning

Since climate change impacts are cross-sectoral by nature, mainstreaming of climate change will require regular revisiting of development policies, plans, and projects as climate and socio-economic conditions change. This section briefly describes a generic four-step approach that decision makers can take to address adaptation to climate change (OECD, 2009). Policy processes can vary, and these steps can be modified or adopted in a different order depending on circumstances. This four-step approach is similar to a climate risk management approach, as it starts with the consideration of both current and future vulnerabilities and climate risks.

Step 1: Identify current and future vulnerabilities and climate risks

The first step is to identify the vulnerability of the system of interest and the climate risks to that system (Smith, 1996; Smith and Lenhart, 1996). These assessments can either be done quantitatively or more qualitatively through expert judgement. A simple rule of thumb is that, if an area or system is affected by climate variability (extreme events, variability in precipitation, and extended periods of warm temperatures), it is therefore sensitive to climate change. In addition to assessing current vulnerability and climate risks, an assessment of future vulnerability and future climate risks needs to be carried out. In order to understand possible future vulnerability and opportunities, a qualitative understanding of challenges and opportunities needs to be developed.

Step 2: Identify adaptation and mitigation measures

This next step involves the identification of a list of adaptation and mitigation measures to be considered. Adaptation measures can be designed to provide net benefits regardless of climate change (these are known as “no regrets” or “low regrets” measures) or can, on the other

hand, depend on projections of changes in climate to justify their benefits (known as “climate justified” measures). In addition, a distinction needs to be made between reactive (in response to observed climate change) and anticipatory (plan for future change) adaptation measures. Mitigation measures should be picked depending on their short and (especially) long-term economic, social, and environmental benefits deriving from their implementation, when compared to a Business as Usual (BAU) approach.

Step 3: Evaluate and select options

Having identified the options, the next step may be to evaluate and select some for implementation. A number of criteria can be used to evaluate policy options, including: (1) the extent to which climate vulnerability is reduced within and across sectors (Effectiveness); (2) the overall costs of the selected option, compared with costs of inaction as well as externalities and cross-sectoral ancillary benefits (Cost); and (3) the existence of the necessary legal, administrative, financial, technical, and other resources for the implementation of the policy option (Feasibility) (OECD, 2009).

Step 4: Evaluate “success” of mitigation and adaptation options

The final step in the process is to monitor and evaluate the success of the implemented strategy. Adaptation measures that were designed to reduce vulnerability to infrequent extreme events can only be evaluated if and after those extreme events occur. Conversely, adaptation measures that have benefits in any case (i.e. no regrets measures), can be easily evaluated, as the benefits should be seen in the near term. Mitigation options can be evaluated through scientific measurement (i.e. level of GHG emissions) and also in terms of the benefits derived to human development in the long term (i.e. employment creation, resource efficiency, improved health conditions as result of reduced pollution, etc.).



8.2.2 Introduction to Integrated Policymaking (IP)

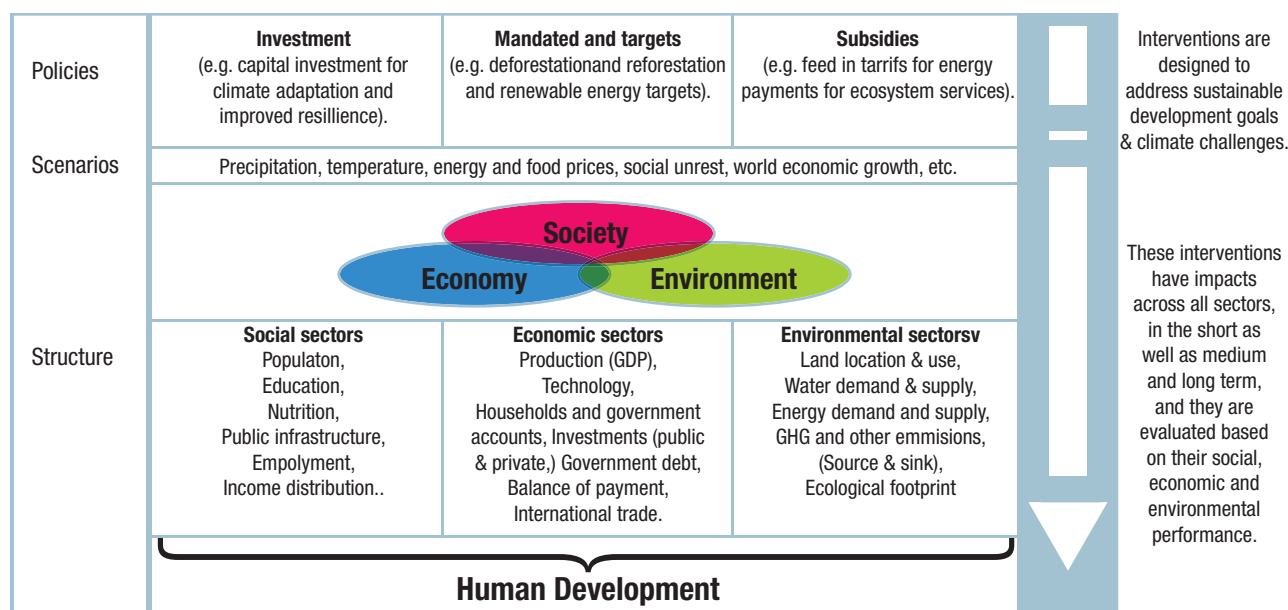
In order to incorporate climate change adaptation and mitigation into national development planning, the structure of the system (e.g. social, economic, and environmental) should be properly understood. Integrated Policymaking (IP) is an approach that incorporates environmental, social, and economic (ESE) implications of policy implementation. Underlying this approach is the recognition that the algebra among the social, economic, and environmental pillars of human development (how the variables relate and affect one another in context, and how they combine towards the equation of sustainable development) is more important than the arithmetic among them (added or subtracted as convenient) (EMG, 2011).

Figure 1 indicates that policy formulation and evaluation need to be carried out in the context of scenarios (e.g. for climate change, precipitation, and temperature among others, as well as technological development, energy, and food prices), and policies (e.g. subsidies, incentives and/or mandates) have to be evaluated across a variety of indicators (social, economic and

environmental) simultaneously. How these three levels are supported with solid and coherent information, and interact with each other, will greatly determine the success of any national plan over the medium to longer term, be it for climate change mitigation and adaptation and/or for poverty reduction and human development. This information is also crucial to truly understand the drivers of change and design policies that attain the desired impacts effectively.

Medium to longer-term sectoral and cross-sectoral implications of policy implementation have to be analysed with the understanding that different sectors are influenced by different key causes defining the success (or failure) of policies. From a policymaking perspective, selecting the correct set of indicators is particularly relevant for assessing the feasibility of the integrated policy, as well as monitoring and evaluating its outcomes. The identification of indicators to measure the impact of national policies and plans that combine climate change and environmental concerns with human development objectives is an essential step that can provide benefits throughout the entire process of IP. The indicators should focus specifically on three key phases of IP: agenda setting (issue identification), policy formulation, and policy evaluation.

Figure 8.1: The three main layers for carrying out integrated policy formulation and evaluation



8.3 Strategic and Policy Directives

Key strategic documents that address human development and climate change already exist in Kenya. The National Climate Change Response Strategy (NCCRS) and the National Climate Change Action Plan (2013 – 2017)(NCCAP) address both mitigation and adaptation challenges and opportunities. Based on climate change impacts on key economic sectors, the NCCRS and NCCAP suggest a number of actions to be undertaken in order to improve resilience and mitigate future changes. Even if not prioritized, resilience to climate change is also included in some sectoral policies and plans. For example, the Ministry of Water Strategic Plan 2009-

2012 recognizes climate change as a threat to water security, and suggests the adoption of sustainable water management practices. Similarly, the Policy on Wetland Conservation and Management (2008) clearly states that climate change, together with inappropriate human activities and the lack of coordinated and holistic policy guidelines, could reduce the potential contribution of wetlands to the socio-economic development of Kenya. The Agricultural Sector Development Strategy 2010-2020 highlights the impacts of rainfall fluctuations, droughts, and floods on cultivations, and calls for the implementation of the NCCRS. Also, the National Disaster Management Policy stresses that preparedness to natural disasters should be improved through increased climate change adaptation.

Overall, climate change is given a significant space in national strategic and policy directives. Under an integrated policymaking approach, the realization of climate resilient human development is not necessarily linked to the elaboration of new plans or policies, but rather to the identification of synergies and complementarities between climate change responses and development goals. In other words, planned or suggested actions in the field of climate change adaptation and mitigation should be made compatible with the purpose of development planning documents, and implemented under the broader framework of the Vision 2030, which constitutes the main national development blueprint. This approach seeks to avoid disaggregate planning, which could lead to incompatible goals,

and thus be counterproductive for the achievement of sustainable human development.

In order to facilitate the identification of synergies between existing policy and strategic directives, it is useful to organize and classify the content of existing documents into a coherent framework. With a focus on the key sectors identified in Vision 2030, table 8.1 summarises climate change impacts and the related actions listed in key policy documents dealing with climate change issues. The alignment of such actions with the broad objectives identified in the Vision 2030 (divided into economic vision and social strategy) would help increase climate resilience, thus paving the way for the achievement of sustainable human development.

Table 8.1: Sectoral objectives, climate change impacts, and actions in existing policy and strategy documents

Sector	Vision 2030 objectives (2007)	Climate Change Impacts	Actions (Existing policy and strategy documents)
ECONOMIC VISION			
Agriculture	Increase land productivity; increase arable land	Decline in agricultural productivity (e.g. 2009 crop failure); desertification (as a result of deforestation); soil erosion; increasing droughts in arid and semi-arid lands	<ul style="list-style-type: none"> - Increase irrigation (NCCRS) - Invest in water harvesting programmes (NCCRS) - Provision of farm inputs (NCCRS) - Promotion of conservation agriculture (NCCRS) - Orphan Crops Programme (NCCRS) - Agricultural research (NCCRS); Conduct research on drought resistant crops (NEAP 2009-2013) - Promote appropriate land use practice (NEAP 2009-2013) - Intensify river bank protection (NEAP 2009-2013) - Control agrochemical based pollution (NEAP 2009-2013) - Livelihood support, micro finance and disaster reduction (SEI, 2009) - Early Warning Systems (SEI, 2009) - Integrate population and family planning issues into agricultural extension (Population Policy for National Development, 2012-2030) - Provide guidelines on effective use of water and soil conservation for sustainability (Population Policy for National Development, 2012-2030)
Trade	Lower transaction costs (i.e. thanks to improved transport infrastructure, creation of wholesale hubs)	Damage/inundation of coastal roads (as result of sea level rise); destruction of ports, roads, bridges, railways (due to storms).	<ul style="list-style-type: none"> - Development of Light Rail (NCCRS) - Road Maintenance (NCCRS) - Promotion of appropriate technology in production, processing and transportation - Develop integrated plans for market centres
Manufacturing	Increase regional market share from 7% to 15%.	Damages to industrial buildings (as result of storms, floods); reduced hydroelectric power generation (as result of destruction of water catchment areas, increased droughts, soil erosion and siltation of dams).	<ul style="list-style-type: none"> - Sustainable forestry to support tea factory tea drying (NCCRS) - Mini or Micro hydro for power generation for all factory processing units (NCCRS) - Methane reduction in processing activities of rice and coffee pulp processing (NCCRS)

Business	Attract foreign IT companies to invest in Kenya; Create a BPO Park in Nairobi.	Damage to the telephone network (caused by storms), poor radio and TV signals; delay in the delivery of mails during storm events.	<ul style="list-style-type: none"> - Climate-proofing the ICT sector; accelerated development of the sector to help
SOCIAL STRATEGY			
Water	More irrigation infrastructure and dams; expansion of urban and rural water supply and sanitation; rehabilitation of hydrometric stations; development of water harvesting technologies.	Soil erosion and siltation of dams; reduced volume of rivers; water contamination due to pollution and salinization; turbidity from landslides and erosion; deterioration of water quality due to eutrophication of dissolved fertilizers.	<ul style="list-style-type: none"> - Construction of inter-basin and intra-basin water transfers (NCCRS) - Installation of hydrometric stations (NCCRS) - Additional water treatment chemicals and technologies (NCCRS) - Irrigation projects (NCCRS) - Construction and maintenance of water pans, dams and boreholes (NCCRS) - Exploitation and artificial recharging of aquifers (NCCRS) - Construction of dams (NCCRS) - Implementation of Integrated Water Resources Management (NWRMS, 2007) - Rehabilitation of degraded water catchments through planting of appropriate species (NEAP 2009-2013) - Finalization of policy on trans-boundary water resources (NEAP 2009-2013) - Development of water harvesting and storage systems in arid and semi-arid lands (NEAP 2009-2013) - Regular Water Quality Surveillance (NEAP 2009-2013) - Provide an enabling environment for sustainable management of national and trans-boundary water resources (MOW Strategic Plan 2009-2012) - Drilling of key strategic boreholes to mitigate climate change (drought) (MOW Strategic Plan 2009-2012) - Ensure provision of safe water to the population to reduce morbidity and mortality (Population Policy for National Development, 2012-2030)
Environment	Increase forest coverage; decrease environment related diseases.	Extinction of tree species and increased forest fires (due to higher temperatures); invasive species (due to ecosystem changes); increase in vector borne diseases such as malaria and RVF.	<ul style="list-style-type: none"> - Strengthening disease surveillance support systems (NCCRS) - Afforestation and reforestation targeting additional 4.1 million Ha of land under forest cover (NCCRS) - Enhancing conservation and management of all types of forests, including mobilization of volunteers and expanded portfolio of stakeholders (NCCRS) - Promoting sustainable management and utilization of Industrial Forest Plantations (NCCRS) - Pursuit of innovative funding mechanisms for Forestry Development (NCCRS) - Operationalization of the Forests Act and Environment Management and Coordination Act (NCCRS) - Integrate population, health and environment issues into programmes to stem human-wildlife conflict and protection of fragile ecosystem (Population Policy for National Development, 2012-2030)

Health	Reduce incidence of malaria; decentralization of health care.	Increase of malaria incidence in highlands due to higher temperatures; damages to local health care facilities due to extreme weather events.	<ul style="list-style-type: none"> - Strengthening disease surveillance support systems (NCCRS) - Construction of more health facilities (NCCRS) - Strengthening Health Systems Governance (NCCRS) - Strengthening public health education and health promotion programmes to reduce vulnerability (NCCRS) - Improving access to water and sanitation (NCCRS) - Providing population health and environment education (PHE) for sustainability (Population Policy for National Development, 2012-2030).
Housing	Increase in annual production of housing units.	Damage to houses and displacement of populations due to climatic catastrophes (especially in highlands and low lying areas at the Coast).	<ul style="list-style-type: none"> - Undertake slum upgrading (NEAP 2009-2013) - Enforce existing legislation and building codes as well as regulations (NEAP 2009-2013) - Review urban land use plans (NEAP 2009-2013) - Develop regional and local plans (NEAP 2009-2013) - Enforcement of the Public Health Act (Housing and Sanitation Requirements) (NEAP 2009-2013) - Monitor trends in demand and supply for housing, taking into account population trends (Population Policy for National Development, 2012-2030) - Design medium to long term plans for development of intermediate towns to curb rural-urban migration (Population Policy for National Development, 2012-2030)
Education	Have a globally competitive quality education, training and research for sustainable development; Increase number of schools and teachers.	Damages to schools due to extreme weather events especially flooding.	<ul style="list-style-type: none"> - Mainstreaming climate change education and awareness (NCCRS) - Youth Sensitization Programmes on Environmental Management and Climate Change (NCCRS)

Source: Authors' own conceptualization



8.3.1 Enabling conditions

The concrete implementation of climate change response actions suggested in existing national policy and strategy documents (Table 8.1) demands that the Government of Kenya, as well as other key stakeholders and local communities, create or reinforce a number of enabling conditions. As stated by UNEP, “enabling conditions consist of national regulations, policies, subsidies, and incentives, as well as international market and legal infrastructure, trade, and technical assistance” (UNEP, 2011). Well-designed interventions would facilitate the implementation of integrated policies, plans, and actions that focus on climate change and human development.

Generally, there are three main ways to create the required conditions and influence future trends in order to reach stated goals: (1) capital investment, (2) public targets mandated by law, and (3) incentives (such as tax reductions and subsidies). Since targets and mandates ensure reaching stated goals while controlling expenditure, and incentives as well as capital investments support cost sharing across the key actors in the economy, creating a comprehensive package would allow making the best of all the analysed options. The appropriate combination of investments, incentives, and regulations is expected to foster voluntary behavioural change among companies and individuals in Kenya, thus facilitating a shared vision of sustainable human development.

The Government of Kenya is already taking initiatives to create favourable conditions for the operationalization of climate change strategies that are expected to enhance the resilience of key development sectors. Among others, the National Environmental Management and Coordination Act (NEMA) sets standards and provides strict regulations to promote environmental protection, which are enforced by a National Environment Tribunal (NET). A number of sector specific acts, laws, and decrees are also contributing to the establishment of ‘sound regulatory systems’ that support climate change adaptation and mitigation efforts, as suggested by international guidelines and studies (UNEP, 2011). The Forests Act (2005), for example, poses strict conditions for any change of forest reserve boundaries and land use, while regulating the efficiency of extraction, processing, and utilization of forest products. The Water Act (2002) regulates sustainable water catchment by enabling the gazettement of water

catchment areas, and water distribution through the commercialization of water supply and possible inclusion of a conservation levy, such as a user pay scheme (MENR, 2005). Other regulations are also in place for the control of polluting activities (e.g. EA/EIA regulations, Occupational Health Act 2007).

Standards and regulations are being combined with tax benefits and other incentives to facilitate the compliance of the private sector as well as to encourage new green businesses and widespread adoption of mitigation and adaptation technologies, techniques, and behaviours. For example, the Government has recently approved a policy to provide tax incentives for solar household energy systems. The use of renewable energy will have a positive impact not only on health, as result of reduced pollution, but also on household budget, as a result of energy cost reduction in the long-term.

As far as investments are concerned, the government is allocating increasing shares of the national budget to the adoption of climate change adaptation and mitigation initiatives and technologies. For example, dedicated institutions have been created to provide financial support to the greening of key sectors, such as the Forest Management and Conservation Fund. Moreover, some national sectoral policies provide for investments in green technologies and infrastructure. For example, the National Biotechnology Development Policy highlights the commitment of the government to invest in biotechnologies for the development of crops that are resistant to rainfall oscillations (Government of Kenya, 2006). Other essential investments are indicated in strategies and studies, including, inter alia, those for the supply of water in zones affected by droughts (i.e. rehabilitation of catchment areas, building of new dams, and drilling of boreholes) (MOW, 2008), and the rehabilitation of degraded soils (Forests Act, 2005). The government, together with development partners and the private sector, has also allocated investments in household energy efficiency (i.e. provision of light bulbs that save energy), and alternative forms of energy (i.e. investments in geothermal, solar, and wind sources).

The following table offers some examples of current interventions that the Government of Kenya has made to foster climate resilience in the framework of human development. In the next section, a systemic analysis will facilitate the identification of key priority actions that the Government could still perform to pave way for resilient human development.

A number of sector specific acts, laws, and decrees are also contributing to the establishment of ‘sound regulatory systems’ that support climate change adaptation and mitigation efforts



Table 8.2: Examples of policy options that the government of Kenya could adopt to create the enabling conditions for a transition to climate resilient human development

Type of Instrument	Description	Actor	Source of Finance	Who benefits (directly)	Why
Public targets mandated by law					
Payments for Ecosystem Services	Payments to local communities and private sector for the conservation and efficient use of natural resources (e.g. forests, water).	National Government	National budget	Communities, private sector.	Maintenance of forests and other ecosystems enhances long-term availability of natural resources and ecosystem services.
Standards and targets	Energy and water efficiency, waste management and pollution standards for the manufacturing sector. *Ecological standards for the tourism sector (e.g. coastal conservation, waste management, water, and energy efficiency. *National targets for key demographic indicators (Population Policy for National Development, 2012-2030)	National Government	National budget	Communities, private sector.	Reduced operational costs; increase in energy availability; increased revenues from potential energy exports; decelerated demographic growth leading to increased resource availability and reduced climate vulnerability.
Laws and law enforcement	Creation and enforcement of regulations to reduce environmental impacts of key economic sectors. *Monitoring of the exploitation of natural resources.	National Legislative Institutions	National budget	Communities, private sector.	Reduced pollution and enhanced environmental protection, with long-term benefits for economic growth and climate resilient development.
Capital investment					
Government Investment Programs	Government injection of capital into the development of innovative green sectors, including irrigation systems, integrated water resource management, renewable energy. *Investments in the protection of natural resources, including protected marine and forest areas. *Investments in education on family planning and reproductive health, aimed at reducing population growth.	National Government	National budget; Donors; Global Funds.	Communities, private sector.	Reduced vulnerability to climate change impacts; reduced initial costs for green activities; reduced demographic expansion and improved resilience.
Incentives and disincentives (such as tax reductions and subsidies)					
Incentives to ecological agricultural practices	Tax deduction, financial incentive or other forms of economic incentives to farmers and private companies for the adoption of new techniques and technologies.	National Government	National budget	Farmers; farming companies; communities.	Increased resilience of the agricultural sector to the impacts of climate change; increased production and revenues; increased food security.
Incentives to green business	Incentives to green business, including in the field of agriculture (e.g. ecological practices); manufacturing (e.g. green industries, establishment of sustainable clusters); tourism (small-scale eco-tourism activities).	National Government	National budget	All stakeholders with business in Kenya.	Support to emerging green businesses or to the greening of existing ones.

8.3.2 A systemic analysis of policy and strategic options in Kenya

Policy options and stakeholder involvement

Overall, the Kenyan government has demonstrated its commitment to create the enabling conditions for the achievement of climate resilient human development. Targeted policy interventions are obtaining positive results, with benefits for society, economy, and the environment. However, a better combination of (enforced) regulations, incentives, and investments is needed to reduce the country's vulnerability to climate change impacts, in particular of vulnerable groups, and the alignment of human development and climate resilience targets.

More specifically, synergies could be created by using:

- **Mandates:** to ensure attainment of a stated goal.
- **Incentives and capital investments:** to reduce upfront costs (shared between government and other actors, such as households and the private sector). Incentives are especially effective if the upfront cost is contained while capital investments are particularly successful when the required initial investment is high.

Policy interventions should be adopted taking into consideration the complex interactions and causal relations occurring within the system. In some cases, unintended consequences can be avoided through the combination of complementary policies. For example, regulatory measures such as vehicle inspection rules to ensure compliance with pollution limits should be reinforced. This can be done through incentives for the importation and purchase of environmental-friendly and low-fuel consuming motor vehicles, through tax rebates, as well as adequate investments in more efficient public transport networks, such as Bus Rapid Transit (BRT) and Light Rail Transit. Also, the establishment of energy and water efficiency standards for the manufacturing sector should be combined with proper incentives for medium and small enterprises that might be otherwise cut out of the market by excessive compliance costs.

The goal is to find a strategy to balance funding responsibilities, sharing benefits with all actors of society and the economy, while providing support to low income and disadvantaged families. The Government should be the main driver in this initial phase, especially for the provision of incentives, the allocation of budget, and the formulation (or amendment) of laws and regulations. However, international donors and global funds can play an essential role in funding such efforts (i.e. providing budget support). The suggested interventions will provide business opportunities to the national private sector, and they also have the potential to attract foreign investment. Overall, the entire Kenyan population will benefit from the creation of these enabling conditions. Indeed, the greening of the Kenyan economy will facilitate climate change adaptation and sustainable economic and social development, thus improving the wellbeing of all Kenyans.

Public targets and laws: The regulatory and standard setting framework can still be strengthened to ensure that key economic sectors pursue a climate resilient development. Tourism, which is one of the driving sectors expected to boost national development under Vision 2030, is still lacking clear standards for the promotion of responsible practices (i.e. Green Code Certification Scheme) and a stricter enforcement of existing

regulations (i.e. EA/EIA regulations and the 1966 Physical Planning Act). The establishment of a sustainable transport sector, a key condition for the development of trade and tourism, calls for the setting of thresholds for the reduction of greenhouse gas emissions as well as regulations to ban the use of ageing vehicles and vessels (National Ministry of Transport, 2009). Also, the agricultural sector would certainly benefit from stronger regulations on the use of water resources (water efficiency leading to reduced costs). In general, stricter enforcement of existing laws is a fundamental condition to ensure compliance with the rules of the game, reducing abuses and usurpations in view of balanced, inclusive, and sustainable growth.

Incentives: Other key incentives could be provided to enable the transition to climate resilient human development. In agriculture, subsidies and tax incentives could impulse sustainable farming activities and inputs, such as climate resilient crops, and organic fertilizers and pesticides. Payments for Ecosystem Services (PES) schemes, as an alternative measure that rewards farmers for reducing the cost of externality with a stable revenue flow, could motivate them to reduce the negative effects on the environment and strengthen ecosystem services such as rehabilitation and restoration of degraded forests, with potential social and economic benefits to the poor. Also, tax incentives and the organization of national multi-stakeholder events (such as the recently concluded "First Kenya Agricultural Transformation Forum") are essential instruments to promote the participation of private investors in the development of a resilient agricultural sector. Incentives could also be provided to private operators in the tourism sector for compliance with international standards, including beach and coral reef conservation, energy efficiency, sustainable water management, and waste disposal by hotels and resorts along Kenyan coasts. Conservation could have long-term benefits for tourism revenues and coastal communities. These benefits include conservation of natural resources and new employment opportunities.

Investments: Despite current efforts, an increase in green investments would be essential to ensure the alignment of human development objectives with climate resilience principles and targets. For example, the construction and maintenance of irrigation systems, health facilities (especially for climate-related diseases), and road infrastructure in low-income areas should be accelerated in the light of current and future climate change impacts. Moreover, adequate funds should be allocated to the protection of coral reefs and tourist attractions, the creation and extension of marine and forest protected areas, and intensive training on climate change adaptation techniques in all sectors, especially targeting low-income population and vulnerable groups. Global funds and country donors can play an essential role in supporting the government budget to meet such challenges.

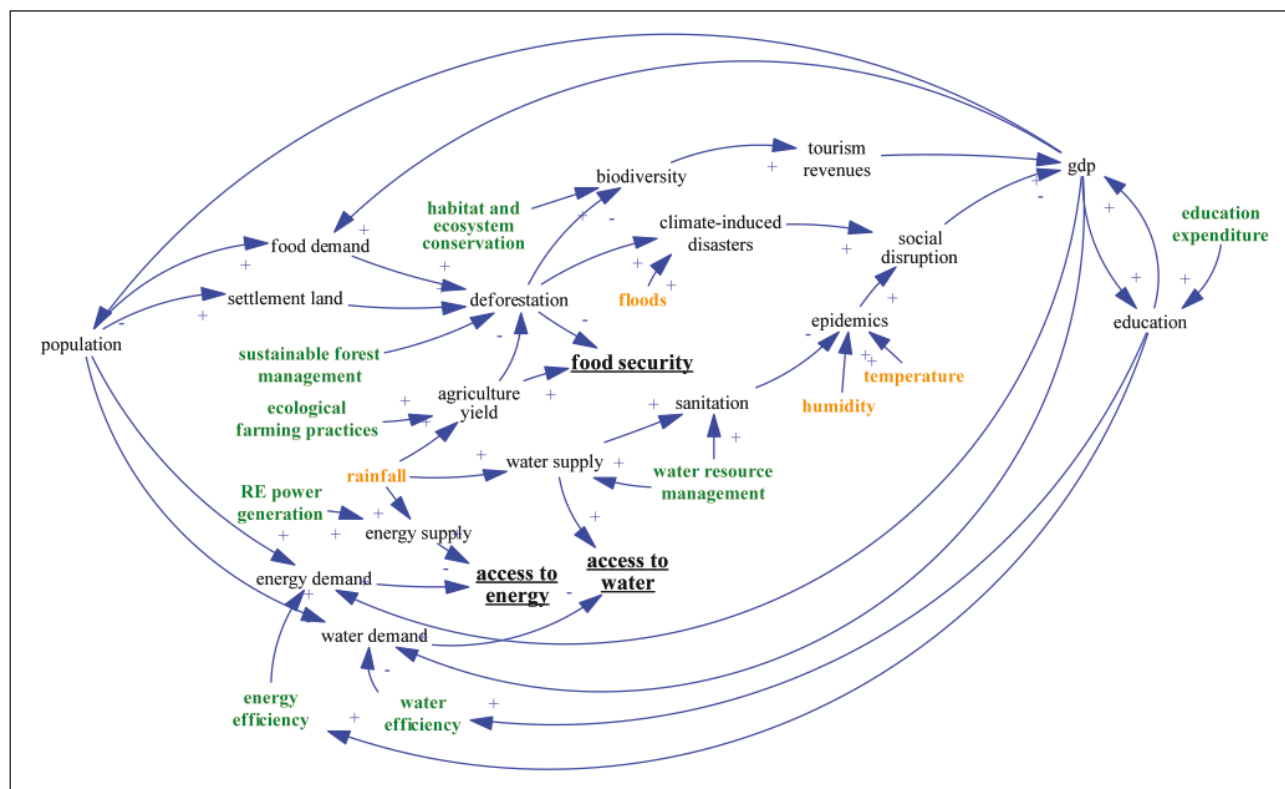
Sectoral and thematic opportunities

The adoption of an Integrated Policymaking approach in the Kenyan context contributes to the identification of key strategic issues that need to be addressed in order to ensure the achievement of human development goals in the framework of climate change. Climate mitigation and adaptation actions are analyzed together with national development interventions to highlight their synergies and their mutual reinforcement in moving towards a more climate resilient and more sustainable future

for the Kenyan population. The sectors prioritized in this report are considered in this analysis. However, climate change response touches

all sectors of the economic, social, and environmental reality as indicated in figure 8.2.

Figure 8.2: Simplified causal diagram between Climate Change and Human Development.



Source: T 21 System Dynamic Model

NB: Figure indicates the cross-sectoral relations existing among society, economy, and the environment, which are all impacted by climate change and all affect human development. Climate change impacts are highlighted in orange, while possible interventions are highlighted in green⁶¹.

Figure 8.2 shows that the various manifestations of climate change (changes in precipitation, floods and droughts, temperature and humidity) greatly affect human development through impacts on GDP, food security, access to energy and water, and on population (e.g. through epidemics and social disruption). Similarly, the interventions available to mitigate climate change and adapt to it have cross-sectoral impacts (often creating synergies). It can be noted that adaptation measures such as those reducing water demand (improving water efficiency) and increasing water supply can have positive impacts on food production (and hence nutrition), and access to energy (hence support economic development), and also increase access to sanitation, further reducing the risk of epidemics.

Synergies across sectors, originating from the design and implementation of interventions that complement each other should be prioritized, with the end goal to sustainably improve human development despite the threat of climate change. It is also often the case that these synergistic interventions also create employment and support GDP growth (on top of reducing or avoiding the negative impacts of climate change, and subsequently lowering government expenditure), further stimulating poverty reduction.

The following sections highlight the creation of possible synergies within and across key sectors and themes. These opportunities can be accrued when using a systemic approach, which prioritizes medium and long-term prosperity over short-term (and often short-lived) economic benefits.

Agriculture and food security: Agricultural Sector Development Policy 2010-2020 puts emphasis on the increase of both small-scale and large-scale agricultural production. Since this policy is expected to facilitate access to credit and inputs, it is essential to set clear rules for the investment of funds into sustainable water management, climate resistant crops, and adaptive techniques and technologies. The use of innovative technologies and techniques will have positive effects on water: reduced water use in agriculture would increase the overall water supply, including water availability for hydroelectricity, an essential source of energy for households (especially in rural areas) and the manufacturing sector. Moreover, the export of green agricultural products would provide a competitive advantage to Kenya in global markets where compliance with environmental standards and regulations is a decisive condition. The resilience of the agricultural sector would thus produce benefits across the key sectors, generating opportunities for the achievement of the development objectives set in Vision 2030.

⁶¹ This causal diagram represents a simplified view of reality. It is therefore not exhaustive and should be interpreted as illustrative of the systemic complexity of the Kenyan context. Further, while certain causal relations are well studied and established, others are still being researched and evaluated.

The following policy recommendations are derived from the integrated analysis presented in the report:

- 1) Agricultural productivity: In view of the perils of climate change, among other factors, priority agricultural policies in Kenya should focus on raising agricultural productivity aimed at ensuring food security and increasing incomes particularly among the small scale farmers. The key policy areas include:
 - a. Intensifying irrigated agriculture to reduce reliance on rain-fed agriculture in the face of limited high-potential agricultural land.
 - b. Improving the availability, affordability and accessibility of inputs, finance, appropriate subsidies, crop and livestock insurance, and dependable extension services.
 - c. Encouragement of diversification into drought resistant and faster maturing crop varieties, especially the so-called "orphan crops", in order to increase the adaptive capacities of small scale holders.
- 2) Research and ICT: For the whole agricultural sector, policy should also be directed towards innovation through technology, for example ICT, in order to take advantage of current opportunities such as mobile telephony and associated services such as MPESA. This will improve commercialisation of agriculture and also attract the youth to participate in farming.
- 3) Governance and inclusiveness: At the governance level, the recent establishment of the National Land Commission as per the new constitution should open the way for policies related to critical issues of land tenure and ownership, including gender dimensions and land use. These are issues which have constrained agricultural productivity and even led to conflicts.

Table 8.3: Integrated analysis of the impacts of agriculture productivity interventions on human development indicators

Agriculture productivity			
Dimension	Indicator	Expected impacts	Interpretation
Health	Mortality rate (infant and maternity)	↔	Improved land use is expected to reduce climate vulnerability and enhance food security, thus indirectly reducing mortality rate.
	Access to health care	↔	Indirect and induced impacts could be expected, due to an increase in income.
	Access to clean water	↑	The introduction of sustainable agriculture practices would reduce water pollution from chemical fertilizers and pesticides, leading to improved access to clean water.
	Access to adequate sanitation	↑	Sustainable land use would reduce overall water consumption through the adoption of water efficiency processes and technology. Saved water could be used to expand access to sanitation.
	Electricity availability	↔	Water saved from sustainable agriculture practices could be used to an increased supply of hydroelectricity.
Knowledge (education)	Formal years of schooling	↔	Indirect and induced impacts could be expected due to an increase in income.
	On the job training	↑	In order to ensure adequate implementation of the land use policy, farmers should be trained in sustainable and climate resilient agriculture techniques.
Income	Gross National Income	↑	Improved climate resilience through sustainable land use is likely to bring about an increase in productivity and overall production, and thus have a positive impact on national income.
	Employment	↑	New jobs would be created as a result of the introduction of innovative, green, agriculture practices.
	Productivity (e.g. agricultural yield)	↑	Resource-conserving and ecological agriculture is expected to considerably increase productivity by reducing environmental degradation and climate change impacts.
	Ownership of assets	↑	The promotion of small-scale farming to support sustainable land use could improve farmers' control over agricultural assets, with positive returns in terms of livelihoods and overall well-being.

↑ : Increase ↓ : Decrease ↔ : No Obvious Change

Source: Authors

Infrastructure: Building of climate resilient infrastructure is prioritized in national policies to reduce economic losses. The adoption of clear, enforceable standards for climate-proof buildings (including houses, schools, health facilities), roads, water catchments, etc. would impulse the development of other sectors, such as trade (ease to transport goods, reduced incidents, commercialization of products by small-scale producers), health (reduced disruption of health facilities in areas vulnerable to natural disasters), education (climate resistant schools would help increase access to education), and agriculture (more efficient irrigation systems, reduced loss of water).

The following policy recommendations are derived from the integrated analysis presented in the report:

1) **Ecosystem restoration:** The restoration of ecosystems, such as forests and river basins, through tree planting and other conservation

measures would strengthen ecosystem services (e.g. mitigating floods), thus reducing climate change impacts on key infrastructure.

- 2) **Climate change mainstreaming:** Infrastructure policies and laws should be carefully reviewed to incorporate climate change mitigation and adaptation.
- 3) **Dedicated institutions:** A specific department in the Government should be tasked with designing and implementing policies to improve the climate resilience of key infrastructure.
- 4) **Entrench adaptation and mitigation planning:** Climate change strategies and plans should be strengthened through more extensive research on impacts, vulnerabilities & risks, and improvement of data collection and packaging including resource assessments such as wind speeds.

Table 8.4: Integrated analysis of ecosystem restoration impacts on infrastructure preservation and human development indicators

Infrastructure: ecosystem restoration for the preservation of infrastructure			
Dimension	Indicator	Expected impacts	Interpretation
Health	Mortality rate (infant and maternity)	↔	The restoration and preservation of ecosystems is expected to reduce climate change impacts on infrastructure. As a result, mortality from infrastructure deterioration is likely to decline.
	Access to health care	↔	By improving resilience of infrastructure, ecosystem restoration would have an indirect positive impact on access to hospitals and primary care facilities.
	Access to clean water	↑	Ecosystem restoration would reduce damages to water supply systems and reservoirs, increase water availability and natural purification, thus improving access to clean water.
	Access to adequate sanitation	↔	Sanitation infrastructure would indirectly benefit from improved climate resilience deriving from ecosystem restoration and preservation interventions.
	Electricity availability	↔	Reduced vulnerability to climate change is likely increase the life span of power plants and electricity supply systems.
Knowledge (education)	Formal years of schooling	↑	Ecosystem preservation would help reduce damages caused to educational infrastructure by extreme weather events (e.g. floods, storms etc.), thus producing an indirect effect on access to education.
	On the job training	↑	Professional training would be required to support ecosystem preservation.
Income	Gross National Income	↑	Infrastructure is a cornerstone of development. Reducing climate change damages to key infrastructure is likely to boost national economy, and income.
	Employment	↑	Ecosystem restoration requires labor force and environmental experts to be successfully accomplished.
	Productivity (e.g. agricultural yield)	↑	Improving infrastructure resilience is likely to increase productivity of key economic sectors.
	Ownership of assets	↔	Ecosystem restoration allows the stock of natural resources to be maintained, limiting negative impacts on the communities that rely on nature for subsistence.

↑ : Increase ↓ : Decrease ↔ : No Obvious Change

Source: Authors

Health: The health sector is directly linked to human development, as well as to climate change threats, and opportunities. Adaptation measures in other sectors are essential to reduce the negative impacts of climate change on the health of the Kenyan population. Sustainable water management would reduce illnesses deriving from water pollution, while increasing the hydroelectricity supply required for heating and cooling purposes, especially in urban settings. Resilient infrastructure would reduce deaths and injuries deriving from extreme natural events such as floods, storms, droughts, etc. The reduction of GHG emissions as a result of the adoption of climate change mitigation initiatives (i.e. reduced deforestation, public transport networks, energy and water efficiency, etc.) will contribute to stopping global warming, thus controlling the spread of malaria in Kenyan highlands in the long term. An urgent need is to supply the health system with the equipment needed to respond to the emerging threats linked to climate change (i.e. malaria treatment in highlands, medicines for intoxication from polluted water, and adequate equipment to attend people affected by natural disasters).

The following policy recommendations are derived from the integrated analysis presented in the report:

- 1) Accessibility and affordability of health care: Health is a basic human right according to the 2010 Constitution. As a result, all policies should be geared towards accessibility and affordability of health care services particularly to the rural poor and inhabitants of informal settlements in urban areas. The access to affordable health care becomes even more important when considering the current and expected climate change impacts on human health.
- 2) Human resources policy: Within the health sector in Kenya there is need to formulate a workable human resources policy to address the chronic problem of staffing of public health facilities and to avert what have now become regular strikes by health personnel.
- 3) Health mainstreaming: It is essential that climate change impacts on human health be addressed in all sectoral adaptation and mitigation policies, such as water and sanitation, agriculture and food security, energy, transport, etc. All these policies can have positive impacts on health conditions of the Kenyan population.

Table 8.5: Integrated analysis of health care policy impacts on climate change response and human development indicators

Health: accessibility and affordability of health care			
Dimension	Indicator	Expected impacts	Interpretation
Health	Mortality rate (infant and maternity)	↓	Accessible and affordable health care would reduce mortality rate, including mortality caused by climate change (e.g. due to increased incidence of malaria and other vector borne diseases, extreme weather events, etc.)
	Access to health care	↑	Access to health care would be improved, especially in rural and remote areas, where climate change impacts on health threaten the local population.
	Access to clean water	↔	No explicit change expected.
	Access to adequate sanitation	↔	No explicit change expected.
	Electricity availability	↔	No explicit change expected.
Knowledge (education)	Formal years of schooling	↑	Improved access to health would reduce diseases and mortality among children, thus having an indirect impact on school attendance.
	On the job training	↔	Indirect impacts could be expected to improve skills and knowledge of the current staff of health care facilities.
Income	Gross National Income	↑	Better health conditions and overall well-being are likely to increase the number of people able to actively participate in the national economy, thereby increasing gross national income.
	Employment	↑	Improved access to health care would require an increase in health personnel, thus creating new jobs in the health sector.
	Productivity (e.g., agricultural yield)	↑	Improved access to health is expected to strengthen the productivity of working age people.
	Ownership of assets	↔	No explicit change expected.

↑ : Increase ↓ : Decrease ↔ : No Obvious Change

Water: The sustainable management of water resources, which constitutes a priority under the sectoral strategic plan as well as the NCCRS, is essential not only to ensure availability of water for drinking and cooking, but also for reducing the impact of climate change on other sectors, such as agriculture (floods and droughts), energy (hydroelectricity), and health (water pollution). Water efficiency in the agriculture and manufacturing sectors would help increase the national water supply to meet the increasing demand. This will have positive impacts on human development, especially in drought prone areas, whose inhabitants (especially women) walk long distances to collect water from remote catchments. Water efficiency should be supported by the construction of infrastructure for adequate water distribution and irrigation, especially in vulnerable areas that still rely on traditional, unsustainable methods for water collection and use.

The following policy recommendations are derived from the integrated analysis presented in the report:

- 1) **Community-Led Total Sanitation (CLTS):** Rapidly accelerate sanitation coverage through CLTS in rural areas.
- 2) **Safe hygiene practices:** Promote safe hygiene practices including household water treatment and safe storage (HWTS) and hand-washing with soap to enhance the health benefit of improved sanitation.
- 3) **Provision of water in ASAL:** The provision of water in ASALs should take into consideration the water needs and quality for both human and livestock consumption.
- 4) **Integration of climate change in sectoral plans:** Relevant national authorities should systematically include climate change consideration into water and sanitation.

Table 8.6: Integrated analysis of Community-Led Total Sanitation (CLTS) impacts on climate change response and human development indicators

Water: community-led total sanitation (CLTS)			
Dimension	Indicator	Expected impacts	Interpretation
Health	Mortality rate (infant and maternity)	↓	CLTS is expected to reduce mortality caused by sanitation related diseases. CLTS is particularly relevant in the case of climate change, since rising temperatures increase the incidence of endemic diseases caused by unhealthy practices such as open defecation.
	Access to health care	↔	No explicit change expected.
	Access to clean water	↑	CLTS is expected to have positive impact on access to water, especially among rural communities with poor sanitation conditions.
	Access to adequate sanitation	↑	Access to sanitation is an indicator directly targeted by CLTS. Improved access to adequate sanitation, particularly in rural areas, is an expected result of this policy intervention.
	Electricity availability	↔	No explicit change expected.
Knowledge (education)	Formal years of schooling	↑	Sanitation related diseases force many children to skip school for prolonged time periods. CLTS would thus have a positive impact on formal education.
	On the job training	↑	Following the CLTS approach, communities would be trained and educated in order to become the main protagonists of change in hygiene and sanitation practices.
Income	Gross National Income	↑	CLTS is expected to increase climate change resilience and improve health conditions of the population. These outcomes might have an indirect impact on people's livelihoods, and income.
	Employment	↔	No explicit change expected.
	Productivity (e.g., agricultural yield)	↑	People's productivity largely depends on health and mental conditions. Since CLTS is expected to improve overall well being, productivity should indirectly benefit from this policy initiative.
	Ownership of assets	↔	No explicit change expected.

↑ : Increase ↓ : Decrease ↔ : No Obvious Change

Source: Authors

Tourism: The National Tourism Policy (2006) seeks to transform tourism into ‘a major vehicle for job creation, poverty reduction, and wealth creation for Kenyans in the future’. According to the document, tourism practices should be harmonised with national policies pertaining to wildlife conservation. The conservation of biodiversity, which is an essential prerequisite for Kenyan tourism to thrive, is being challenged by the combination of climate change and human-induced alterations of ecosystems. The adoption of Sustainable Ecosystem Management (SEM) practices can ensure the sustainable productivity of the natural environment, satisfying economic needs indefinitely. Sustainable tourism would benefit not only private companies, but also local communities (e.g. due to availability of resources, creation of employment, respect of cultural and natural heritage) and other key sectors analyzed in this report (e.g. increased water and energy efficiency).

The following policy recommendations are derived from the integrated

analysis presented in the report:

- 1) **Research on tourism and climate change:** Focused empirical localized research is required to demonstrate the impact of climate change on the tourism sector.
- 2) **Preservation of tourism attractiveness:** Tourism is a climate sensitive service sector whose development depends on a destination’s entire resource base (human, land, water, and air resources). To sustain tourism, changes, particularly of land-use, need to be controlled to ensure they do not detract from Kenya’s unique endowment of diverse tourism attractions.
- 3) **Law harmonization:** The Government should ensure that tourism related policies and laws (e.g. those relating to wildlife conservation and management; protection of endangered species; wildlife cropping; wildlife hunting; land ownership, land-use; etc.) are harmonized in order to minimize areas of conflict and contention in the wake of climate change.

Table 8.7: Integrated analysis of Community-Led Total Sanitation (CLTS) impacts on climate change response and human development indicators

Tourism: preservation of tourism attractiveness			
Dimension	Indicator	Expected impacts	Interpretation
Health	Mortality rate (infant and maternity)	↔	No explicit change expected.
	Access to health care	↔	No explicit change expected.
	Access to clean water	↑	The preservation of tourism attractiveness in the wake of climate change requires, inter alia, the adoption of sustainable land use and water resources management practices, which would improve overall access to clean water.
	Access to adequate sanitation	↔	No explicit change expected.
	Electricity availability	↔	No explicit change expected.
Knowledge (education)	Formal years of schooling	↔	No explicit change expected.
	On the job training	↑	Under this policy option, tourism personnel would be trained in innovative processes and techniques for the sustainable management of Kenya’s resources.
Income	Gross National Income	↑	A sustainable and climate resilient approach to tourism is expected to preserve medium to long term profitability of the sector, thus ensuring an increase in earnings for those working in this sector, as well as for communities reliant on tourism for their livelihoods.
	Employment	↑	The transition towards sustainable tourism is likely to create additional jobs, particularly in energy, water and waste services.
	Productivity (e.g., agricultural yield)	↔	No explicit change expected.
	Ownership of assets	↑	While stricter regulations would be imposed on the use of natural resources, on the other hand a shift could be promoted towards the empowerment of local communities in managing tourism activities and preserving natural assets and cultural heritage.

↑: Increase ↓: Decrease ↔: No Obvious Change

Source: Authors

Public information and training: Public information on current and projected impacts of climate change on Kenyan development would certainly increase the awareness of the population on current threats, thus encouraging voluntary behavioural change, spontaneous adaptation initiatives and the participation in the national debates about climate resilient human development. Such information should be done through all means of communication (radio, press, television, etc.) and using a simple and accessible language.

However, information is not enough. Specific skills need to be created through training and educational courses for different audiences in order to increase national resilience. For example, investment in infrastructure to prevent future disasters need to be complemented with educational programmes on their use and maintenance, as well as mainstreaming of disaster response and management trainings for local communities and responsible authorities. Educational initiatives should be taken (including in schools) to inform the population about new threats derived from climate change impacts and, in general, new living styles to be adopted in response to shifts in temperatures and rainfall patterns. Also, medical staff needs to be trained on unusual diseases (i.e. medical workers in the highlands need to receive information on malaria) as well as proper responses to increased natural disasters.

Women: Women bear most of the burden of climate change effects in Kenya. Indeed, they need to face the challenge of water collection under drought increase; female peasant farmers are suffering from the impacts of changing weather on cultivations; they have to adapt cooking techniques

to increased food and resources scarcity; and they are particularly vulnerable in case of extreme weather events. Therefore, gender needs should be taken into adequate consideration when planning climate change response actions in all key sectors for human development.

Summary

The adoption of a systemic approach to national development planning helps in framing the broad picture of advantages (and possible unintended consequences) derived from climate change adaptation and mitigation for the achievement of priority development goals (Table 8.8). For example, climate change mitigation would lead to less pollution and improved health conditions, as well as reduced depletion of natural resources, in turn leading to increased revenues from eco-tourism, which could be invested in new adaptive technologies and the development of other key sector. On the other hand, investments in adaptive techniques tend to bring more immediate returns, especially with respect to human development objectives. For example, increased water storage capacity would help the development of the agricultural sector leading to strengthened food security and health; preventive adaptation would reduce 'curative' future expenses for food aid and health care, leaving more budget for other adaptive measures, such as the protection of Kenyan coasts from erosion, which would lead to more revenues and employment in the tourism sector as well as increased trade along the coast, with additional benefits for the commercialisation of products by local farmers and fishers.

Table 8.8: Integrated Analysis on Health, Education and Income Impacts from Climate Change

Dimension	Indicator	Land-use Policy	Ecosystem Restoration	Health Care Policy	CLTS	Tourism attractiveness
Health	Mortality rate (infant and maternity)	↔	↔	↓	↓	↔
	Access to health care	↔	↔	↑	↓	↔
	Access to clean water	↑	↑	↔	↑	↑
	Access to adequate sanitation	↑	↔	↔	↑	↔
	Electricity availability	↔	↔	↔	↔	↔
Knowledge (education)	Formal years schooling	↔	↑	↑	↑	↔
	On the job training	↑	↑	↔	↑	↑
Income	Gross National Income	↑	↑	↑	↑	↑
	Employment	↑	↑	↑	↔	↑
	Productivity (e.g. agricultural yield)	↑	↑	↑	↑	↔
	Ownership of assets	↑	↔	↔	↔	↑

↑ : Increase ↓ : Decrease ↔ : No Obvious Change

Source: Authors

Policy-makers should adopt an integrated method to guide the decision-making process, involving all relevant stakeholders in the definition of short-term and long-term objectives. An important issue to take into consideration is that the acceptability of policy options depends on costs and benefits for all the actors involved, including the timing of

revenues. The role of public policy-makers is to strike a balance between economic incentives and the distribution of benefits across the entire Kenyan population, which is the recipient and final beneficiary of national development policies.

8.4 Responsibilities and Suggested Institutional Arrangements

Concrete implementation of national policies and strategies requires an agreed distribution of roles and responsibilities among all relevant stakeholders, including the public and private sectors, as well as NGOs, CBOs and individuals (OECD, 2009). A well-designed collaborative framework will rely on the establishment of synergies between private and public responsibilities and incentives, having as final goal the distribution of economic, social and environmental benefits of climate change adaptation and mitigation policies across all sectors of the Kenyan society.

Public sector: As guarantors of the public good, Kenyan authorities should lead the process and establish the 'rules of the game' to coordinate and facilitate the transition to human development that is resilient to climate change. They are responsible for the creation of a favourable environment that would enable the implementation of climate change response actions by all relevant stakeholders, including the provision of economic and other incentives, budget allocations and the structuring and enforcement of an adequate legislative and standard framework. To do so, horizontal coordination across relevant ministries should be ensured; the ideal structure to make shared top policy decisions would be the National Ministerial Coordination Committee, chaired by the Cabinet Secretary responsible for coordination of government.

The general strategic directives should be then further elaborated and adapted to specific climate change challenges; the Climate Change Policy Steering Committee could be the ideal institution for this role. The National Climate Change Secretariat (NCCS) should play the central role for the translation of policy and strategic directives into concrete actions. The NCCS should provide advice and guidance to the ministerial climate change focal points for the mainstreaming of climate change issues into sectoral plans, under the broader framework of Vision 2030. It should also be the liaison actor for vertical coordination between central and local authorities, as well as the focal point for donor countries and global funds.

County governments should advise the NCCS regarding actions that could be carried out in each location according to specific climate change challenges, as well as the distribution of responsibilities in project implementation, including the role local leaders, NGOs and civil society organizations. County governments should also be responsible for informing and raising awareness among the people about climate change threats and possible adaptive responses. Educational and training programmes should be carried out in collaboration with other local stakeholders.

Private sector: Both international and national companies should be obliged to respect the environment in their business operations. National authorities should contribute not only to the regulation of private activities in line with international standards, but also to the creation of economic opportunities that promote green businesses. Kenya has a vibrant private sector, especially in sectors such as tourism, manufacturing and agribusiness that can play a central role in greening of the national economy. The Kenya Private Sector Alliance (KEPSA) could represent

the focal institution to promote green businesses in the country, in strict collaboration with the government. Public-private partnerships are essential to ensure sustainable management of natural resources and equal distribution of adaptation and mitigation benefits for sustainable development. The private sector should establish committees, participate in forums and events on green economy and collaborate in changing the mentality of individuals towards climate resilient consumption, production and recreational behaviours.

NGOs and CBOs: NGOs and CBOs play an important role in the achievement of human development in Kenya. They are active at national, district and community level in different sectors, and they are directly involved with the vulnerable groups that are mostly affected by climate change impacts. For this reason, they have the opportunity to better identify the adaptation needs for the sustainable development of Kenyan people, and to advocate with the government and the private sector. There are several coordinating bodies and associations of NGOs, which could facilitate the relations with central and local authorities, and represent non-governmental actors in multi-stakeholder processes for national development planning.

Individuals: Human development places individuals at the centre. In the 1990 Human Development Report, it was stated that "people are the real wealth of a nation. The basic objective of development is to create an enabling environment for people to live long, healthy and creative lives. This may appear to be a simple truth. But it is often forgotten in the immediate concern with the accumulation of commodities and financial wealth". Climate change adaptation reinforces this message, giving priority to the impact of climate change on the wellbeing of individuals, and focusing on reducing their vulnerability to such impacts. Individuals should thus be the protagonists of climate change response actions. Local leaders should be included in national development planning, especially with regards to disaster risk management and climate change adaptation. The communities should recognize the public interest of climate change response and (1) undertake voluntary behavioural change, (2) respect existing laws and regulations for the protection of the environment, (3) express their specific concerns regarding climate change impacts on development, and (4) participate in educational programmes and trainings to reduce climate vulnerability and increase adaptability to changing conditions.

Multi-Stakeholder Processes (MSP) are a fundamental prerequisite for a balanced division of roles and responsibilities in climate change adaptation and mitigation. It is widely acknowledged now that the knowledge required to articulate what would constitute sustainable development in any given context (i.e. country or sub-regions therein) is often dispersed within the system boundary (i.e. country and its sub-regions), which is why a multi-stakeholder approach is necessary for successful outcomes. In other words, the complex system of socio-economic conditions existing within Kenyan natural ecosystems can only be seen collectively for the adequate response to the increasing demands for policy-relevant interventions. MSP can also help ensure better coordination between programmes and projects that may be overlapping, on top of ensuring that knowledge is combined and properly utilized by sharing common mental models.

Climate change impacts, vulnerability, adaptive capacity, and barriers to adaptation are location-specific and will change over time, but the processes needed for adaptation that supports all affected parties are similar. Bottom-up as well as top-down processes are key for adaptation, from community-level design and implementation, to access to information across all levels, to the enabling national-level processes to finance, build capacity, and integrate. The MSP is an appropriate model to achieve this.

It is also important to remember that climate change is a trans-boundary issue that requires international cooperation on different levels of governance, including multilateral, bilateral, global, regional and sub-regional. Policies and strategies, especially those on the management of natural resources, should be coordinated beyond Kenyan borders, through the creation of international plans and treaties, as well as through informal partnerships and collaboration spaces.

8.5 Conclusions

The integrated analysis conducted throughout this chapter on policy and strategic options for the promotion of climate resilient human development in Kenya, led to a number of recommendations to influence future trends in order to reach stated goals. These can be summarized as follows:

Key sectoral recommendations

- The National Land Commission should introduce clear and coherent land-use regulations, taking into careful consideration climate change impacts on agricultural production, food security and human development. In general, institutional responsibilities with respect to climate change adaptation of the agricultural sector have to be established, including clear division of roles between national and county governments.
- A specific department of the Government should be in charge of designing adequate policy measures to reduce climate change impacts and pursue opportunities emerging from climate change.
- Mainstreaming of climate change considerations into existing infrastructure policies and plans is essential to support human development, as indicated in the NCCAP.
- Having recognized that climate change has a negative impact on health (e.g. due to an increase in vector borne diseases, extreme natural events, etc.), it is crucial that national authorities prioritize accessibility and affordability of health care into national health policies. Moreover, specific trainings should to be carried out for medical doctors on new diseases deriving from climate change impacts.
- Behavioural change should be promoted with regard to safe hygiene practices, in particular concerning water use and sanitation. In this

sense, awareness should be raised with respect to climate change impacts on water availability.

- Sustainable tourism management should be promoted through a balanced mix of incentive packages, standards, and regulations. Tourism policies should focus on human development, including through the empowerment of local communities, which should play a central role in the transition towards climate resilient tourism practices.

Climate change adaptation

- More research is needed on location-specific adaptation options that could reduce vulnerability of local communities to climate change impacts.
- Public information should be prioritized to increase awareness of climate change threats and opportunities for development.
- The gender component of adaptation initiatives should be prioritised, given the impact of climate change particularly on vulnerable women.
- The Government should continue in its efforts to achieve key demographic targets set out in the Population Policy for National Development 2012-2030. In particular, education on family planning is essential to raise awareness on the need for balanced demographic and economic growth, especially considering climate change impacts on available resources.

Climate change mitigation

- The link between climate change mitigation and sustainable development needs to be reinforced through integrated policymaking and raising of public awareness.
- Incentives should be provided to individuals and the private sector for compliance with international standards for the reduction of GHG emissions. For example, payments for ecosystems services could be a useful rewarding instrument for the protection of natural resources and ecosystem conservation.
- More investments in green technologies are needed, including for the improvement of energy and water efficiency in all key sectors of the national economy.

General recommendations

- An integrated policymaking approach should be adopted to align objectives of existing climate change, development and sectoral policies and plans, in order to reduce duplication and build on synergies and complementarities to improve human development.
- The Government of Kenya, and especially the National Climate Change Secretariat, should ensure horizontal and vertical coordination on climate change issues, acting as the liaison actor with the international donor community.
- Multi-Stakeholder approaches should be adopted for the formulation of concerted strategies and action plans on climate change and human development, bringing together the government, the private sector, NGOs, CBOs as well as local leaders.

9 CONCLUSION AND RECOMMENDATIONS

9.1 Overview of human development trends - past challenges

Since independence, Kenya has been progressing towards the realization of human development. The national economy has expanded throughout the years, and significant progress has been achieved in reducing gender-based differences, supporting the development of the most vulnerable segments of the population, improving access to health and sanitary condition, promoting a more equitable access to resources, protecting human rights, and valuing individual goals and objectives. The 2012 Human Development Index estimate for Kenya is 0.522, which would represent an improvement with respect to the previous HDI rating (0.509), as well as a value placed above the average of Sub-Saharan African countries.

However, many challenges still have to be faced in order to ensure equitable and sustainable human development. Poverty is still widespread, leading to food insecurity and malnutrition in many areas of the country, especially in the north. Access to health and education represents a major barrier to the achievement of development objectives. Moreover, good governance has to be further improved in order to ensure transparency, rule of law, the elimination of any sort of conflict and the realization of a peaceful environment conducive to the full enjoyment of democratic rights and principles by all citizens. In general, the distribution of wealth is still highly unbalanced across the different regions and social groups, and women's development trends are following a slower trajectory than men's.

This Human Development Report focused on a specific challenge that, if not dealt with in a timely and effective manner, is expected to hinder the efforts the country has made so far towards the achievement of human development: climate change. As it was shown throughout the report, changing climate patterns, resulting from global CO₂ emissions, are already producing harmful impacts on the Kenyan economy, society, and environment. Economic sectors, such as agriculture and tourism, are suffering significant losses from uncertain weather patterns, with direct

Poverty is still widespread, leading to food insecurity and malnutrition in many areas of the country, especially in the north.



consequences for the well-being of the population. Health challenges are being exacerbated by the effects of rising temperatures on the incidence of certain diseases, such as malaria. Access to water and energy, and basic conditions for human development, are being seriously threatened by the progressive depletion of ecosystems as well as the impacts of extreme weather events on delivery infrastructure.

As presented throughout the report, Kenya is already active in the implementation of strategies and actions to respond to current and projected climatic changes. Starting from the consideration that climate change adaptation is fundamental for the realization of human development in Kenya, this Human Development Report sought to review current efforts under a systemic perspective, in order to integrate them into a coherent framework for action, with the goal to reach a more resilient and sustainable development path.

9.2 Presentation of Human Development Goals and Future Challenges Related to Climate Change

The Vision 2030 is the main national strategic document, providing the framework for the achievement of human development in Kenya. Based on three 'pillars'- economic, social, and political - it aims at achieving macroeconomic stability, governance reforms, equity, sound infrastructure, availability and equal access to energy resources, development of science and technology, land reforms, human resource development, security, and public service reforms (GoK, 2007). The key macroeconomic target is to achieve a GDP annual growth rate of 10%. Such economic development should be coupled with "social equity in a clean and secure environment", as well as the realisation of a "democratic political system founded on issue-based politics that respects the rule of law, and protects the rights and freedoms of every individual in the Kenyan society" (GoK, 2007).

In order to translate Vision 2030 into reality, climate change threats need to be properly addressed and incorporated into national development planning. Indeed, Kenya is expected to increasingly suffer from the negative effects of climate change in the coming years, manifesting themselves in several ways. Extreme weather events, sea level rise, high temperatures, and unpredictable rainfall patterns will continue to have considerable effects on the livelihoods of the population. The challenges ahead are substantial, especially when considering that: (1) the frequency and severity of droughts and floods is anticipated to increase, especially in arid and semi-arid lands, areas where livestock production and subsistence farming are greatly dependent on rainfall; (2) surface water resources in arid and semi-arid regions of the country will become scarcer along with ground water in coastal regions; (3) biological, biochemical, and physical characteristics of the marine systems will be impacted; (4) climate sensitive diseases including malaria, tuberculosis, and diarrhoea will increase; (5) rangelands and forests may both be impacted by rainfall, rising temperatures, humidity, winds and evapo-transpiration, with possible changes in terrestrial vegetation structure, forage quality and quantity, livestock and wildlife productivity, water quality and quantity, and distribution of diseases and parasites; (6) climate change related events, such as floods, storms and sea level rise, will have an impact on transport, waste and, in general, urban infrastructure.

Given its adverse impact on famine, energy shortages, desertification, diseases, and overall economic, environmental, and human degradation, climate change constitutes a threat to human and economic development in Kenya, especially for the most vulnerable communities, which still lack the capacity and technology to properly address such challenges. On the other hand, it is possible to turn climate change challenges into opportunities by developing long-term policies that both address short-term vulnerability and increase long-term resilience.

Poverty is still widespread, leading to food insecurity and malnutrition in many areas of the country, especially in the north.

9.3 Overview of Opportunities to Address Climate Change and Improve Human Development

9.3.1 National policy perspective

It is estimated that Kenya will need about US \$1-2 billion per year by 2030 to address current and future climate change effects (Mutai and Ochola, 2009). Unless effective mitigation and adaptation mechanisms are urgently instituted, the combined effect of 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.

In 2010 Kenya developed a National Climate Change Response Strategy (NCCRS), which identifies the agriculture, tourism, infrastructure, health and natural resources areas as being most vulnerable to climate change (MENR, 2010). The NCCRS identifies a number of priority adaptation actions by sector in Kenya. On November 22nd 2012, Kenya validated the Climate Change Action Plan to operationalise the NCCRS. This is a step further towards addressing climate change concerns in the country.

While the National Climate Change Response Strategy (NCCRS) was finalized in 2010 and the National Adaptation Plan validated in 2012, there is need to go further and formulate a national policy on climate change and enact a climate change law.

The goal is to find a strategy to balance funding responsibilities, sharing benefits with all actors of society and the economy, while providing support to low income and disadvantaged families. The Government should be the main driver in the initial phase, especially for the provision of incentives, the allocation of budget and the formulation (or amendment) of laws and regulations. However, international donors and global funds can play an essential role in funding such efforts (i.e. providing budget support). The suggested interventions will provide business opportunities to the national private sector, and they also have the potential to attract foreign investment. Overall, the entire Kenyan population will benefit from the creation of these enabling conditions. Indeed, the greening of the Kenyan economy will facilitate climate change adaptation and sustainable economic and social development, thus improving the wellbeing of all Kenyans.

In order to incorporate climate change concerns into national development policies, the Government of Kenya should:

- Foster the development of strategies, plans and processes to:
 - » Avoid, minimise, or adapt to the negative impacts of climate change on key assets of Kenya, including, among others, agriculture, water, fisheries, and forests.
 - » Avoid or reduce damage to human settlements and infrastructure caused by climate change.
 - » Build capacity to understand, analyse, and react in a timely manner in the wake of future climate change impacts within the country.
- Integrate and mainstream climate change adaptation into core development policies, strategies and plans:
 - » Adopt an Integrated policymaking approach (IP), taking into consideration economic, social, and environmental variables that influence the achievement of policy objectives (Section 2.2).

- » Consider the three layers of policy development (structure, scenarios, policies). Establish clear and reliable indicators for policy formulation and evaluation.
- » Adopt UNEP's DPSIR framework to mainstream environmental concerns into development policies, strategies, and plans (Section 2.3).

More specifically:

- Concerning the definition and introduction of long term planning mechanisms:
 - » Ensure that adequate planning (physical, socio-economic etc.) is undertaken on a continual basis to address the impacts of climate change. Such planning should be undertaken, not in isolation but in the wider context of sustainable development, and using an integrated, cross-sectoral, and trans-disciplinary approach (i.e. systems approach).
- Concerning improving climate resilience:
 - » Recognize that the resilience of the natural environment is key to coping with climate change, and do everything possible to enhance and maintain environmental quality.
 - » Recognize that economic resilience is key to coping with climate change, and do everything possible to promote the development of a strong and diversified economy.
 - » Create an enabling environment for the adoption of appropriate technologies and practices that will assist in meeting national and international commitments with respect to the causes and effects of climate change.
- Concerning financing options to meet national adaptation financial needs:
 - » Procure and allocate financial and other resources, as appropriate and feasible, to ensure that climate change is addressed in the manner required.
- Concerning strengthening capacities and institutional frameworks:
 - » Endeavour, to the extent possible and necessary, to develop national human and institutional capacity in all aspects of climate change research, response, planning, etc.
 - » Endeavour to foster or create an institutional, administrative, and legislative environment which engenders/ supports the effective implementation of climate change adaptation activities.
 - » Collaborate as appropriate and feasible, with other regional and international states and organisations which pursue confluent agendas in climate change;
 - » Endeavour to obtain, to the extent feasible, the involvement and participation of all stakeholders at the national level in addressing issues related to climate change.
 - » Endeavour to ensure that such involvement and participation occurs on an appropriately coordinated basis which minimises duplication of effort and conflict, and which ensures efficient use of resources and the creation of positive synergies.

Based on this general strategic approach, sectoral strategies should be implemented to transform green economy opportunities into real actions.

9.3.2 Sectoral opportunities

Agriculture and food security

The Agricultural Sector Development Policy 2010-2020 puts the emphasis on the increase of both small-scale and large-scale agricultural production. Since this policy is expected to facilitate access to credit and inputs, it is essential to set clear rules for the investments of funds into sustainable water management, climate resistant crops, and adaptive techniques and technologies. The use of innovative technologies and techniques will have positive effects on water: reduced water use in agriculture would increase the overall water supply, including water availability for hydroelectricity; an essential source of energy for households (especially in rural areas) and the manufacturing sector. Moreover, the export of green agricultural products would provide a competitive advantage to Kenya in global markets where compliance with environmental standards and regulations is a peremptory condition. The resilience of the agricultural sector would thus produce benefits across the key sectors, generating opportunities for the achievement of the development objectives set in the Vision 2030.

Infrastructure

The building of climate resilient infrastructure is prioritized in national policies to reduce economic losses. The adoption of clear, enforceable standards for climate-proof buildings (including houses, schools, health facilities), roads, water catchments, etc. would impulse the development of other sectors, such as trade (ease in transport of goods, reduced incidents, commercialization of products by small-scale producers), health (reduced disruption of health facilities in areas vulnerable to natural disasters), education (climate resistant schools would help increase access to education), and agriculture (more efficient irrigation systems, reduced loss of water).

Health

The health sector is directly linked to human development, as well as to climate change threats and opportunities. Adaptation measures in other sectors are essential to reduce the negative impacts of climate change on the health of the Kenyan population. Sustainable water management would reduce illnesses deriving from water pollution, while increasing the hydroelectricity supply required for heating and cooling purposes, especially in urban settings. Resilient infrastructure would reduce deaths and injuries deriving from extreme natural events such as floods, storms, droughts etc. The reduction of GHG emissions as a result of the adoption of climate change mitigation initiatives (i.e. reduced deforestation, public transport networks, energy and water efficiency etc.) will contribute to stopping global warming, thus controlling the spread of malaria in Kenyan highlands in the long term. An urgent need is to supply the health system with the equipment needed to respond to the emerging threats linked to climate change (i.e. malaria treatment in highlands, medicines for intoxication from polluted water, adequate equipment to attend people affected by natural disasters).

Water

The sustainable management of water resources, which constitutes a priority under the sectoral strategic plan as well as the NCCRS, is essential not only to ensure availability of water for drinking and cooking, but also for reducing the impact of climate change on other sectors, such

as agriculture (floods and droughts), energy (hydroelectricity), and health (reduce water pollution). Water efficiency in the agriculture and manufacturing sectors would help increase the national water supply to meet the increasing demand. This will have positive impacts on human development, especially in drought prone areas, whose inhabitants (especially women) need to walk long distances to collect water from remote catchments. Water efficiency should be supported by the construction of infrastructure for adequate water distribution and irrigation, especially in vulnerable areas that still rely on traditional, unsustainable methods for water collection and use.

Tourism

The National Tourism Policy (2006) seeks to transform tourism into 'a major vehicle for job creation, poverty reduction, and wealth creation for Kenyans in the future'. According to the document, tourism practices should be harmonised with national policies pertaining to wildlife conservation. The conservation of biodiversity, which is an essential prerequisite for Kenyan tourism to thrive, is being challenged by the combination of climate change and human-induced alterations of ecosystems. The adoption of Sustainable Ecosystem Management (SEM) practices can ensure the sustainable productivity of the natural environment, satisfying economic needs indefinitely. Following a sustainable approach, the tourism sector would benefit not only private companies, but also local communities (i.e. due to availability of resources, creation of employment, respect of cultural and natural heritage) and other key sectors analyzed in this report (i.e. increased water and energy efficiency).

Public information and training

Public information on current and projected impacts of climate change on Kenyan development would certainly increase the awareness of the population on current threats, thus encouraging voluntary behavioural change, spontaneous adaptation initiatives, and the participation in the national debates about climate resilient human development. Such information should be done through all means of communication (radio, press, television etc.) and using a simple and accessible language.

However, information is not enough. Specific skills need to be created through training and educational courses for different audiences in order to increase national resilience. For example, investments in infrastructure to prevent future disasters need to be complemented with educational programmes on their use and maintenance, as well as the mainstreaming of disaster response and management trainings for local communities and responsible authorities. Educational initiatives should be taken (including in schools) to inform the population about new threats derived from climate change impacts and, in general, new living styles to be adopted in response to shifts in temperatures and rainfall patterns. In addition, medical staff need to be trained on unusual diseases (i.e. medical workers in the highlands need to receive information on malaria) as well as on proper responses to increased natural disasters.

Women

Women bear the brunt of climate change effects in Kenya. They face the challenge of water collection under drought increase: suffer the impacts of changing weather on cultivation, adapt cooking techniques to increased food and resources scarcity, and they are particularly vulnerable in case of extreme weather events. Therefore, gender needs to be taken into

adequate consideration when planning climate change response actions in all key sectors for human development.

The adoption of a systemic approach to national development planning helps in framing the broad picture of advantages (and possible unintended consequences) derived from climate change adaptation and mitigation for the achievement of priority development goals. For example, climate change mitigation would lead to less pollution and improved health conditions, as well as reduced depletion of natural resources, which in turn would lead to increased revenues from eco-tourism, which could be invested in new adaptive technologies and the development of other key sectors.

On the other hand, investments in adaptive techniques tend to bring more immediate returns, especially with respect to human development objectives. For example, increased water storage capacity would help the development of the agricultural sector leading to strengthened food security and health; preventive adaptation would reduce 'curative' future expenses for food aid and health care, leaving more budget for other adaptive measures, such as the protection of Kenyan coasts from erosion, which would lead to more revenues and employment in the tourism sector as well as increased trade along the coast, with additional benefits for the commercialization of products by local farmers and fishers.

9.4 Concluding statement

"The basic objective of development is to create an enabling environment for people to live long, healthy and creative lives. This may appear to be a simple truth. But it is often forgotten in the immediate concern with the accumulation of commodities and financial wealth" (HDR, 1990). Climate change adaptation reinforces this message, giving priority to the impact of climate change on the wellbeing of individuals, and focusing on reducing their vulnerability to such impacts. Individuals should thus be the protagonists of climate change response actions. Local leaders should be included in national development planning, especially with regard to disaster risk management and climate change adaptation.

The impacts of climate change on human development in Kenya are not stopped by single institutional mandates or geographic boundaries. In order to effectively address these risks and explore potential opportunities, the collaboration among all relevant stakeholders is needed. This requires having the right information and creating strong communication networks to ensure that there is constant awareness of complementarities and synergies, in order to increase cooperation and maximize results towards the achievement of sustainable and resilient human development.

Multi-Stakeholder Processes, where all stakeholders at all levels of a process are directly involved, are a fundamental prerequisite for balanced division of roles and responsibilities in climate change adaptation and mitigation. It is widely acknowledged now that the knowledge required to articulate what would constitute sustainable development in any given context (i.e. country or sub-regions therein) is often dispersed within the system boundary (i.e. country and its sub-regions), which is why a multi-stakeholder approach is necessary for successful outcomes. In other words, the complex system of socio-economic conditions existing within Kenyan natural ecosystems can only be seen collectively for the adequate response to the increasing demands for policy-relevant interventions.

MSP can also help ensure better coordination between programmes and projects that may be overlapping, on top of ensuring that knowledge is combined and properly utilized by sharing common mental models.

Climate change impacts, vulnerability, adaptive capacity, and barriers to adaptation are location-specific and will change over time, but the processes needed for adaptation that support all affected parties are similar. The Multi-Stakeholder Processes are an appropriate model to achieve this.

It is also important to remember that climate change is a trans-boundary issue that requires international cooperation on different levels of governance: multilateral, bilateral, global, regional, and sub-regional. Policies and strategies, especially those on the management of natural resources, should be coordinated beyond Kenyan borders, through the creation of international plans and treaties, as well as informal partnerships and collaboration spaces.

REFERENCES

- Adger, W.N. 1999. Social vulnerability to climate change and extremes in coastal Vietnam. *World Development Studies* 27(2): 249-269.
- Adger, W.N. & Kelly, M. 1999. Social vulnerability to climate change and architecture of entitlements. *Mitigation and Adaptation Strategies for Global Change* 4: 253-266.
- AEA Group. 2008a. Final report. Kenya: Climate screening and information exchange (ED 05603, Issue 2). Retrieved from <http://www.dewpoint.org.uk/Asset%20Library/DFID/Climate%20Risk%20Assessment%20Report%20-%20Kenya.pdf>
- AEA Group. 2008b. Kenya: Climate screening and information exchange. Retrieved from <http://www.dewpoint.org.uk/Asset%20Library/Climate%20Risk%20Assessment%20Flier%20-%20Kenya.pdf>
- African Union (AU). 2010. Climate Change and Human Development. Issues Paper # 3. ADF VII, 10-15 October 2010. United Nations Conference Centre, Addis Ababa, Ethiopia.
- Agnew, M. & Palutikof, J. 2006. Impact of short-term climate variability in the UK on demand for domestic and international tourism. *Climate Research* 31, 109-120.
- Alkire, S. & Santos, E.M. 2010. Acute Multidimensional Poverty: A New Index for Developing Countries. UNDP Human Development Research Paper 2010/11 July 2010, Washington, DC.
- Allen, K. 2003. Vulnerability reduction and the community-based approach: A Philippines study. In: M. Pelling (Ed.), *Natural Disasters and Development in a Globalizing World*. Routledge, New York, pp. 170-184.
- Altizer S., Bartel, R. & Han, B.A. 2011. Animal migration and infectious disease risk. *Science*, 311: 296-302.
- Amelung, B., Nicholls, S. & D. Viner. 2007. Implications of Global Climate Change for Tourism Flows and Seasonality. *Journal of Travel Research*, 45, 285-296.
- AQUASTAT FAO. 2010. Food and Agriculture Organisation for the United Nations. Country Profile and Factsheet for Kenya. Available at www.fao.org/nr/water/aquastat/main/index.stm
- Awuor, C.B., V.A. Orindi & A. Adwerah. 2007. Climate Change and Coastal Cities: The Case of Mombasa, *Environment and Urbanisation* 20:1: 231-242.
- Baettig, M.B., M. Wild, & D.M. Imboden. 2007. A Climate Change Index: Where climate change may be most prominent in the 21st century. *Geophysical Research Letters* 34, 2007.
- Bates, B., Kundzewics, Z.W., Wu, S. & Palutikof J. (Eds.). 2008. Climate change and water. IPCC Technical Paper VI.
- Becken S. & Hay J. 2007. *Tourism and Climate Change – risks and opportunities*. Clevedon: Channel View Publications.
- Bindoff, N L, J Willebrand, V. Artale, A. Cazenave, J. Gregory, S. Gulev, K. Hanawa, C. Le Quere, S. Levitus, Y. Nojiri, C. K. Shum, L. D. Talley and A. Unnikrishnan 2007. "Observations: oceanic climate change and sea level", in S Solomon, D Quin, M Manning, Z Chen, M Marquis, K B Averyt, M Tignor and H I Miller (editors), *Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge and New York, pages 385-432.
- Bloom, D.E. & Canning, D. 2009. *The Health and Wealth of Nations*, River Path: www.riverpath.com
- BirdLife International. 2011. Endemic bird area factsheet: Kenyan mountains. (available at www.birdlife.org on 01/08/2011).
- Briceño-Garmendia, C.M. and M. Shkaratan (2010). Kenya's Infrastructure: A Continental Perspective. *Africa Infrastructure Country Diagnostic (AICD) Country Report*. World Bank, Washington, DC, March 2010.
- Brooks, N., Adger, W.N. and Kelly, P.M. (2005). The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environ. Change* 15: 151-163.
- Brown, O., Hammill, A. & Mcleman, R. 2007. Climate change as the 'new' security threat: implications for Africa. *International Affairs* 83: 1141-1154.
- Bruckner, M. 2012. Climate change vulnerability and the identification of least developed countries. CDP Background Paper No. 15, ST/ESA/2012/15. Committee for Development Policy (CDP) Secretariat, Development Policy and Analysis Division, Department of Economic and Social Affairs, United Nations. June 2012.
- Burke, M.B., Miguel, E., Satyanath, S., Dykema, J.A. and Lobell, D.B. (2009). Warming increases the risk of civil war in Africa. *Proceedings of the National Academy of Sciences in the United States of America*, 106 (49), p20670-20674.
- Butler, R. 2001. Seasonality in tourism: Issues and implications. pp. 5-22. In: T. Baum & S. Lundtorp (Eds.). *Seasonality in Tourism*. London: Pergamon.

- Cameron, L., L.Würtenberger and S. Stierbert, 2012a. "Kenya's Climate Change Action Plan: Mitigation", Chapter 7: Transportation, Unpublished Report, August 2012.
- Cameron, L., L.Würtenberger and S. Stierbert, 2012b. "Kenya's Climate Change Action Plan: Mitigation", Chapter 5: Electricity Generation, Unpublished Report, August 2012.
- Central Intelligence Agency [CIA]. 2010. The World Factbook: Kenya. Retrieved from <https://www.cia.gov/library/publications/the-world-factbook/geos/ke.html>
- Centre for Ecology and Hydrology. 2007. Oxford Centre for Water Resources. The Climate Vulnerability Index. Available at: www.ocwr.ouce.ox.ac.uk/research/wmpg/cvi/
- Chambers, R. & Conway, G.R. 1992. "Sustainable Rural Livelihoods: Practical Concepts for the 21st Century". Discussion Paper 296. Brighton, UK: Institute of Development Studies.
- Chattopadhyay R. & Duflo, E. 2004. Women as policy makers: evidence from a randomized policy experiment in India. *Econometrica* 72(5):1409-43.
- COHRE, WATERAID, SDC & UN-HABITAT. 2008. Sanitation: A human right imperative. Geneva.
- Conway, D., Hanson, C.E., Doherty, R. and Persechino, A. (2007). GCM simulations of the Indian Ocean dipole influence on East African rainfall: Present and future. *Geophysical Research Letters* 34(3): L03705.1–L03705.6.
- Crouch, G.I. 1994. The Study of International Tourism Demand: a Survey of Practice, *Journal of Travel Research* 32 (4), 41-55.
- Cutter, S.L., Mitchell, J.T., & Scott, M.S. 2000. Revealing the vulnerability of people and places: A case study of Georgetown county, South Carolina. *Annals of the Association of American Geographers* 90(4): 713-737.
- Danda, M. 2006. "Vulnerability and capacity assessment in Mombasa district", Survey Report for the Kenya Red Cross Society, Mombasa Branch, unpublished.
- de La Rocque, S., Rioux, J.A., & Slingenbergh, J. 2008. Climate change: effects on animal disease systems and implications for surveillance and control. *Rev. Sci. Tech. Off. Int. Epiz.*, 27(2): 339–354
- deFreitas, C.R. 2003. Tourism climatology: evaluating environmental information for decision making and business planning in the recreation and tourism sector. *International Journal of Biometeorology*, 48, 45–54.
- deFreitas, C.R. 2005. The climate-tourism relationship and its relevance to climate change impact assessment. In: *Tourism, Recreation and Climate Change: International Perspectives*. C.M. Hall and J. Higham (eds.). Channelview Press, UK.29-43.
- deFreitas C.R., Scott, D. & McBoyle, G. 2008. A second generation climate index for tourism (CIT): specification and verification. *International Journal of Biometeorology*, 52, 399-407.
- Decanq, K. & Lugo, M.A. 2009. Weights in Multidimensional Indices of Well-being. OPHI Working Paper No. 18.
- Deressa, T., Hassan, R.M., & Ringler, C. 2008. Measuring Ethiopian Farmers' Vulnerability to Climate Change Across Regional States. IFPRI Discussion Paper # 00806.
- DFID. 1998. Guidance Manual on Water and Sanitation Programs, DFID, London.
- DFID. 2010. Guidance Sheets on Climate Change (Draft): Key sheets that summarise the existing guidance available on the implications of climate change for various strategic, sectoral and thematic policy issues (prepared by Cranfield University and the University of Sussex).
- Diffenbaugh, N.S., F. Giorgi, L. Raymond & X. Bi. 2007. Indicators of 21st century socioclimatic exposure. *Proceedings of the National Academy of Sciences* 104 (51): 20195, 2007.
- Elsasser, H. & Buerki, R. 2002. Climate change as a threat to tourism in the Alps. *Climate Research*, 20, 253–257.
- Emerton, L. 2001. Why forest values are important to East Africa. *Innovation*, 8(2): 1–5.
- Ericksen, S.H., & Kelly, P.M., 2007. Developing credible vulnerability indicators for climate adaptation policy assessment. *Mitigation and Adaptation Strategies for Global Change* 12(4): 495-524.
- Escribano, Alvaro, J. Luis Guasch, and Jorge Pena. 2010. "Assessing the Impact of Infrastructure Quality on Firm Productivity in Africa." Policy Research Working Paper 5191, World Bank, Washington DC.
- Eugenio-Martin, J.L. & Campos-Soria, J.A. 2009. Climate in the region of origin and destination choice in outbound tourism demand. *Tourism Management*, in press.
- FAO. 1996. Rome Declaration and World Food Summit Plan of Action, Rome.
- FAO. 2008. Climate Change and Food Security: A Framework Document, FAO, Rome.
- FAO. 2010. Global Forest Resource Assessment: Country Report: Kenya
- FAO. 2012. The State of Food Insecurity in the World, FAO, Rome, 2012.
- Fischer, E., Schmidt, T., Hora, S., Geisdorf, J., Stinner, W., and Scholwin, F. 2010. Agro-Industrial Biogas in Kenya: Potentials, Estimates for Tariffs, Policy and Business Recommendations. German International Cooperation (GIZ), Berlin.
- Foster, V. & Briceño-Garmendia (eds.). 2010. Africa's Infrastructure: A Time for Transformation. Co-publication of the Agence Française de Développement (AFD) and the World Bank. Washington, DC, 2010. ISBN 978-0-8213-8083-3 (electronic).
- Füssel, H-M. 2007. Vulnerability: A generally applicable conceptual framework for climate change research. *Global Environmental Change* 17(2): 155-167.
- Füssel, H-M. 2009. Review and quantitative analysis of indices of climate change exposure, adaptive capacity, sensitivity, and impact. Background Note to the World Development Report 2010. Potsdam Institute for Climate Impact Research (PIK), Germany.

- Global Alliance for Clean Cookstoves. 2011. Igniting Change: A Strategy for Universal Adoption of Clean Cookstoves and Fuels. Accessed at: <http://www.euei.net/sites/euei.net/files/Igniting-Change-2011-2-MB-low-res.pdf>.
- Global Environment Facility. 2004. Mt Kenya East Pilot Project for Natural Resources Management (MKEPP) project executive summary. Embu, IFAD.
- GoK. 2002. First national communication of Kenya to the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC). Nairobi, National Environment Secretariat, Ministry of Environment and Natural Resources. 155 pp. (also available at unfccc.int/resource/docs/natc/kennc1.pdf).
- GoK. 2002a. Mombasa District Development Plan 2002–2008, Ministry of Finance and Planning. Nairobi.
- GoK. 2002b. Kenya's First National Communication to the Conference of Parties to the United Nations Framework Convention on Climate Change, Ministry of Environment and Natural Resources, Government Printers, Nairobi.
- GoK. 2003. Economic Recovery Strategy for Wealth and Employment Creation 2003-2007. Ministry of Planning & National Development & Vision 2030. Government of Kenya, Government Printer, Nairobi.
- GoK. 2006a. Disaster Risk Reduction Strategy for Kenya 2006 – 2016: A Resilient and Safer Nation. Government of Kenya, Government Printer, Nairobi.
- GoK. 2006b. National Tourism Policy. Ministry of Tourism and Wildlife. Government of Kenya, Government Printer, Nairobi.
- GoK. 2007a. Kenya Vision 2030: A Globally Competitive and Prosperous Kenya. Ministry of Planning & National Development & Vision 2030. Government of Kenya, Government Printer, Nairobi.
- Government of Kenya (GoK). 2007b. Kenya Vision 2030: The popular version. Nairobi: Government of Kenya.
- GoK. 2008. First Medium Term Plan (2008-2012). Office of the Prime Minister, Ministry of State for Planning, National Development and Vision 2030. Government of Kenya, Government Printer, Nairobi.
- GoK, Medium Term Plan II (2013-2017), Ministry of Devolution and Planning
- GoK, T 21 System Dynamic Model (2012), Ministry of Devolution and Planning
- GoK. 2009. Economic Survey 2009. Government of Kenya, Government Printer, 2009.
- GoK. 2010a. National Climate change Response Strategy: Executive Brief. Ministry of Environment and Mineral Resources, Government of Kenya (GoK), Nairobi.
- GoK. 2010b. Kenya Malaria Indicator Survey, 2010. Kenya National Bureau of Statistics (KNBS).
- GoK. 2011. Kenya's Climate Change Action Plan: National Adaptation Plan. Ministry of Environment and Mineral Resources, Government Printer, Nairobi.
- GoK. 2012a. Economic Survey 2012. Government of Kenya, Government Printer, 2012.
- GoK. 2012b. Kenya Post-Disaster Needs Assessment (PDNA); 2008-2011 Drought. Government of Kenya, with technical support from the European Union, United Nations and World Bank.
- GoK. 2012c. National Climate Change Action Plan 2012. Ministry of Environment and Mineral Resources. Government Printer, Nairobi.
- GoK. 2012d. Third Annual Progress Report 2010-2011 on the Implementation of the First Medium Term Plan (2008-2012). Monitoring and Evaluation Directorate, Ministry of State for Planning, National Development and Vision 2030, Government of the Republic of Kenya, Nairobi.
- Gómez Martín, Ma. (2005). Weather, Climate and Tourism. A Geographical Perspective. *Annals of Tourism Research*, 32(3), 571-591.
- Grey, D. & Sadoff, C.W. 2007. "Sink or Swim? Water security for growth and development." *Water Policy* 9:545–571.
- Gwilliam, K., V. Foster, R. Archondo-Callao, C. Briceño-Garmendia, A. Nogales, & K. Sethi. 2008. "The Burden of Maintenance: Roads in Sub-Saharan Africa." AICD Background Paper 14, Africa Region, World Bank, Washington, DC.
- Hamilton, J., Maddison, D. & Tol, R. 2004. The effects of climate change on international tourism. Working Paper FNU-36. Centre for Marine and Climate Research, Hamburg.
- Hamilton, J.M. & Lau, M. 2005. The Role of Climate Information in Tourist Destination Choice Decision-Making. Pp. 229-250. In: Gössling, S. and C.M. Hall (eds.). *Tourism and Global Environmental Change*. London: Routledge.
- Harvell, C.D., Mitchell, C.E., Ward, J.R., Altizer, S., Dobson, A.P., Ostfield, R.S. & Samuel, M.D. 2002. Climate warming and disease risks for terrestrial and marine biota. *Science*, 296: 2158–2162.
- Hove, H., Echeverria, D. & Parry, J.E. 2011. Review of Current and Planned Adaptation Action: East Africa. International Institute for Sustainable Development. Available at <http://www.adaptationpartnership.org>
- Hsiang, S.M., Meng, K.C., Cane, M.A. (2011). Civil conflicts are associated with the global climate. *Nature* 476, 438-41.
- Hu, Y. & Ritchie, J. 1993. Measuring destination attractiveness: a contextual approach. *Journal of Travel Research*, 32(20), 25-34.
- Human Development Index. 2009. Available at: www.hdr.undp.org/en/statistics
- Huq, S. & Reid, H. 2005. Climate Change and Development in East Africa: A Regional Report. IIED report for the African Centre for Technology Studies (ACTS), Nairobi, Kenya.
- ICLEI (Undated). Local Government Perspective on adapting water management to climate change. Perspectives on water and climate change adaptation. Local Governments for Sustainability (ICLEI), Co-operative Programme on Water and Climate (CPWC),
- International Water Association (IWA), IUCN, and World Water Council.
- IDRC & DFID. 2010. Stories from the Field: reducing vulnerability among pastoralists in Northern Kenya. In *Climate Change Adaptation in Africa*

- Program: 2009-20 Annual Report. International Development Research Centre and the Department for International Development. Retrieved from <http://www.idrc.ca/uploads/user-S/12876935131Pastoralism.pdf>
- IFAD. 2009. Case study from Kenya – Mount Kenya East Pilot Project for Natural Resources Management: increasing the resilience of the ecosystem to human and natural stresses. IFAD's response to climate change through support to adaptation and related actions. Comprehensive report: final version, pp. 118–122. Rome. 154pp. (available at www.ifad.org/climate/resources/adaptation.pdf).
- IISD (Unpublished). "Climate Risks, Vulnerability and Governance in Kenya: a state of the art review". International Institute for Sustainable Development.
- IISD. 2009. Enhancing resilience to drought in Kenya's arid and semi-arid lands. Case study prepared for the Canadian Coalition on Climate Change and Development. International Institute for Sustainable Development. Retrieved from http://www.iisd.org/pdf/2010/c4d_enhancing_resiliency_kenya.pdf
- ILO. 2007. Chapter 4: Employment by Sector in Key Indicators of the Labour Market (KILM), 5th Edition.
- ILRI. 2007. Kenya Adaptation to Climate Change in the Arid Lands: Anticipating, adapting to and coping with climate risks in Kenya—operational recommendations for KACCAL. International Livestock Research Institute. Retrieved from <http://mahider.ilri.org/bitstream/10568/2186/1/KACCAL%20Final%20Report.pdf>
- ILRI. 2010. An assessment of the response to the 2008–2009 drought in Kenya. A report to the European Union Delegation to the Republic of Kenya. International Livestock Research Institute. Retrieved from http://mahider.ilri.org/bitstream/10568/2057/3/assessment_drought_2010.pdf
- IPCC. 2000. Emissions Scenarios. Available at http://www.ipcc.ch/publications_and_data/publications_and_data_reports.htm#2 (Accessed November, 2012).
- IPCC. 2001. Climate Change 2001: Synthesis report. Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.
- IPCC. 2007a. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland.
- IPCC. 2007b. Guidance Notes for Lead Authors of the IPCC Fourth Assessment Report on Addressing Uncertainties. <http://www.ipcc.ch/pdf/supporting-material/uncertainty-guidance-note.pdf>.
- IPCC. 2007c. Fourth Assessment Report (AR4): Synthesis Report - Summary for Policymakers. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland. Available at http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm (Accessed November, 2012).
- IPCC. 2007d. The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S. D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC.2007e. Impact, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, UK, 7-22.
- IPCC. 2012. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., Barros, V., Stocker, T.F. Qin, D., Dokken, D.J., Ebi, K.L., Mastrandrea, M.D., Mach, K.J., Plattner, G.-K., Allen, S.K., Tignor, M. and Midgley, P.M. (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp.
- IPCC Africa. Climate Change 2007: Impact, Adaptation and Vulnerability: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Available at: www.ipcc.ch/publications_and_data/ar4/wg2/en/ch9.htm
- ISO/IEC (2002). Guide 73: Risk management – Vocabulary – Guidelines for use in Standards.
- Jacobsen, M., Wabster, M., & Vairavamoorthy, K. (Eds.). 2012. The Future of Water in African Cities: Why Waste Water? Directions in Development. Washington, DC: World Bank. Doi:10.1596/978-0-8213-9721-3.
- Kabubo-Mariara. 2009. Global warming and livestock husbandry in Kenya: Impact and adaptations. *Ecological Economics* 68: 1915-1924.
- Kebede, A.S., Hanson, S., Nicholls, R.J. & Mokrech, M. 2009. Impact of Climate Change and Sea-Level Rise: A Case Study of Mombasa, Kenya. In Stockholm Environment Institute (SEI), *Economics of Climate Change in Kenya*, Oxford, 2009.
- Kelly, P.M. & Adger, W.N. 2000. Theory and practice in assessing vulnerability to climate change and facilitation adaptation. *Climate Change* 47(4): 925-1352.
- Kenya Wildlife Service, African Conservation Centre, Amboseli Conservation Program. 2010. The impact of the 2009 drought on wildlife, livestock and tourism: Recommendations for ecosystem restoration. Proceedings of the Amboseli Ecosystem workshop. (also available at www.conservationafrica.org/en/resources/downloads.html?task=finish&cid=3&catid=1).
- Keriga, L. and Bujra, A. (2009). "Social policy, development and governance in Kenya: A profile on healthcare provision in Kenya." Research Report, Development Policy Management Forum (DPMF), Nairobi, p. 38.
- Kilavi, M.K. 2008. Analysing the temporal characteristics of extreme temperature events over ASALs and the coastal regions of Kenya as an indicator of climate change.
- King'uyu, S. M., L. A. Ogallo & Anyamba, E.K. 2000. Recent trends of surface minimum and maximum temperatures over Eastern Africa. *Journal of Climate* 13(16): 2876- 2885.
- KIPPRA. 2010. A Comprehensive Study and Analysis on Energy Consumption Patterns in Kenya: A Synopsis of the Draft Final Report. Kenya Institute for Public Policy Research and Analysis, Nairobi.

- Kiva 2008. Large Scale Hydropower, Renewable Energy Adaptation & Climate Change & Energy Security in East & Horn of Africa: A paper presented at HBF Regional Workshop on 21st November, 2008.
- KNBS. 2012. Kenya Economic Survey Highlights 2011. Kenya National Bureau of Statistics, Ministry of State for Planning, National Development & Vision 2030. Government of Kenya, Government Printer, Nairobi.
- Kolossa, K. 2006. The Kenyan Transport System. Institut für Afrikanistik der Universität zu Köln.
- Kozak, N., Uysal, M. & Birkan, I. 2008. An analysis of cities based on tourism supply and climatic conditions in Turkey. *Tourism Geographies*, 10(1), 81-97.
- Kremer, M., Leino, J., Miguel E., & Zwane, A. 2008. Managing rural water infrastructure in Kenya. Workshop Paper.
- Kremer, Michael, Amrita Ahuja and Alex Peterson Zwane. 2010. "Providing Safe Water: Evidence from Randomized Evaluations". Discussion Paper 2010--23, Cambridge, Mass.: Harvard Environmental Economics Program, September, 2010.
- Kurukulasuriya, P. & Mendelsohn, R. 2006. A Ricardian analysis of the impact of climate change on African cropland. CEEPA Discussion Paper # 8. Centre for Environmental Economics and Policy in Africa, University of Pretoria, Pretoria, South Africa.
- Lim, C., Min, J.C.H. & McAleer, M. 2008. Modelling income effects on long and short haul international travel from Japan. *Tourism Management* 29(6), 1099-1109.
- Lise, W. & Tol, R. 2002. Impact of climate on tourist demand. *Climatic Change*, 55, 429-449.
- Lohmann, M. & Kaim, E. 1999. Weather and holiday preference - image, attitude and experience. *Revue de Tourisme*, 2, 54-64.
- LTS International & Acclimatise. 2012. Government of Kenya National Adaptation Plan: Technical Report 1 - Risk Assessment Report.
- LTS International. 2012. Government of Kenya National Adaptation Plan: Technical Report 8 - Availability and Accessibility to Climate Data for Kenya.
- Maddison, A. 2010. *Historical Statistics of World Economy: 1-2008 AD*. Organization for Economic Cooperation and Development (OECD), Paris.
- Maddison, D. (2001). In search of warmer climates? The impact of climate change on flows of British tourists. *Climatic Change*, 49, 193-2208.
- Maeda, E.E., Pellikka, P.K.E., Siljander, M. & Clark, B.J.F. (2010a). Potential impacts of agricultural expansion and climate change on soil erosion in the Eastern Arc Mountains of Kenya. *Geomorphology* 123, 279-289.
- Maeda, E.E., Pellikka, P.K.E., Clark, B.J.F. & Siljander, M. (2010b). Prospective changes in irrigation water requirements caused by agricultural expansion and climate changes in the eastern arc mountains of Kenya. *Journal of Environmental Management* 92, 982-993.
- Mahongo, S. 2006. "Impacts of sea-level change", Paper presented at the ODINAFRICA/GLOSS Training Workshop on Sea-Level Measurement and Interpretation, 13-24 November, Oostende, Belgium.
- Maitima, J.M., Kariuki, P.C., Mugatha, S.M., & Mariene, L.W. 2009. An ecosystems approach towards costing of climate change adaptations in East Africa. Report for Economics of Climate Change Adaptations in Africa.
- Marshall, S. 2011. The water crisis in Kenya: Causes, effects and solutions. *Global Majority E-Journal* 2(1): 31-45.
- Mathews, J.T. 1989. Redefining security. *Foreign Affairs* 68(2): 162-177.
- Mcgray H., Hammil, A., & Bradley, R. 2007: *Weathering the Storm: Options for Framing Adaptation and Development*. World Resources Institute (WRI).
- McMichael, A. J., Campbell-Lendrum, D. H., Corvalan, C.F., Ebi, K.L., Githeko, A.K., Scherega, J. D. & Woodward, A. (Eds.). *Climate change and human health: risks and responses*, World Health Organization (WHO), Geneva.
- McSweeney et al., 2009. UNDP Climate Change Country Profiles: Kenya. Retrieved from <http://country-profiles.geog.ox.ac.uk/index.html?country=Kenya&d1=Reports>
- Mendelsohn, R., A. Dinar, and L. Williams. 2006. The distributional impact of climate change on rich and poor countries. *Environment and Development Economics*, 11(02):159-178, 2006. doi: 10.1017/S1355770X05002755.
- Mehta, L. 2006. Water and human development capabilities, entitlements and power. Background paper for the 2006 Human Development Report on 'Beyond Scarcity: Power, Poverty and Development: Global Water Crisis'.
- MENR. 2002. First National Communication of Kenya to the Conference of the Parties of the United Nations Framework Convention on Climate Change. Ministry of Environment and Natural Resources Ministry of Environment and Natural Resources. Retrieved from <http://unfccc.int/resource/docs/natc/kenncl.pdf>
- MENR. 2003. First National Communication of Kenya to the Conference of the Parties to the United Nations Framework Convention on Climate Change. 1NC-KEN01. GEF UNEP MENR. Ministry of Environment and Natural Resources. Available at: www.ncsp.undp.org/sites/default/files/Kenya%27s%201NC.pdf
- MENR. 2009. Kenya Climate Change Response Strategy. Ministry of Environment and Natural Resources. Available at: www.environment.go.ke/
- MENR. 2010. National Climate Change Response Strategy. Ministry of Environment and Natural Resources Ministry of Environment and Natural Resources. Retrieved from <http://www.ambnairobi.um.dk/NR/rdonlyres/426063EF-AF18-4AE0-A1D4-89F2F8179232/0/FINALNCCRS2010.pdf>
- Mieczkowski, Z. 1985. The tourism climate index: a method for evaluating world climates for tourism. *The Canadian Geographer*, 29, 220-233.
- Millennium Project. 2004. Background Paper of the Millennium Project Task Force on Water and Sanitation.
- MOE. 2011. Updated Least Cost Power Development Plan. Ministry of Energy, Nairobi.
- MOE. 2012a. National Energy Policy, third draft. Ministry of Energy.
- MOE. 2012b. The Energy (Solar Water Heating) Regulations, 2012. Ministry

- of Energy (MOE). Accessed at: <http://www.erc.go.ke/erc/Regulations/Solar%20Water%20Heating%20Regulations.pdf>.
- Molden, D. (ed.). 2007. *Water for life, water for good: A comprehensive assessment of water management in agriculture*. International Water Management Institute, Colombo and Earthscan, London.
- More, G. 1988. Impact of Climate Change and Variability on Recreation in the Prairie Provinces. In Magill, B.L. & F. Geddes (eds.), *The Impact of Climate Variability and Change on the Canadian Prairies: proceedings of the Symposium / Workshop*, Edmonton, Alberta September 9-11, 1987.
- Morens, D.M., Folkers, G.K., Fauci, A.S. 2004. The challenge of emerging and re-emerging infectious diseases. *Nature*, 430(6996): 242–249.
- Muchemi, S. W. (n.d.). *Adaptation lessons learnt in Kenya on climate variability and change*. Nairobi: Kenya Meteorological Department.
- Munasinghe, M. 1999. *Development, Equity and Sustainability (DES) in the Context of Climate Change*. IPCC Guidance Paper.
- Munasinghe, M. 2010. *Addressing sustainable development and climate change together using sustainomics*. Wiley Interdisciplinary Review: Climate Change. doi: 10.1002/wcc.86.
- Munasinghe, M. & Deraniyagala, Y. 2006. *Human development needs clean water and sanitation: Nanotechnology, Water & Development – Parts 1 & 2*. Paper presented at a workshop on Nanotechnology, Water and Development: Global Dialogue on Nanotechnology and the Poor: Opportunities and Risks, 10-12 October 2006, Chennai, India.
- Munga, B., O. Nyanjom, E. Onsomu & G. Mwabu. 2012. *Inequalities and Social Cohesion in Kenya: Evidence and Policy Implications*. Report submitted to Office of Prime Minister and JICA. Draft December 2012. Kenya Institute for Public Policy Research and Analysis (KIPPRA).
- Mutai, C.C. & Ochola, S.O. 2011. *Climate change and variability*. In NEMA 2011: Kenya State of the Environment Outlook 2010. National Environment Management Authority.
- Mutimba, S., Mayieko, S., Olum, P. & Wanyama, K. 2010. *Climate Change Vulnerability and Adaptation Preparedness in Kenya*. Heinrich Boll Stiftung Foundation, Regional Office for East and Horn of Africa.
- NEMA. 2005. *Kenya's Climate Change Technology Needs and Needs Assessment Report under the United Nations Framework Convention on Climate Change (UNFCCC)*. National Environment Management Authority. Available at: www.unfccc.int/tclear/pdf/TNA/Kenya/TNA%20%20REPORT%20Kenya%20final%20_nov05.pdf
- Ngecu, W.M. & E.M. Mathu. 1999. "The El Nino triggered landslides and their socio-economic impact in Kenya". *Episodes* 22:284-288.
- Ngigi, S.N. 2009. *Climate Change Adaptation Strategies: Water Resources Management Options for Smallholder Farming Systems in Sub-Saharan Africa*. The MDG Centre for East and Southern Africa. The Earth Institute at Columbia University, New York.
- Nicholls, R.J., Hanson, S., Herweijer, C., Patmore, N., Hallegatte, S., Corfee-Morlot, J., Chateau, J., & Muir-Wood, R. 2008. *Ranking port cities with high exposure and vulnerability to climate extremes: exposure estimates*. OECD Environment Working Paper No. 1. Organisation for Economic Co-operation and Development (OECD), Paris.
- NIDOS. 2009. *Climate Change Impact Kenya*. Network of International Development Organisations in Scotland. Available at www.nidos.org.uk/downloads/KenyaFactsheet.pdf
- Noorbakhsh, C. 1998. The Human Development Index: Some Technical Issues and Alternative Indices. *Journal of International Development* 10: 589-605.
- Nordhaus, W.D. 2006. *Geography and macroeconomics: New data and new findings*. Proceedings of the National Academy of Sciences, 103(10):3510–3517, MAR 7 2006. ISSN 0027-8424. doi: 10.1073/pnas.0509842103.
- O'Brien, K., Leichenko, R., Kelkar, U., Venema, H., Aandahl, G., & Tompkins, H. 2004. *Mapping vulnerability to multiple stressors: Climate change and globalization in India*. *Global Environmental Change* 14(4): 303-313.
- Ochola, S.O., Eitel, B. & Olago, D.O. (2010). *Vulnerability of schools to floods in Nyando River catchment, Kenya*. *Disasters* 34(3), 732-754.
- Olago, D. 2009. *Holocene palaeohydrology, groundwater and climate change in the Lake Basins of the Central Kenya Rift*. *Journal of Hydrological Sciences* 54: 765-780. Available at www.informaworld.com/smpp/content~db=all~content=a917971133
- Omolo, A. 2011. *Policy proposals on citizen participation in devolved governance in Kenya*. Nairobi: The Institute for Social Accountability (TISA).
- OECD (2009). *Integrating Climate Change Adaptation into Development Co-operation*. Policy Guidance. OECD Publishing, 196p.
- Osahr, H. & Viner, D. 2006. *Linking climate change adaptation and disaster risk management for sustainable poverty reduction: Kenya Case Study*, EC.
- Otiende, B. 2009. *The Economic Impacts of Climate Change in Kenya: Riparian Flood Impacts and Cost of Adaptation - Case Study*. In Stockholm Environment Institute (SEI), *Economics of Climate Change in Kenya*, Oxford, 2009.
- Parry, J.E., Echeverria, D., Dekens, J. & Maitima, J. 2012. *Climate risks, vulnerability and governance in Kenya: A review*.
- Patz, J.A. & Olson, S.H. 2006. *Climate change and health: global to local influences on disease risk*.
- Payet, R. & Obura, D. 2004. *The negative impacts of human activities in the Eastern African region: an international waters perspective*. *Ambio* 33: 24-33.
- Petra, D. 2009. *Vulnerability to the impact of climate change on renewable groundwater resources: a global-scale assessment*. *Environmental Research Letters* 4(3).
- Pike, S. 2002. *Destination image analysis – a review of 142 papers from 1973 to 2000*. *Tourism Management*, 23, 541-549
- Riché, B. 2009. *Climate-Related Vulnerability and Adaptive-Capacity in Ethiopia's Borana and Somali Communities*. Final Assessment Report. Retrieved from http://www.iisd.org/pdf/2010/climate_ethiopia_communities.pdf
- Riley, J.C., 2005. *Poverty and Life Expectancy*. Cambridge University Press. Cambridge, UK.

- Sachs, J.D. 2001. Macroeconomics and health: Investing in health for economic development. Report of the Commission on Macroeconomics and Health prepared for WHO.
- Saidi, R., L. Würtenberger and S. Stierbert (2012), "Kenya's Climate Change Action Plan: Mitigation", Chapter 6: Energy Demand, Unpublished Report, August 2012.
- Sausen, R. et al. 2005. Aviation radiative forcing in 2000: An update on IPCC (1999).
- Scanlon, J., Cassar, A., & Nemes, N. 2004. Water as a human right? IUCN Environmental Policy and Law paper No. 51, Gland, Switzerland & Cambridge, UK.
- Scott, D. & Lemieux, C. 2009. Weather and Climate Information for Tourism. White Paper commissioned by the World Meteorological Organisation.
- Scott, D., Jones, B. & Konopek, J. 2008. Exploring the impact of climate-induced environmental changes on future visitation to Canada's Rocky Mountain National Parks. *Tourism Review International* 12, 43-56.
- Scott, D., McBoyle, G., & Schwartzentruber, M. 2004. Climate change and the distribution of climatic resources for tourism in North America. *Climate Research* 27(2), 105-117.
- SEI. 2009. Economics of Climate Change in Kenya. Stockholm Environment Institute, Oxford.
- Shisanya & Khayesi. 2007. How is climate change perceived in relation to other socioeconomic and environmental threats in Nairobi, Kenya? *Climate Change*, 85: 271-284.
- Shongwe, M.E., van Oldenborgh, G.J., van den Hurk, B., & van Aalst, M. 2010. Projected changes in mean and extreme precipitation in Africa under global warming. Part II: East Africa. Paper revised and resubmitted to *Journal of Climate*, Nov. 2010. Found at http://www.knmi.nl/africa_scenarios/projected_changes_east_africa.pdf
- Stern, N. 2006. *The Economics of Climate Change: The Stern Review*. Cabinet Office - HM Treasury, United Kingdom.
- Syekei, J. and Opijah, D. 2012. "Intellectual Property and Small and Medium-Sized Enterprises (SMEs) in Kenya." *Nature of Law*, Edition 1 (2012): 28-31. Also available at: <http://services.bowman.co.za/Brochures/NatureOfLaw/2012/1/NOL201201.pdf>
- TEC (Undated). Climate Change Adaptation and Integrated Water Resource Management – An Initial Overview. Policy Brief 5, Global Water Partnership Technical Committee (TEC).
- Tropp, H. 2010. Making water a part of economic development: The economic benefits of improved water management and services. Cited in UNEP (2011).
- United Nations. 2009. Climate change and its possible security implications. Report of the Secretary-General. (A.64/350)
- UNDP. 1999. Kenya National Human Development Report 1999: Gender and Human Development. United Nations Development Programme.
- UNDP. 2001. Kenya National Human Development Report 2001: Addressing social and economic disparities for human development. United Nations Development Programme.
- UNDP. 2002. Kenya National Human Development Report 2002: Participatory governance for human development. United Nations Development Programme.
- UNDP. 2003. Human Development Report 2003: Millennium Development Goals: a compact among nations to end poverty. United Nations Development Programme.
- UNDP. 2005. Kenya National Human Development Report 2005: Linking industrialization with human development. United Nations Development Programme.
- UNDP. 2006. Kenya National Human Development Report 2006: Human security and human development: a deliberate choice. United Nations Development Programme.
- UNDP. 2008. Human Development Report 2007: Fighting Climate Change: Human solidarity in a divided world. United Nations Development Programme.
- UNDP. 2009a. Kenya National Human Development Report 2009: Youth and Human Development - Tapping the untapped resource. United Nations Development Programme.
- UNDP. 2009b. Case study on the impact of climate change on water and sanitation in Jamaica.
- UNDP. 2009c. Resource Guide on Gender and Climate Change. ISBN 978-92-1-326031-9. United Nations Development Programme.
- UNDP. 2010a. Climate Change Country profiles. Analyses of up-to-date observed data and multi-model scenario-based projections. Providing observed and IPCC AR4 model data based on data from 23 different GCMs. Available at: www.country-profiles.geog.ox.ac.uk
- UNDP. 2010b. Disaster Profile. UNDP, Kenya Office.
- UNEP. 2006. Kenya: Integrated assessment of the Energy Policy: With focus on the transport and household energy sectors. United Nations Environment Programme, Nairobi.
- UNEP. 2007. Sudan: post-conflict environmental assessment. United Nations Environment Programme, Nairobi.
- UNEP. 2009a. Kenya: Atlas of Our Changing Environment. Division of Early Warning and Assessment (DEWA), United Nations Environment Programme (UNEP), Nairobi, Kenya.
- UNEP. 2009b. UNEP Year Book 2009: new science and developments in our changing environment. United Nations Environment Programme, Nairobi. (available at www.unep.org/yearbook/2009/). 65 pp.
- UNEP. 2010. Green Economy, Health: Briefing Paper, United Nations Environment Programme, Nairobi, Kenya.
- UNEP. 2011. Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. www.unep.org/greeneconomy. United Nations Environment Programme. ISBN: 978-92-807-3143-9
- UNESCO. 2006. Kenya National Water Development Report, Prepared for the 2nd UN World Water Development Report 'Water: A Shared Responsibility', World Water Assessment Programme 'Case Study: Kenya', UN-WATER/WWAP/2006/12.
- UNWTO, UNEP & WMO. 2008. Climate Change and Tourism: Responding

- to Global Challenges. United Nations World Tourism Organization, United Nations Environment Program, and World Meteorological Organization.
- Urban, F. & Mitchell, T. 2011. Climate change, disasters and electricity generation. Institute of Development Studies (IDS), Brighton.
- USAID. 2006. Kenya Water and Sanitation Profile. United States Agency for Aid and Development. Available at www.pdf.usaid.gov/pdf_docs/PNADO931.pdf
- USDS. 2010. Background Note: Kenya. United States Department of State. Retrieved from <http://www.state.gov/r/pa/ei/bgn/2962.htm>
- Veritec Consulting. 2008. "Region of Durham efficient community: Final report." Regional Municipality of Durham, Ontario. Available at <http://www.durham.ca/departments/works/water/efficiency/ECfinalReport.pdf>
- Vermeer, M. & Rahmstorf, S. 2009. Global sea level linked to global temperature. Proceedings of the National Academy of Sciences of the United States of America. Available at <http://www.pnas.org/content/early/2009/12/04/0907765106.full.pdf+html> (Accessed October 2012).
- Vincent, K. 2004. Creating an index of social vulnerability to climate change for Africa. Tyndall Centre Working Paper No. 56.
- Viner, D. & Agnew, M. 1999. Climate Change and its impact on tourism. Report prepared for WWF, United Kingdom, July 1999.
- Vörösmarty, C.J., McIntyre, C.J., Gessner, M.O., Dudgeon, D., Prusevich, A., Green, P., Glidden, S., Bunn, S.E., Sullivan, C. A., ReidyLiermann, C., & Davies, P.M. 2010. "Global threats to human water security and river biodiversity." *Nature* 467:556–561.
- Wall, G. & Badke, C. 1994. Tourism and climate change: an international perspective. *Journal of Sustainable Tourism* 2(4), 193-203.
- Wamahiu, S.P., Barebwoha, C., & Watola, C. 2011. The relationship between water, sanitation and girls' schooling in Africa. Unpublished Seminar Paper Presented at the Women Education Researchers of Kenya (WERK) Offices, 27th January, 2011.
- Wandiga, S.O., Opondo, M., Olago, D., Githeko, A., Githui, F., Marshall, M., Downs, T., Opere, A., Yanda, P.Z., Kangalawe, R., Kabumbuli, R., Kirumira, E., Kathuri, J., Apindi, E., Olaka, L., Ogalo, L., Mugambi, P., Sigalla, R., Nanyunja, R., Baguma, T. & Achola, P. 2006. Vulnerability to climate induced Highland Malaria in East Africa: Assessments of Impacts and Adaptations to Climate Change (AIACC). Working Paper No.25. March, 2006.
- Ward, J., Kazcan, D., Ogilvie, A., & Lukasiewicz, A. 2010. Challenging hydrological panaceas: evidence from the Niger River Basin. Cited in UNEP (2011).
- WBCSD. 2009. Global Water Tool. World Business Council for Sustainable Development. Available at www.abcSD.org/templates/TemplateWBCSD5/layout.asp?type=p&Meuld=MTUxNQ&doOpen=1&ClickMenu=LeftMenu
- WEDO. 2007. Changing the Climate: Why Women's Perspectives Matter. Fact Sheet. Women's Environment and Development Organization (WEDO), New York.
- Wheeler, David. 2012. "Energy+ Country Performance Ratings 2001–2010." CGD Working Paper 301. Washington, D.C.: Center for Global Development. <http://www.cgdev.org/content/publications/detail/1426349>
- WHO. 1948. Preamble of the Constitution of the World Health Organisation. Official Records of the World Health Organisation, No. 2. Geneva.
- WHO. 2003. Climate change and human health – Risks and responses. [<http://www.who.int/globalchange/climate/en/ccSCREEN.pdf>]. World Health Organization, Geneva.
- WHO. 2006. WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide - Global update 2005. World Health Organisation, Geneva.
- WHO. 2008. Protecting Health from Climate Change World Health Day 2008. Geneva: World Health Organization.
- WHO. 2009. Global Health Risks: Mortality and burden of disease attributable to selected major risks. Geneva: World Health Organization.
- WHO. 2010. UN-Water Global Annual Assessment of Sanitation and Drinking-Water (GLAAS) 2010: Targeting Resources for Better Results. World Health Organization, Geneva. Available at http://www.who.int/water_sanitation_health/glaas/en/
- WHO. 2012. UN-water global annual assessment of sanitation and drinking water (GLAAS) 2012 report: The challenge of extending and sustaining services. World Health Organization, Geneva.
- WHO/UNICEF. 2010. Progress on sanitation and drinking-water: 2010 Update. Available at http://www.who.int/water_sanitation_health/publications/9789241563956/en/index.html
- Wilby, R.L. & Dessai, S. 2010. Robust adaptation to climate change. *Weather* 65(7), pp. 180-185.
- World Bank. 2004. The Republic of Kenya: Towards a Water-Secure Kenya – Water Resources Sector Memorandum. Report No. 28398-KE. April 2004.
- World Bank. 2006. Climate variability and water resources degradation in Kenya: Improving water resources development and management. World Bank Working Paper No. 69, Washington, DC.
- World Bank – Water and Sanitation Programme. 2008. Economic Impacts of Sanitation in Southeast Asia: A four-country study conducted in Cambodia, Indonesia, the Philippines and Vietnam under the Economics of Sanitation Initiative (ESI). World Bank, Jakarta.
- World Bank. 2009a. Climate Variability and Water Resources Degradation in Kenya: Improving Water Resources Development and Management. Working Paper No. 69 34854. Available at: www.wds.worldbank.org/external/default/main?pagePK=64193027&piPK=64187937&theSitePK=523679&menuPK=64187510&searchMenuPK=64187283&siteName=WDS&entityID=000090341_20060110161654
- World Bank. 2009b. World Development Report 2010: Development and climate change. Washington, D.C.: World Bank.
- World Bank. 2010. World Development Indicators. Washington, DC; The World Bank (downloaded on October 20, 2012).

World Bank. 2011. Turning the tide in turbulent times: Making the most of Kenya's demographic change and rapid urbanization. Kenya Economic Update No. 4. World Bank, Poverty Reduction and Economic Management Unit Africa Region.

World Bank. 2012a. World databank. <http://databank.worldbank.org/ddp/home.do?Step=12&id=4&CNO=2>

World Bank. 2012b. World Development Report (on line).

World Resources Institute (WRI), Kenya Ministry of Environment and Natural Resources, Kenya Ministry of Planning and National Development, & International Livestock Research Institute. 2007. Nature's benefits in Kenya: An atlas of ecosystems and human well-being. Washington, DC and Nairobi: World Resources Institute. Retrieved from http://pdf.wri.org/kenya_atlas_fulltext_150.pdf

Yu, G., Schwartz, Z. & Walsh, J.E. 2009. A weather-resolving index for assessing the impact of climate change on tourism related climate resources. *Climatic Change* 95, 551-573.

Zafar, U.A., Franklin, B., Krohn, V. & Heller, L. 1997. "International tourism ethics as a way to world understanding." *The Journal of Tourism Studies*, 2: 36-44..

Zwaagstra, L., Sharif, Z., Wambile, A., de Leeuw, J., Johnson, N., Njuki, J., Said, M., Ericksen, P., & Herrero, M. 2010. An assessment of the response to the 2008-2009 drought in Kenya. A report to the European Union Delegation to the Republic of Kenya. International Livestock Research Institute (ILRI).

APPENDICES

Appendix 2.1: Indices used in the calculation of Human Development

The Human Development Index (HDI) is a summary composite index that measures a country's average achievement in three basic aspects of human development: health, knowledge, and income. It was first developed by the late Pakistani economist MahbubulHaq with the collaboration of the Nobel laureate AmartyaSen and other leading development thinkers for the first Human Development Report in 1990. It was introduced as an alternative to conventional measures of national development, such as level of income and the rate of economic growth. The HDI represents a national average of human development achievements in the three basic dimensions making up the HDI: health, education and income. Like all averages, it conceals disparities in human development across the population within the same country. Two countries with different distributions of achievements can have the same average HDI

In this report, the following composite indices have been tabulated for 2012 (see Appendices 2.2a-d): The Human Development Index (HDI), the Inequality adjusted Human Development Index (IHDI), the Gender Inequality Index (GII), Multidimensional Poverty Index (MPI) and the

Climate Vulnerability Index (CVI). The latter is a new index which has been calculated for the first time and for which a special note is included in Appendix 2.3.

With regard to HDI, IHDI, GII and MPI, the methodology used in their calculation is the one used by UNDP Human Development Report Office (HDRO) as detailed, for example, in the Technical Notes for the Human Development Report, 2011. We, however, note that for the MPI, only the national estimate is calculated since the data required for the various components of the index such as poverty headcount, intensity of deprivation and the population vulnerable to poverty were not disaggregated at the county level. The sampling for the Kenya Integrated Household Budget Survey (KIHBS) and other poverty-related surveys was done at the national level. As a result, there were very few observations to make any meaningful county analysis. More details about the challenges encountered in the calculation of the indices are presented in Appendix 2.2d.

Appendix 2.2a: National and County Level HDI, 2012

S. No.	National/County	HDI	S. No.	National/County	HDI
1	Nairobi	0.6412118	25	West Pokot	0.4532174
2	Mombasa	0.5485811	26	Samburu	0.4264032
3	Kwale	0.4354491	27	Trans-Nzoia	0.5013785
4	Kilifi	0.4736045	28	UasinGishu	0.5727920
5	Tana River	0.4010696	29	Marakwet	0.5321566
6	Lamu	0.4987809	30	Baringo	0.5108275
7	TaitaTaveta	0.5360360	31	Nandi	0.5165280
8	Garissa	0.4679776	32	Laikipia	0.5741344
9	Wajir	0.4212424	33	Nakuru	0.5233880
10	Mandera	0.4214010	34	Narok	0.5112620
11	Marsabit	0.4375797	35	Kajiado	0.5910425
12	Isiolo	0.4508188	36	Bomet	0.5440333
13	Meru	0.5508144	37	Kericho	0.5218517
14	Tharaka	0.5149844	38	Kakamega	0.4834511
15	Embu	0.5523959	39	Vihiga	0.5003012

S. No.	National/County	HDI	S. No.	National/County	HDI
16	Kitui	0.4806530	40	Bungoma	0.4831586
17	Machakos	0.5405617	41	Busia	0.4279898
18	Makueni	0.4801437	42	Siaya	0.4449727
19	Nyandarua	0.5337233	43	Kisumu	0.5233395
20	Nyeri	0.5897697	44	Homa Bay	0.4070214
21	Kirinyaga	0.5690398	45	Migori	0.4455059
22	Muranga	0.5621093	46	Kisii	0.5119360
23	Kiambu	0.5611412	47	Nyamira	0.5428060
24	Turkana	0.3741289		Kenya	0.5200289

Appendix 2.2b: National and County Level IHDI, 2012

S. No.	National/County	IHDI	S. No.	National/County	IHDI
1	Nairobi	0.452018734	25	West Pokot	0.360527395
2	Mombasa	0.439412758	26	Samburu	0.328744302
3	Kwale	0.337735269	27	Trans-Nzoia	0.402313315
4	Kilifi	0.356291632	28	UasinGishu	0.415563949
5	Tana River	0.315974034	29	ElgeyoMarakwet	0.411941469
6	Lamu	0.398585178	30	Baringo	0.390241476
7	TaitaTaveta	0.410445855	31	Nandi	0.407994605
8	Garissa	0.372737889	32	Laikipia	0.443120958
9	Wajir	0.338684251	33	Nakuru	0.411701951
10	Mandera	0.317020187	34	Narok	0.396514383
11	Marsabit	0.326479757	35	Kajiado	0.460336361
12	Isiolo	0.355120653	36	Bomet	0.421608567
13	Meru	0.427090722	37	Kericho	0.421228207
14	Tharaka	0.395475962	38	Kakamega	0.378730676
15	Embu	0.430794706	39	Vihiga	0.401198703
16	Kitui	0.378251691	40	Bungoma	0.388878745
17	Machakos	0.400120046	41	Busia	0.336877639
18	Makueni	0.371098123	42	Siaya	0.359200969
19	Nyandarua	0.427947802	43	Kisumu	0.336081551
20	Nyeri	0.462113658	44	Homa Bay	0.324677552
21	Kirinyaga	0.461675566	45	Migori	0.34617958
22	Muranga	0.448385934	46	Kisii	0.395139822
23	Kiambu	0.436682063	47	Nyamira	0.427032195
24	Turkana	0.246918871		Kenya	0.383007328

Appendix 2.2c: National and County Level GII⁶³, 2012

S. No.	National/County	GII	S. No.	National/County	GII
1	Wajir	0.731875	25	UasinGishu	0.629914
2	Lamu	0.710844	26	Kisii	0.629134
3	Migori	0.694035	27	Vihiga	0.627173
4	Marsabit	0.692630	28	Kericho	0.623097
5	Mandera	0.686063	29	Trans-Nzoia	0.619930
6	Siaya	0.685635	30	Bomet	0.619299
7	Tana River	0.685413	31	Machakos	0.617157
8	Homa Bay	0.669356	32	ElgeyoMarakwet	0.617103
9	Kilifi	0.666134	33	Bungoma	0.616744
10	Samburu	0.660595	34	Nairobi	0.615957
11	West Pokot	0.654415	35	Laikipia	0.604289
12	Narok	0.654239	36	Nyandarua	0.600842
13	Garissa	0.653227	37	TaitaTaveta	0.600021
14	Turkana	0.652964	38	Kajiado	0.597345
15	Nandi	0.652113	39	Kitui	0.593352
16	Nyamira	0.646602	40	Tharaka	0.583067
17	Busia	0.645737	41	Baringo	0.582458
18	Mombasa	0.645664	42	Kirinyaga	0.574185
19	Nakuru	0.644109	43	Kiambu	0.570463
20	Isiolo	0.640425	44	Muranga	0.565320
21	Meru	0.638746	45	Makueni	0.553506
22	Kwale	0.633533	46	Embu	0.549622
23	Kisumu	0.633440	47	Nyeri	0.529647
24	Kakamega	0.632527		Kenya	0.621728

Appendix 2.2d: Technical Notes and Caveats on Human Development Indices

1. Human Development Index (HDI).

As a summary measure of human development, the HDI measures average achievements in three dimensions, namely life expectancy, educational attainment and standard of living. The overall index is computed as the geometric mean of the three dimensional indices. In the calculation of HDI for this report, several sources of data were used. For life expectancy, the data used was from the population and housing census undertaken in 1999. For the mean number of years of schooling, the data used was from the 2009 census while data on expected years of schooling was derived from UNESCO estimates as was the case in the 2013 global HDR. Income data was derived from the 2005/06 Kenya Integrated Household Budget Survey (KIHBS). GNI data is only available at the national level and hence it was difficult to compute county-level

data. The small sample sizes at the county level may have affected the tabulated county indices.

2. Inequality Adjusted Human Development Index (IHDI).

The IHDI adjusts the HDI taking into account the inequalities in distribution of each dimension across the population. When there are no inequalities among the various groups in the population, the two indices are equal, but where there are inequalities, the IHDI declines relative to HDI as inequalities increase. Thus, in the case of Kenya, the computed IHDI is 0.383 which is 26.3 percent lower than the corresponding HDI at 0.520.

The data requirements for computing the IHDI are much broader than for HDI. These include cohort data such as age-specific mortality rates, average age at death and household income statistics. These data were derived from different sources, namely population census data and KIHBS, thereby making it difficult to capture overlapping inequalities. For more details about this challenge see <http://hdr.undp.org/en/statistics/ihti/>.

63 Elected and nominated members of National Assembly and Senate are mapped to Counties.

3. Gender Inequality Index (GII)

The GII is a composite index which seeks to show the loss in potential human development arising from inequalities in achievements between women and men in three dimensions: reproductive health, empowerment and labour market. The five indicators for which data is required are: maternal mortality, adolescent fertility rate, share of parliamentary seats, attainment at secondary and higher education levels and labour market participation rate.

The index is calculated as the general mean of general means of different orders and aggregating across dimensions with each gender group using geometric means. Aggregation across gender is achieved using a harmonic mean. The two final stages of the computation involve calculating the geometric mean of the arithmetic means for each indicator and then comparing the equally distributed gender index to the reference standard to get the GII. For further details see <http://hdr.undp.org/en/statistics/gii/>.

The major limitation in calculating the index for Kenya emanates from inadequate databases particularly with regard to labour market data, poor gender disaggregated leadership representation data, gaps in time-use data and non-capture of unpaid family labour particularly among women. Specifically, due to the introduction of a bicameral parliamentary system, difficulties were experienced in mapping nominated members of both the National Assembly and the Senate after the March 2013 General Elections. Moreover, it was difficult to get maternal mortality data at the country level and the national figure was therefore used. The adolescent fertility data for the 15-19 year cohort was derived from the 2009 Demographic and Health (DHS) Survey. Labour market participation rates were derived from the 2005/06 KIHBS.

4. The Multidimensional Poverty Index (MPI)

This is a relatively new index which was used for the first time in the 2010 global HDR replacing the previous Human Poverty Index (HPI). The index is basically the percentage of the population that is multi-dimensionally poor, adjusted by the intensity of the deprivation. It seeks to give a multidimensional view of people living in poverty and hence it can be a powerful tool for policy-makers to target resource allocation. Like the HDI, it has the three dimensions (life expectancy, educational attainment and standard of living) but with 10 indicators whose data should be, ideally, from the same source or database. In the case of Kenya, the data is mainly from KIHBS which had limitations as contained on page 15 of its basic report. Some data was also derived from KHDS which was not disaggregated at the county level. For this reason, only national data for 2012 has been given. For more information on the computation methodology, see http://hdr.undp.org/en/media/HDR_2013_EN_TechNotes.pdf.

Appendix 2.3: Special Note on Climate Change Vulnerability Index (CCVI)

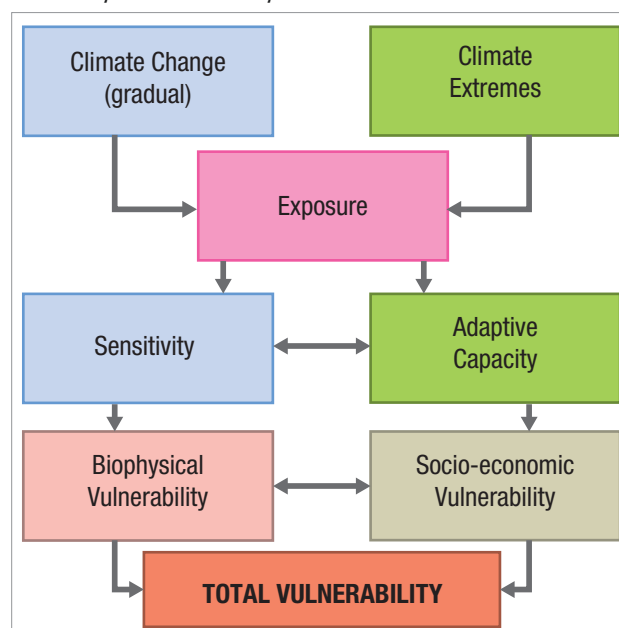
The CCVI was constructed as a function of exposure to climate variability and natural disasters; sensitivity to the impacts of that exposure; and capacity to adapt to on-going and future climatic changes.

Conceptual approaches to vulnerability

Three conceptual approaches to analyzing vulnerability have been identified (Deressa et al., 2008): socioeconomic, biophysical (impact assessment) and integrated assessment. The socioeconomic approach focuses mainly on the socioeconomic and political status of individuals or social groups (Adger, 1999; Fuessel, 2007). Individuals in a community vary in terms of education, gender, wealth, health status, access to credit, access to information and technology, formal and informal (social) capital, political power, among others. These variations are responsible for variation in vulnerability (Adger & Kelley, 1999; Allen, 2003; Kelly & Adger, 2000). The main limitation of the socioeconomic approach lies in its failure to recognize that variations in societies are also attributable to environmental attributes.

The biophysical approach focuses on the level of damage environmental stress causes on both social and biological system through climate prediction models (Kurukulasuriya & Mendelsohn, 2006) or creating indicators of sensitivity (Cutter et al., 2000). Although informative, this approach fails to show what a particular damage means for different people. The integrated approach combines the two. The hazard-of-place model (Cutter et al., 2000) and vulnerability mapping approach (O'Brien et al., 2004) are good examples. A major weakness of this approach is that it does not take cognizance of dynamism in vulnerability. Coping and adaptation are characterized by continual change of strategies to take advantage of opportunities (Eriksen & Kelly, 2007). The conceptual framework to vulnerability assessment is shown in Appendix Figure 2.3.1.

Appendix Figure 2.3.1: Conceptual framework for vulnerability assessment in Kenya



Source: After Deressa et al. (2008)

As the Figure shows, a country is exposed to both gradual climate change (temperature and precipitation) and extreme climate change (drought and flood). Exposure affects sensitivity, which means that exposure to higher frequencies and intensities of climate risk highly affects outcome (crop yield, income, health, among others). Exposure is also linked to adaptive capacity. For instance, higher adaptive capacity reduces the potential damage for higher exposure. Sensitivity and adaptive are also linked: Given a fixed level of exposure, the adaptive capacity influences the level of sensitivity. In other words, higher adaptive capacity (socioeconomic vulnerability) results in lower sensitivity (biophysical vulnerability) and vice versa. Therefore, sensitivity and adaptive capacity add up to total vulnerability. In summation, vulnerability can therefore be expressed as:

$$V_i = f(H_i, S_i, A_i)$$

Where:

V = Vulnerability to Climate Change (of a region i of Kenya, say County)

H = Climatic hazard

S = Sensitivity

A = Adaptive capacity

The CCVI was therefore based on a theory driven approach and the calculation methodology adapted mainly from a paper entitled "Mapping vulnerability to climate Change"⁶⁴. The overall index was calculated as a simple un-weighted average using the formula: Vulnerability = 1/3(Exposure + Sensitivity + (1-Adaptive Capacity)). Appendix Table 2.3.1 shows the variables typically used in the calculation of CCVI (not necessarily all in one study) but also a comment on whether the variable was used in the calculation for Kenya.

Appendix Table 2.3.1: Selection of Variables

Determinant of Vulnerability	Indicator/Variable/Component of Determinant targeted (as informed by literature)	Measurement/Data	Comment on whether the variable was used in this report
Exposure	Average annual temperature change (0C) since year 2000	0 C	Temperature and rainfall projections for 2050 were not used some counties showed very high variations in temperature by 2050 which did not conform to expectations.
	Predicted change in temperature by 2050	0 C (or %)	
	Predicted change in precipitation by 2050	mm (or %)	
	Average annual precipitation change (mm) since year 2000	mm	
	Drought	Average annual rainfall (mm) in the county, since year 2000, that has been less than 20% lower than the 30-year monthly national average	Both variables were used
	Flooding	Average annual rainfall (mm) in the county, since year 2000, that has been more than 20% higher than the 30-year monthly national average	
	Heat Waves	Average annual temperature (0 C) in the county, since year 2000, that has been more than 5 0C higher than the 30-year monthly national average	Both variables were used
Cold Spells	Average annual temperature (0 C) in the county, since year 2000, that has been less than 5 0C lower than the 30-year monthly national average		

64 Mapping vulnerability to climate change by RasmusHeltberg and MishaBonch-Osmolovsky, The World Bank, December 2010.

Determinant of Vulnerability	Indicator/Variable/Component of Determinant targeted (as informed by literature)	Measurement/Data	Comment on whether the variable was used in this report
Sensitivity	Population Density	No. of people per km ²	Land in low lying areas and Population in low lying areas were not used due to lack of data. Population density, population affected by drought, population affected by floods, and the vulnerable population depending on relief food were used.
	Population affected by droughts and floods since 1980	%	
	Land in low lying areas	% of land in county in areas lower than 10 meters	
	Population in low lying areas	% of county's population in areas lower than 10 meters	
Adaptive Capacity	Human capacity: Health	Life expectancy at birth, Years	Population above the poverty line based on the MPI and not the money metric measure was used. It was assumed that people above the poverty line are able to adapt more. Both variables were used Variable was not used due to lack of data at county level Mean years of schooling and literacy levels were used Life expectancy data from the 1999 population census was used Technology variables were not used as data was not available at the county level Improved water source and road density in the county were averaged to form one infrastructure variable Governance variables were not used due to data challenges
	Wealth: Population below poverty line	%	
	Wealth: Population owning land	%	
	Wealth: Population owning livestock	%	
	Wealth: Population with access to non-agricultural income and/or Remittances	%	
	Human capacity: Education	Aggregate 3 variables for each county: % of population exposed to secondary education; % exposed to tertiary education; and Adult literacy rate	
	Human capacity: Health	Life expectancy at birth, Years	
	Technology: Use of agricultural technologies	% of population who use pesticides, improved seeds, and fertilizers	
	Technology: Access to agricultural technologies	% of population with access to improved seeds, pesticides and fertilizers within 5 km of their home	
	Infrastructure: All-weather roads	Ratio of total all-weather roads to total land area in county	
	Infrastructure: Access to water	% of population with access to an improved water source	
Governance: Crime rate	No. of indictable crimes per 100,000 population		
Governance: Management of CDF	Average performance of constituencies in CDF management (assessment by NTA or other agencies, preferably government agency)		

Notes:

Exposure

Four variables were used, namely rainfall gradient, temperature gradient, number of droughts and number of floods that have occurred since 1991. Drought was considered to be the amount of rainfall less than one standard deviation while floods were taken to be rainfall more than 1.3 standard deviations. It was assumed that a weather station represents the rainfall recorded in a county. Since some counties do not have weather stations, data for the homogeneous climatic zones was assigned to them. The climatic zones were available by KMD. In counties with more than one station, the average was used except in Nairobi and Kilifi where one station in each county was chosen through judgment and consensus. The temperature and rainfall measurements for Nairobi used the recordings from Wilson Airport while those from Mtwapa were used for Kilifi County.

Sensitivity

The variables used are population density, population affected by drought, population affected by floods, and the vulnerable population depending on relief food. Vulnerable population depending on relief food ranged from 0.288 to 0.00471159. The inclusion of the minimum of 0.00471159 does not affect the final results. The minimum was used to replace the numbers for counties that don't qualify for relief. The

population affected by drought is distributed based on the population in those counties, due to lack of the actual data. The team reasoned that the need might be there but government may not be able to provide the relief. Mortality would have been used, but this figure is not available at the county level. It was argued that the vulnerable population would take care of the child mortality and malnutrition which are the alternative variables.

Weighting

The vulnerability index was calculated as a simple average of three sub-indices: exposure, sensitivity, and adaptive capacity. The variables were normalized and sub-indices aggregated to form composite indices. The variables were assigned equal weighting. Just like the HDI and the other indices, geometric mean was used.

Results

The tabulated county indices need to be read with caution due to the following factors: First, not all the required variables were used due to data paucity and other reasons discussed above. Second, the use of climatic data derived from fairly generalized climatic zones due to lack of local meteorological data infrastructure. Third, data limitations arising from low survey sample sizes. Finally, lack of comparative time series data since this is the first time this index has been calculated.

Appendix Table 2.3.2: National and County Level Climate Change Vulnerability Index (CCVI), 2012

S. No.	National/County	Exposure	Sensitivity	Adaptive Capacity	Climate Change Vulnerability Index Geo Mean
	Kenya	0.502022212	0.28051828	0.428586101	0.431733036
1	Baringo	0.583683642	0.276412608	0.450608326	0.445871099
2	Bomet	0.627976798	0.302709603	0.442726928	0.473168547
3	Bungoma	0.627976798	0.1923494	0.408893686	0.414862167
4	Busia	0.59499571	0.082342758	0.274858412	0.328744768
5	Elgeyo-Marakwet	0.550915731	0.249329507	0.478879605	0.415211581
6	Embu	0.453794942	0.268585901	0.571112031	0.373909513
7	Garissa	0.501607093	0.281812466	0.279423292	0.467022714
8	Homabay	0.453794942	0.360409478	0.210143409	0.505519209
9	Isiolo	0.637254389	0.287032782	0.392834092	0.480677455
10	Kajiado	0.627976798	0.287748902	0.570480658	0.426563509
11	Kakamega	0.400904002	0.360866434	0.348271912	0.455149976
12	Kericho	0.583683642	0.267753336	0.464766381	0.437343011
13	Kiambu	0.435625976	0.221673488	0.614829215	0.333809264
14	Kilifi	0.500083071	0.168018253	0.342409195	0.380880708
15	Kirinyaga	0.414719759	0.088594048	0.585576916	0.24786039
16	Kisii	0.62369647	0.422344962	0.444519452	0.526953874
17	Kisumu	0.501607093	0.370193598	0.514633851	0.448357222

S. No.	National/County	Exposure	Sensitivity	Adaptive Capacity	Climate Change Vulnerability Index_Geo Mean
18	Kitui	0.457716515	0.329228087	0.349928491	0.460986521
19	Kwale	0.5	0.120158242	0.284789024	0.350259941
20	Laikipia	0.502022212	0.252593077	0.551982559	0.384429982
21	Lamu	0.252201251	0.026722822	0.399965707	0.159322283
22	Machakos	0.446518724	0.322527306	0.483545751	0.420548836
23	Makueni	0.457716515	0.319022442	0.427022221	0.437376512
24	Mandera	0.207937877	0.333426422	0.273841328	0.369254708
25	Marsabit	0.390521473	0.247940556	0.306947231	0.406371749
26	Meru	0.440389149	0.347205935	0.524936606	0.417249254
27	Migori	0.501607093	0.35572922	0.261292743	0.508926179
28	Mombasa	0.5	0.52762823	0.601826064	0.471838688
29	Murang'a	0.414719759	0.135002137	0.551761891	0.292779086
30	Nairobi	0.522507413	0.501178998	0.736301823	0.410268353
31	Nakuru	0.57711039	0.373475624	0.528689268	0.466601508
32	Nandi	0.59499571	0.285570526	0.411135883	0.464248776
33	Narok	0.637254389	0.307277793	0.334946033	0.506877776
34	Nyamira	0.62369647	0.320912326	0.526259598	0.456005534
35	Nyandarua	0.50648375	0.089966595	0.535779015	0.276564291
36	Nyeri	0.414719759	0.100793736	0.6499554	0.244592611
37	Samburu	0.596646246	0.243850005	0.317265749	0.463127391
38	Siaya	0.501607093	0.342583971	0.233278752	0.508852997
39	TaitaTaveta	0.296578053	0.237205713	0.503175418	0.326959478
40	Tana River	0.453794942	0.248316389	0.226734609	0.443337773
41	Tharaka	0.440389149	0.245821625	0.459641681	0.388195314
42	Trans-Nzoia	0.699324197	0.295323538	0.455184511	0.482775457
43	Turkana	0.596646246	0.313423793	0.2674154	0.515511587
44	UasinGishu	0.59499571	0.300075629	0.586366993	0.419556404
45	Vihiga	0.627976798	0.299685067	0.420284275	0.477834828
46	Wajir	0.375806853	0.28615344	0.264742415	0.42921155
47	West Pokot	0.596646246	0.342152342	0.273582944	0.529310184
	Kenya	0.502022212	0.28051828	0.428586101	0.431733036

Appendix 3.1a: Potential impacts of climate change on food security

A. CO₂ fertilization effects

Impact on food system assets	Impact on food system activities	Impact on food security outcomes	Impact on other human well-being outcomes	Possible adaptive responses
Production assets: <ul style="list-style-type: none"> • Increase in availability of atmospheric carbon dioxide for plant growth 	Production food: <ul style="list-style-type: none"> • More luxuriant biomass • Higher yields of food and cash crops, many in temperate regions 	Food availability (production, distribution, exchange): <ul style="list-style-type: none"> • Increased food production in major exporting countries would contribute to global food supply but diversion of land from food to more economically attractive cash crops could negate this benefit Food availability (allocation, affordability, preference): <ul style="list-style-type: none"> • Increase on food production would limit increases on world markets, but diversion of productive assets to other cash crops could cause food prices to rise 	Livelihoods: <ul style="list-style-type: none"> • Increased income from improved food and cash crop performance would benefit commercial farmers in developed countries but not in developing countries. 	Policies and regulations: <ul style="list-style-type: none"> • Avoidance of subsidies or other monetary or non-monetary incentives for diversion of food production assets to other areas

Source: FAO (2008), Climate Change and Food Security, Adapted from Figure 5.

Appendix 3.1b: Increase in global mean temperature

B: Increase in global mean temperatures			
Impact on food system assets	Impact on food system activities	Impact on food security outcomes	Impact on other human well-being outcomes
<p>Production assets:</p> <ul style="list-style-type: none"> Trend changes in suitability of and for crop and livestock production Gradual loss of biodiversity Trend changes in vectors and natural habits of plant and animal pests and diseases Storage, transport and marketing infrastructure: Strain on electricity grids, air conditioning and cold storage capacity 	<p>Production food:</p> <ul style="list-style-type: none"> Immediate crop and livestock losses due to heat and water stress Lower yields from dairy animals Reduced labour productivity due to heat loss Trend impacts uncertain, conditions on location, availability of water and adoption of new cropping patterns by farmers <p>Storage and processing of food:</p> <ul style="list-style-type: none"> Upgrade in cooling and storage facilities required to maintain food quality at higher temperatures. Increasing energy requirements for cooling <p>Consuming food</p> <ul style="list-style-type: none"> Higher intake of liquids Lower intake of cooked food. Perishable products shorter shelf life. More need for refrigeration Heat stress may negatively affect people's ability to access food (no energy to shop or do productive work) ability to access food (no energy to shop or do productive work) 	<p>Food availability(production, distribution, exchange):</p> <ul style="list-style-type: none"> Reduced production of food crops and livestock products in affected areas Local losses could temporarily affect local markets Reduction in global supplies likely to cause markets to rise. <p>Food accessibility(allocation, affordability, preference)</p> <ul style="list-style-type: none"> Impacts on income, prices and affordability uncertain <p>Food utilization(nutritional value, social value, food safety):</p> <ul style="list-style-type: none"> Risk of dehydration. Risk of health from eating food that is spoiled Ability of body to process food reduced due to heat stress or diseases <p>Food System stability:</p> <ul style="list-style-type: none"> Higher cost of storing grain and perishable products 	<p>Livelihoods:</p> <ul style="list-style-type: none"> Trend changes in vectors and natural habits of pests and diseases that affect human health and productivity <p>Social values and behaviours:</p> <ul style="list-style-type: none"> Acceptance of greater degree of risk and uncertainty as a natural condition of life <p>National and global economies:</p> <ul style="list-style-type: none"> Reorientation of public and private sector investments towards mitigating and adapting to climate change
			<p>Policies and regulations:</p> <ul style="list-style-type: none"> Greater reliance on weather related insurance Development of risk management frameworks <p>Farming, forestry and fishery practises:</p> <ul style="list-style-type: none"> Trend changes in cropping patterns Development and dissemination of more heat-tolerant variety and species <p>Food processing, distribution and marketing practises:</p> <ul style="list-style-type: none"> Greater use of alternative fuels for generating electricity <p>Food preparation practises:</p> <ul style="list-style-type: none"> Greater use of alternative fuels for home cooking

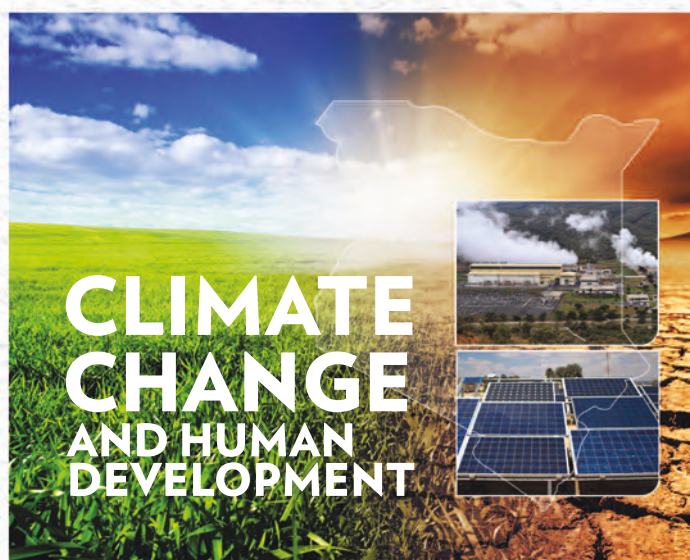
Appendix 3.1c: Increase in frequency and duration of dry spells and droughts

C. 1: Gradual changes in precipitation (increase in frequency, duration and intensity of dry spells and droughts)			
Impact on food system assets	Impact on food system activities	Impact on food security outcomes	Impact on other human well-being outcomes
<p>Production assets:</p> <ul style="list-style-type: none"> Trend changes in suitability of and for crop and livestock production Gradual loss of biodiversity Trend changes in vectors and natural habits of plant and animal pests and diseases Storage, transport and marketing infrastructure: Strain on electricity grids, air conditioning and cold storage capacity 	<p>Production food:</p> <ul style="list-style-type: none"> Immediate crop and livestock losses due to heat and water stress Lower yields from dairy animals Reduced labour productivity due to heat loss Trend impacts uncertain, conditions on location, availability of water and adoption of new cropping patterns by farmers <p>Storage and processing of food:</p> <ul style="list-style-type: none"> Upgrade in cooling and storage facilities required to maintain food quality at higher temperatures. Increasing energy requirements for cooling <p>Consuming food</p> <ul style="list-style-type: none"> Higher intake of liquids Lower intake of cooked food. Perishable products shorter shelf life. More need for refrigeration Heat stress may negatively affect people's ability to access food (no energy to shop or do productive work) <p>ability to access food (no energy to shop or do productive work)</p>	<p>Food availability (production, distribution, exchange):</p> <ul style="list-style-type: none"> Reduced production of food crops and livestock products in affected areas Local losses could temporarily affect local markets Reduction in global supplies likely to cause markets to rise. <p>Food accessibility (allocation, affordability, preference)</p> <ul style="list-style-type: none"> Impacts on income, prices and affordability uncertain <p>Food utilization (nutritional value, social value, food safety):</p> <ul style="list-style-type: none"> Risk of dehydration. Risk of health from eating food that is spoiled Ability of body to process food reduced due to heat stress or diseases <p>Food System stability:</p> <ul style="list-style-type: none"> Higher cost of storing grain and perishable products 	<p>Livelihoods:</p> <ul style="list-style-type: none"> Trend changes in vectors and natural habits of pests and diseases that affect human health and productivity <p>Social values and behaviours:</p> <ul style="list-style-type: none"> Acceptance of greater degree of risk and uncertainty as a natural condition of life <p>National and global economies:</p> <ul style="list-style-type: none"> Reorientation of public and private sector investments towards mitigating and adapting to climate change
			<p>Policies and regulations:</p> <ul style="list-style-type: none"> Greater reliance on weather related insurance Development of risk management frameworks <p>Farming, forestry and fishery practises:</p> <ul style="list-style-type: none"> Trend changes in cropping patterns Development and dissemination of more heat-tolerant variety and species <p>Food processing, distribution and marketing practises:</p> <ul style="list-style-type: none"> Greater use of alternative fuels for generating electricity <p>Food preparation practises:</p> <ul style="list-style-type: none"> Greater use of alternative fuels for home cooking

Appendix 3.1d: Increase in frequency, and intensity of extreme weather events

D. Impacts of Increase in the frequency and intensity of extreme weather events (increase in annual occurrence of high winds, heavy rains, storm surges, flash floods and rising water levels associated with tornados, tropical storms, and prolonged heavy rains)			
Impact on food system assets	Impact on food system activities	Impact on food security outcomes	Impact on other human well-being outcomes
<p>Production assets:</p> <ul style="list-style-type: none"> • Damage to standing crops • Animals stranded • Increase in water-borne livestock diseases • Damage to buildings and equipment • Loss of stored crops <p>Storage, transport and marketing infrastructure:</p> <ul style="list-style-type: none"> • Damage to roads, bridges, storage structures, processing plants and electricity grinds <p>Non-farm livelihood assets:</p> <ul style="list-style-type: none"> • Damage to trade goods <p>Food preparation assets:</p> <ul style="list-style-type: none"> • Loss of household food supplies 	<p>Production food:</p> <ul style="list-style-type: none"> • Possibility of lower yields in flooded agricultural areas. • Increased soil erosion reducing future yields. <p>Processing of food:</p> <ul style="list-style-type: none"> • Pollution of water supply used in processing food <p>Distributing food:</p> <ul style="list-style-type: none"> • Disruption in food supply chains and increase in marketing and distribution costs. <p>Consuming food</p> <ul style="list-style-type: none"> • Reliance on emergency rations • Possibility that preferred foods will be less available in emergency situations and food variety will decrease • Increased health risks from water-borne diseases may negatively affect people's ability to access food (no energy to shop or do productive work) 	<p>Food availability (production, distribution, exchange):</p> <ul style="list-style-type: none"> • Possible decrease in surplus production in flooded agricultural areas. • Increased need for emergency distribution of food rations. <p>Food accessibility (allocation, affordability, preference)</p> <ul style="list-style-type: none"> • Possible increase in food prices. • Possible loss of farm income and non-farm employment, depending on extent of asset loss. <p>Food utilization (nutritional value, social value, food safety):</p> <ul style="list-style-type: none"> • Food safety is compromised by water pollution and damage to stored food. • Ability of body to process food reduced due to diseases. 	<p>Livelihoods:</p> <ul style="list-style-type: none"> • Decline in expenditure for other basic needs, e.g. clothing, shelter, health, education. • Trend changes in vectors and natural habitats of pests and diseases that affect human health and productivity • Changes in geographic distribution of vulnerability. <p>Social values and behaviours:</p> <ul style="list-style-type: none"> • Acceptance of a greater degree of risk and uncertainty as a natural condition of life. <p>National and global economies:</p> <ul style="list-style-type: none"> • Reorientation of public and private sector investments towards mitigating and adapting to climatic change.
			<p>Possible adaptive responses</p> <p>Policies and regulations:</p> <ul style="list-style-type: none"> • Development of weather-related insurance schemes for storms and floods. • Development of risk management frameworks <p>Infrastructure investments</p> <ul style="list-style-type: none"> • New investments in food embankments • Use of wind resistant technologies on new and existing structures • Establishment of emergency shelters on high ground. <p>Farming, forestry and fishery practises:</p> <ul style="list-style-type: none"> • Use of practises that create denser root mass to hold soil in place. • Development and dissemination of more food-tolerant varieties and species <p>Food processing, distribution and marketing practises:</p> <ul style="list-style-type: none"> • Provision for emergency water supplies

KENYA NATIONAL HUMAN DEVELOPMENT REPORT 2013



HARNESSING EMERGING OPPORTUNITIES



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Resilient nations.*