1. INTRODUCTION

Climate variations and change affects human activities and life styles, which in turn affects development and economic production. Climate change is not easy to predict with precision because many variables are involved whose possible interactions are difficult to quantify. Consequently, it is necessary to develop policies and response strategies that are sufficiently broad to address the cross-sectoral impacts of climate change, with specific measures to tackle sector-specific problems.

Kenya ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 30th August 1994. The ultimate objective of the convention is to prevent greenhouse gases (GHG) emission into the atmosphere from reaching a level that would interfere with climate.

Available information in the developed countries shows positive correlation between increased carbon emissions and increased incomes under existing technologies. High economic growth is associated with increased carbon emissions, while reduced carbon emission would (given current technological, managerial, demographic and social arrangements) generally be associated with low rates of economic growth.

The challenge for Kenya is to develop strategies, which would promote sustainable development, without contributing to increased emission of GHG. It is necessary therefore to develop appropriate policies and response strategies to manage GHG emissions. Policies and strategies must be based on reliable inventory of GHG emissions and sinks. This 1st National Communication is the main output of the enabling activity project; ***Kenya: Enabling Activities for the Preparation of Initial National Communication Related to the UNFCCC***, funded by the Global Environment Facility (GEF) through the United Nations Environment Programme (UNEP). The Ministry of Environment and Natural Resources through the National Environment Secretariat executed the Climate Change Enabling Activity. The National Communication is composed of the following information in accordance with the UNFCC guidelines for the preparation of Non-Annex 1 national communication.

1. National Circumstances
2. Sustainable Development
3. National GHG Inventory
4. Vulnerability and Adaptation to Climate Change
5. Mitigation Options
6. Research and Systematic Observation
7. Education Training and Public Awareness

The activities for the preparation of the National Communication was carried out by a National Communication/Project Management Team and four Technical Working Groups (TWG) established along the thematic areas of the Convention, namely TWG on:-

1. National GHG Inventory
2. GHG Mitigation Options
3. Climate Change Vulnerability & Adaptation and Impacts Assessment
4. Education Training & Public Awareness

2. NATIONAL CIRCUMSTANCES

2.1 Geography

The Republic of Kenya covers an area of about 5,000 km^2. It lies approximately between latitudes 5^0 north and 5^0 souths and between longitudes 34^0 and 42^0 east on the east coast of Africa. Fig 2.1. The altitude varies widely from sea level to about 5000 meters above sea level on the central highlands. Lakes occupy about 2% of total area, 18% is occupied by high potential areas while arid and semi-arid lands occupy about 80% of total land area. Its coastline is about 400 km long. The equator bisects the country in almost two equal parts.

Kenya has diverse landforms ranging from the coastal plains through the dry plateaus to the savannah grasslands and the highlands on both sides of the Rift. The vast arid and semi-arid lands of northern Kenya extend from the flat plains in the east to the rugged country west of Lake Turkana.

The major drainage basins in Kenya include the Lake Victoria, Rift Valley, Athi, Tana and Ewaso Nyiro basins and North-Eastern. Drainage is influenced by the country's topography. The main rivers drain radically from the central highlands into the Rift Valley and eastwards into the Indian Ocean and westwards into Lake Victoria, while those north of Mount Elgon and from the highlands along the Sudan-Ethiopian border drain mainly into Lake Turkana.

Although Kenya has numerous rivers, a comparatively small number are permanent, among them are the Tana, Athi, Nzoia, Yala, Sondu, Nyando and Mara. Several of the rivers have been dammed upstream to provide hydroelectric power, irrigation water and water for domestic use.

Kenya's lakes are categorized as fresh and saline/alkaline. Fresh water lakes include Lakes Baringo, Naivasha and Victoria (Africa's largest fresh water lake shared with Tanzania and Uganda). Most other lakes are within the Rift Valley and many of these are alkaline and valuable tourist attractions. The levels and volumes of these lakes fluctuate seasonally. Lake Magadi in the southern part of the Rift Valley is saline/alkaline and is mined for soda ash.

2.2 History

Kenya became independent on 12th December 1963, as a multi-party state. It became a one party state in 1982, but reverted to a multi-party system in 1992. Kenya has 42 ethnic groups each with its own cultures/traditions. Some of which are influenced by climate conditions, which in turn dictate the use of natural resources. For example, some communities are predominantly farmers, while others are pastoralists, fishermen, traders, etc. The characteristics (cultural and climatic) of these ethnic groups (which have developed over many years) incorporate coping mechanisms for climatic variations.

2.3 Climate characteristics

Annual rainfall follows a strong bimodal seasonal pattern. Generally, the long rains occur in March - May, while the short rains occur in October – December, but with variations. Distribution of rainfall is influenced by topography. The country's climate is influenced by its equatorial location, topography, the Indian Ocean, and the inter-tropical convergence zone (ITCZ). The influence of the ITCZ is modified by the altitudinal differences, giving rise to varied climatic regimes. Kenya has seven agro-climatic zone (table 2.1 and figure 2.2)

Figure 2.1 Relief features of Kenya

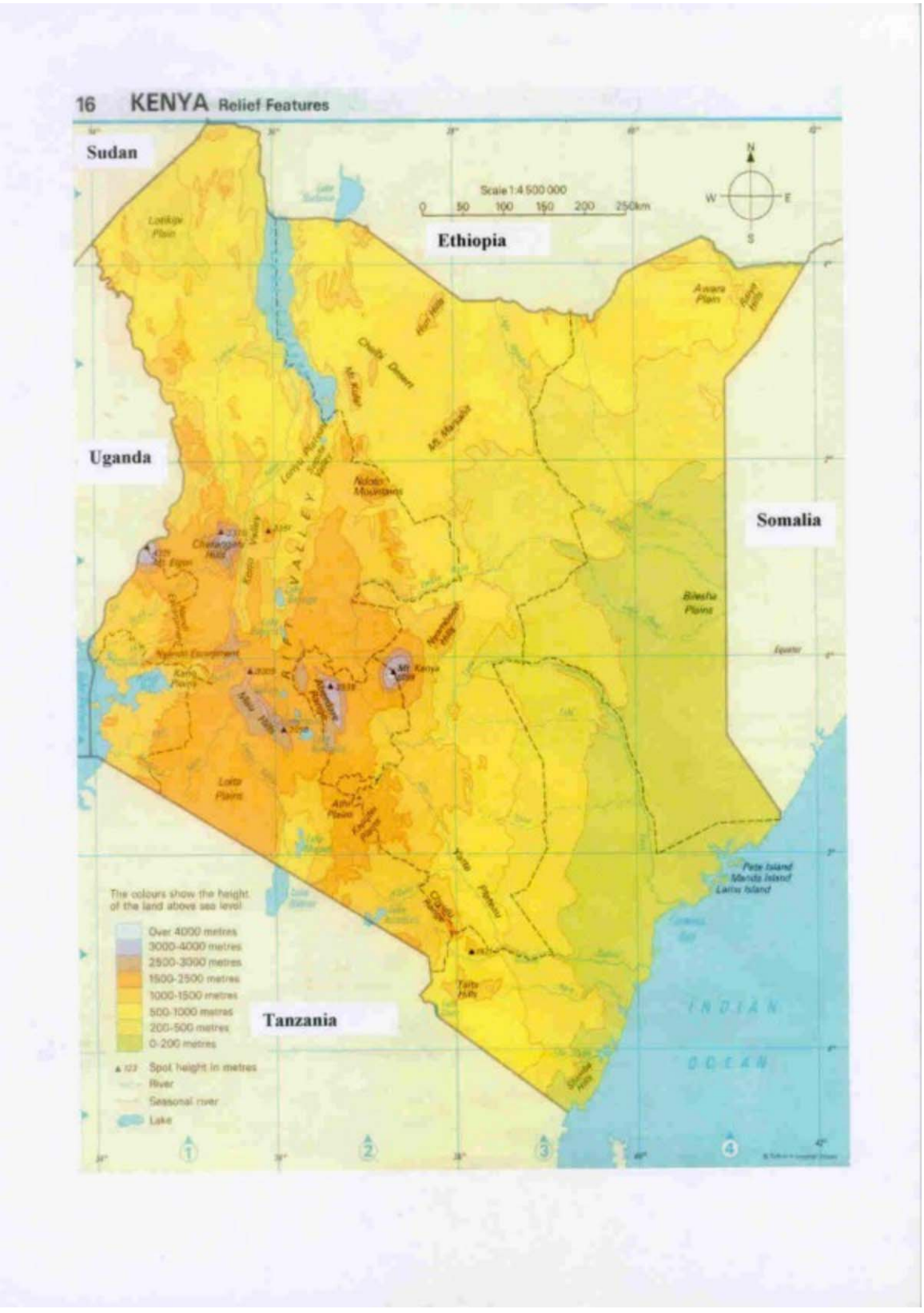
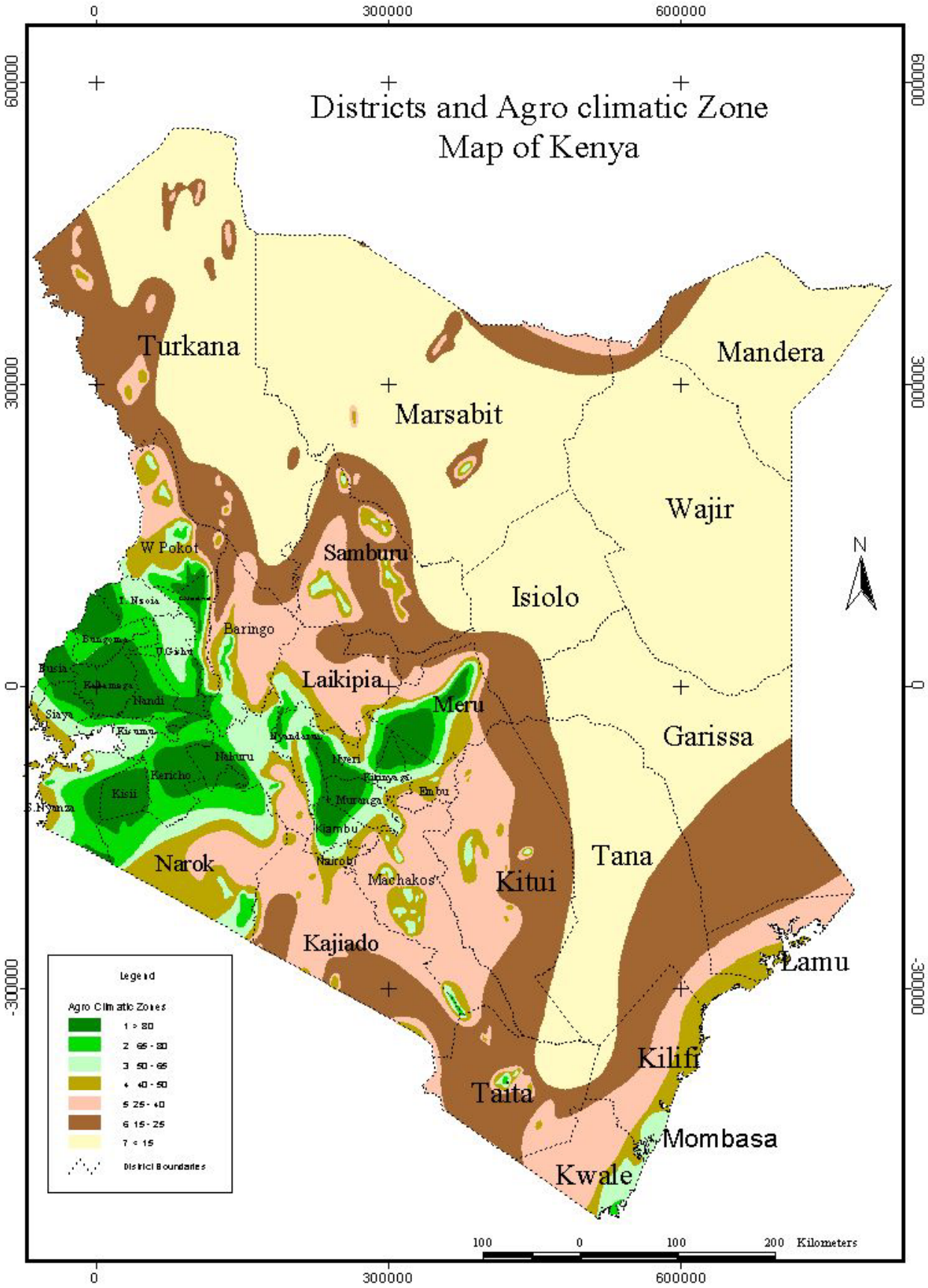


Figure 2.2 Agro-Climatic Zones of Kenya



Altitude exerts the greatest influence on temperature and moisture (Fig. 2.1). There is a wide range between the maximum and minimum temperatures; from below freezing point on the snow-capped Mount Kenya to over 40^0C in northwestern, northern and northeastern parts of the country.

Extreme climate events such as droughts and floods are common in Kenya. Some of these events are linked to ENSO.

Table 2.1 Agro-climatic Zones of Kenya

Zone	Climatic Zones	Mean Annual Rainfall	% Of Total Land Area
I	Humid	1,400 - 2,700	3
II	Sub – Humid	1,000 - 1,600	4
III	Semi – Humid	800 - 1,400	5
IV	Medium to Semi Arid	600 - 700	5
V	Semi Arid	500 - 600	15
VI	Arid	300 - 550	22
VII	Very Arid	< 300	46

Source: NEAP (1994)

2.4 Social and Economic Factors Affecting Climate Change

2.4.1 Population

Kenya had a population of 28.7 million people in 1999, of which 80% live in rural areas with a high growth rate of 2.9%. The population distribution is uneven with patterns being linked to agricultural land potential. This also makes the regional population densities remarkably variable, from an average of 230 persons per km^2 in high potential areas to an average low of 3 persons per km^2 in arid areas. Kenya's population is also characterized by rapid rural to urban migration. Over 50% of the population is below 15 years. However, intercensal population growth rate has declined significantly from 3.9% per annum during 1969 - 1979 period to 2.9% between 1989-1998. Additionally total fertility rates have fallen. Such a rapidly increasing population limits the government's ability to satisfactorily provide social services and invest in productive sectors, create employment and deal effectively with serious environmental concerns.

If climate change results in reduced precipitation in Kenya, then the arid and semi-arid areas would increase while the high potential ones would diminish in size. Consequently, the existing population would have to rely on a constricted resource base. This eventuality might increase immigration to urban areas, increase degradation of the environment in rural and urban areas, increase deforestation for settlement and fuel-wood and over-stretching far and stressing the capacity of infrastructures in urban centres. Increased numbers of immigrants to urban areas will further stress urban facilities beyond their carrying capacities in terms of provision of water, education, health, housing, energy and transport.

2.4.2 Welfare and Gender

Kenya's immediate major development problem is persistent and increasing level of poverty (figure 2.4) The Human Development Report for Kenya (1999) estimates that half of the population is poor. GDP growth has declined since early 1970s and is now lower than that of population growth.

Poverty contributes to unsustainable use of resources and environmental degradation, such as poor farming practices, overgrazing and reliance on wood as the main source of fuel. This is because the immediate survival needs of people often take precedence over the long-term needs for preserving and maintaining the viability and integrity of the environment. The challenge for Kenya is how to reduce

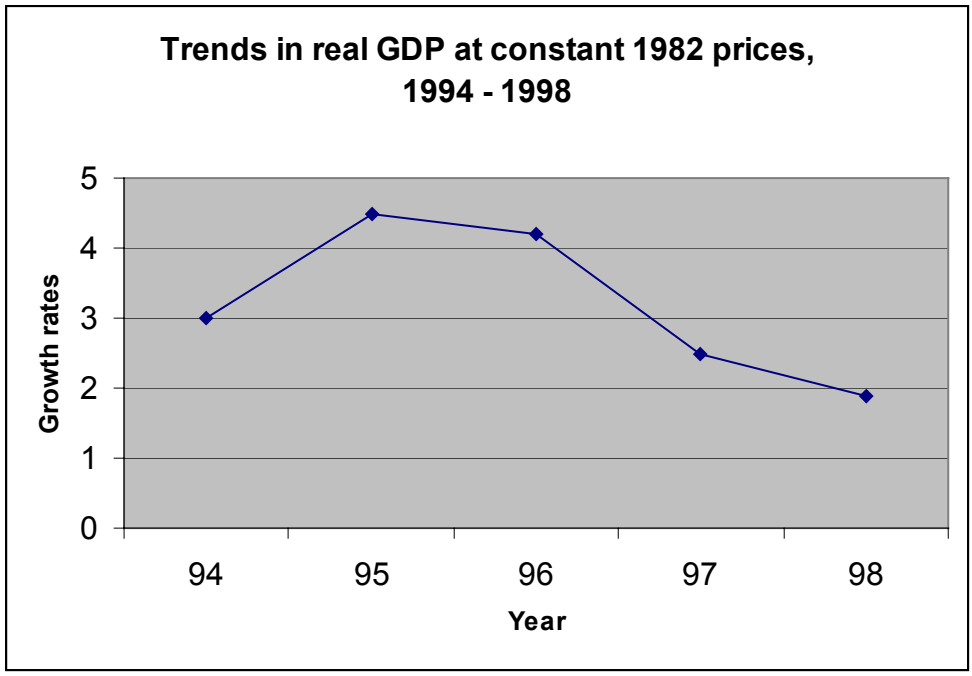
unemployment and poverty.

Kenya's National Poverty Reduction Strategy of 2001 calls for promotion of sustainable livelihoods and diversification of income-generating activities.

Although most of the poor are women, gender imbalances exist because of cultural and other related factors. Issues of gender and climate change are highly correlated because of the productive and reproductive role of women. Women interact with the environment in a variety of ways. They are major players in natural resource use and economic development, food production, and are users and suppliers of fuel wood and water.

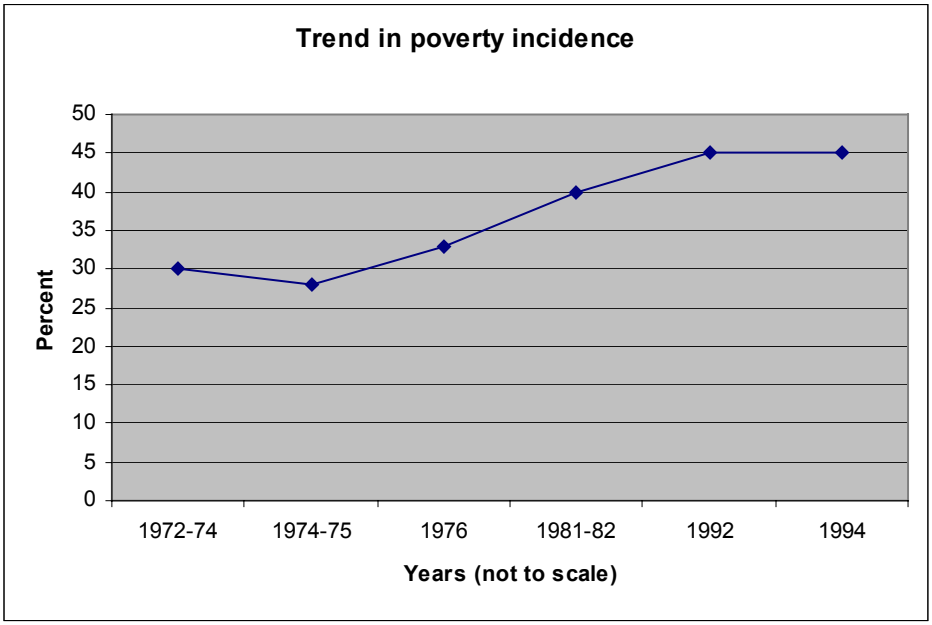
Women would be most affected by climatic variabilities and other related impacts of climate change as they affect food production, water availability, health, energy scarcity and technological changes. Participation of women in decision-making on issues of land management and ownership is limited. This issue is being addressed through policy and legislative reforms

Figure 2.3: Trends in real GDP at constant 1982 prices, 1994 – 1998



Source: Central Bureau of Statistics (1999)

Figure 2.4 Trend of poverty incidence



Source: Human Development Report, Kenya, 1999

2.4.3 Overview of the Economy

Real growth of GDP has been fluctuating over the years showing a downward trend since 1996 (figure 2.3). The decline recorded a negative growth of - 0.3 % in the year 2001. The economy has been characterized by increasing poverty due to a combination of factors, the main ones being poor state of infrastructure, depressed investments, declining tourism activities, slump in industrial production, deteriorating terms of trade and increasing climatic variations. This has been compounded by a decline in development assistance since early 1990s. In addition, foreign debt, which is an enormous economic burden, continues to grow. Moreover, Kenya depends on agricultural and mineral exports in their raw form and also on tourism, for which it has little influence on.

2.4.4. Land use charges and forests

The economic potential and human settlement patterns are closely linked to the agro-climatic regions. Zones I to IV that cover 16% of total land area, are of high to medium agricultural potential (food crop production, cash crops and dairy farming) and supports about 80% of the country's population. The remaining 20% of the population live in zones V to VII, which comprise 84% of the total land area. These zones have the least potential for agriculture but are rich in wildlife, and are therefore important for tourism development.

The concentration of activities and human settlements in the high to medium potential areas creates stiff land use competition. This coupled with heavy reliance on fuel wood and a high population growth has led to deforestation and encroachment of arid areas. This change is evident in the translation of forestland to farmlands, emigration to marginal lands and increased settlement practices requiring sub-divisions of family land. This situation has potential for increasing GHG emissions and for severe impacts of climatic variabilities like floods and droughts. Deforestation increases emission of greenhouses gases into the atmosphere. Additionally, loss of forests reduces carbon sinks. It is therefore important that land use changes involving forestry should be well managed to ensure that least amounts of greenhouse gases are emitted into the atmosphere.

2.4.5 Agriculture

Agriculture is the mainstay of the Kenyan economy. It is the basis for food security, for economic growth, employment creation and foreign exchange generation. The small-scale farm sector accounts for about 75% of the total output in the agricultural sector. Food production accounts for most small-scale agriculture production with cash crops following a distant second. Most Kenyan industrial and manufacturing firms are agro-based. The huge demand for agricultural land has forced many people to emigrate to arid and semi-arid lands, taking with them farming practices that often accelerate land degradation.

The contribution of agriculture to GDP declined from 37% in 1964 to about 24% in 2001. However, the agricultural sector grew on average at a slower pace than overall GDP during the past 30 years (figure 2.5b). Agricultural potential depends on rainfall, soil characteristics, and use of chemicals, but has been adversely affected by land degradation and inappropriate land use practices.

2.4.6. Industry

The contribution of industrial production to GDP has risen over the years (table 2.2 and figure 2.5b). The rate of growth of the sector has been well above that of GDP (Figure 2.5a). Kenya's industrial policy is set in Sessional Paper No. 2 of 1996 on Industrial Transformation to the Year 2020 and the 8th National Development Plan 1997-2001. Rapid industrialization is seen as the quickest avenue for creating employment opportunities, increasing incomes and eradicating poverty. The industrialization policy projects GDP growth at an average rate of 5.9% between 1997 and 2020. Faster economic growth relies on agriculture and industry. However, it is important to critically analyse the industrialization policy and strategies with a view to avoiding increased emission of GHG.

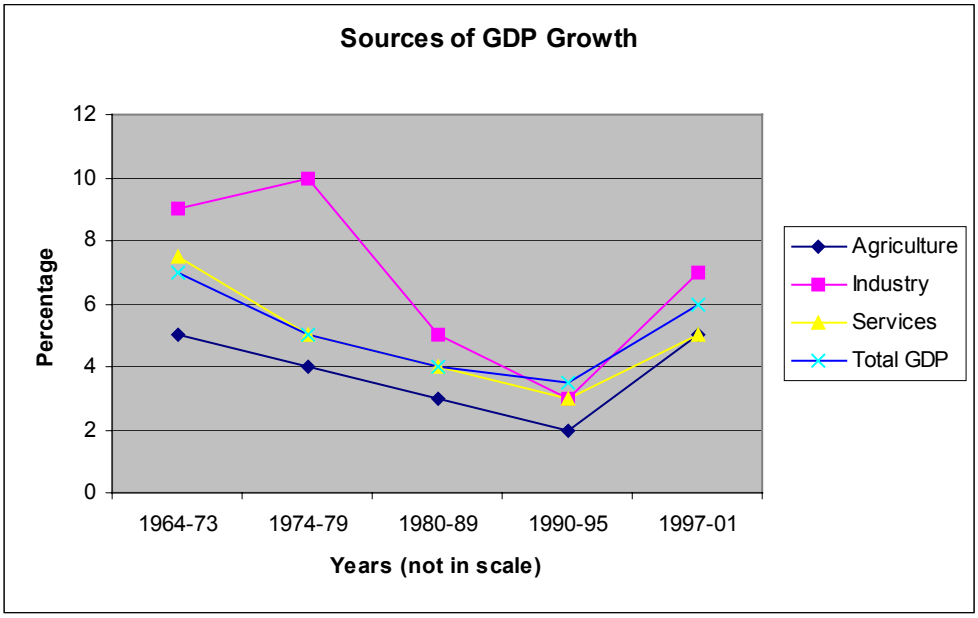


Figure 2.5a: Sectoral Contribution to GDP Growth

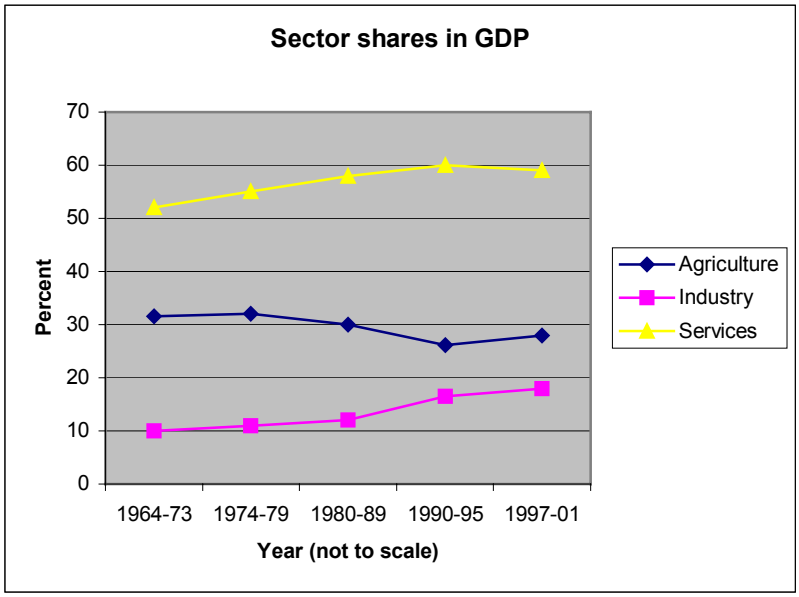


Figure 2.5b: Sector Shares in GDP

2.4.7. Service Sector

The service sector includes transport, tourism, wildlife, energy, informal sector, distribution and other services. This sector contributes over half of Kenya's GDP and provides over two-thirds of total employment. The sector grew faster than agriculture and manufacturing. Its contribution to GDP increased from 53.4% during 1964-1973 to 60.2% during 1990-1995 (table 2.2 and figure 2.5b).

Table 2.2: Key national economic indicators

Criteria	**1994**	**1996**	**1998**
Population (million)	27	28	28.7
Relevant Areas (km^2) Whole Country Arid/semi arid.	587900	587900	587900
Estimated share of informal sector in GDP (%)	6.0	6.1	8.2
Share of manufacturing industry GDP (%)	13.6	13.8	16
Share of services in GDP (%)	58	59	60.2
Share of Agriculture in GDP (%)	25.01	25.00	26
Land area used for agriculture purposes km^2	52047	52047	52047
Urban population as % of total population	20	29	33.6
Livestock population (000)	9175	10170	10170
Forest area (km^2)	20310	20310	20310
Population in absolute poverty (%)	47.8	48.0	48.02
Live expectancy at birth (years)	(1969) 49	(1989) 59.5	(1989) 59.5
Literacy (%)	72.8	73.4	78

a) Transport

The transport sector in Kenya comprises five major types: road, rail, air, sea/lake and pipeline with road dominating. Transport plays a crucial role in the country's development and integration. Motorized transport is by far the most dominant and is a major source of pollution and emitter of GHG, especially in the urban areas. Emission of GHG by vehicles is due to traffic congestion, poor servicing, and large number of old second hand vehicles, poor infrastructure and poor road conditions. Duty on imported second-hand vehicles has been increased to discourage their importation.

b) Tourism and Wildlife

Tourism mainly depends on wildlife, the beach and scenic features. The tourism sector is second to tea in foreign exchange earnings and a major employer in Kenya. National parks occupy about 7% of the total land area in Kenya, though a large population of wildlife is found outside the national parks. Climatic conditions affect abundance and type of wildlife, beaches, mountains and scenic features, all of which attract tourists. Growth in the tourist industry contributes to development through generation of foreign exchange, creation of income earning opportunities, market expansion for agricultural and industrial goods, and development of local entrepreneurship.

c) Energy

Energy is a basic necessity for survival and a critical factor affecting economic development. Petroleum fuels are the major source of energy used by commercial and industrial establishments. Electricity is the third source of energy in Kenya after fuel wood and petroleum products, but is second to petroleum fuel as a source of commercial energy. The demand for electricity by domestic and small commercial establishments increased by 8.2% during 1996-98. However, about 80% of Kenya's population depends on wood fuel for its domestic energy needs. Wood fuel caters for over 70% of Kenya's total energy demand and provides for more than 93% of rural household energy needs. Wood fuel is also used extensively in the rural informal industries such as brick making, pottery, jaggery, manufacturing and food processing.

A great concern in the energy sector is that demand for wood fuel exceeds supply. The scarcity of fuel wood and the impact of its escalating prices are more acute at the household level because of poverty and limited alternatives. These impacts are more felt by women, who are responsible for household cooking.

A practical example of this impact can be explained by a situation in Ngong town,15km to the west of Nairobi, where the escalating prices in fuel wood and poverty have led the use of plastic waste as source of energy. Plastics produce carbon monoxide, which is hazardous to health and contributes to GHG emissions. The women were not aware of the dangers to the environment and their health. However, women scientists who are promoters of new technologies and who try to link policy and research at grassroots level came to the aid of these women (see Box 1).

The government has been promoting energy saving stoves and other alternative sources of energy, including biogas, wind and solar power. Other sources of biomass being investigated, including use of bagasse, short corpiles, and use of human solid waste to generate biogas, especially in areas of high population concentration like schools, markets, slums, etc. However, adoption of technologies is constrained by inappropriateness, patterns of settlement, limited promotional strategies and price structures. The energy sector therefore has potential to increase GHG emissions as well as reduce sinks for carbon sequestration.

d) Informal Sector

The informal sector, also referred to as the *Jua Kali* is an important component of the service sector. It covers all semi-organised and unregulated small-scale activities largely undertaken by self-employed or those employing only a few workers. It excludes all farming and pastoralism activities. It has grown considerably over the last 20 years, employing about 2,987,000 people in 1997 and 3,353,000 in 1998. It represents about 8% of GDP (table 2.2). It is the second largest source of employment after small-scale agriculture. Many poor urban women and men depend on this sector for their livelihood. A large proportion of the labour force continue to join the informal sector as opportunities for securing wage employment in the modern sector has become increasingly scarce. There is also a shift of labour from subsistence farming to informal sector due to continued monetisation of the economy. The activities in the sector are carried out by artisans, traders and other operators under a variety of work sites such as temporary structures, markets, developed and undeveloped plots, residential premises or street pavements.

The potential contribution of the service sector to GHG emissions is through transportation, dumping of waste and deforestation. There is however, limited awareness on the impacts of the sector's activities on the environment.

Box 1: An innovative approach to solving energy problems and reducing emission of GHG in Ngong Town.

In May 1998, a television programme on Kenya the Broadcasting Corporation showed women in Ngong Division using plastic containers as cooking fuel. Ngong is a suburb of Nairobi, an area where deforestation for firewood, human settlements, and food production has taken place over a long period of time.

A group of women scientists, the Gender Research Group (GRG) from Kenya Forestry Research Institute, working in collaboration with Winrock International, the African Women Leaders on Agriculture and Environment Programme (AWLAE) to enhance linkages between policy, research and the woman farmer picked this story. They went on a fact-finding mission, carried out needs assessment on wood and designed an intervention programme. An intervention programme was designed with the participation of the affected women of Ngong using the following procedure(s):

- Participatory Rural Appraisal (PRA);
- Demonstration of energy saving devices to women and other stakeholders;
- Training women to make energy saving devices for use and sale;
- Training women on establishment, management and maintenance of trees and tree nurseries.

These measures enabled the rural women of Ngong to have knowledge, skills and choice of energy saving technologies; increased their incomes from sale of *Maendeleo* Liners and fireless cookers; improved livelihood by providing an alternative source of income; improved health by providing clean energy technology, and make tree and tree products available to these rural women and at the same time provide sinks for GHG.

2.4.8 Biodiversity

Kenya is endowed with a variety of habitats and ecological systems, which makes it a custodian of a unique heritage of biodiversity (table 2.3). This rich biodiversity includes wildlife, forests, farmlands, vegetation, wetlands, marine life forms and microorganisms).

Biological diversity is crucial for ecological stability including regulation of climate, economic development, recreation, medicinal use, socio-cultural use and scientific advancement. Kenya will continue to depend greatly on her biodiversity for present and future development.

The government is committed to the protection of the country's biological diversity through legislation and by setting aside a considerable portion of land area (about 8%) as protected areas for wildlife and forestry conservation, and to ensure the survival, conservation and sustainable use of these valuable assets. In this regard, Kenya has ratified the United Nations Convention on Biological Diversity (CBD). In addition, the government has developed a National Biodiversity Strategy and Action Plan. Many action plans and strategies are being implemented in form of projects and programmes on biodiversity conservation by the government, private sector and civil society organisations.

Causes of loss of biodiversity in Kenya include habitat destruction, over-exploitation through excessive harvesting or hunting, air and water pollution, introduction of exotic species, and ineffective institutional arrangements. Protection of plant diversity has the potential of enhancing climate change mitigation capacity.

Table 2.3. Biotic Communities, excluding agricultural land and barren areas

No.	*Description*	*Percentage land Area*
1.	Afro-Alpine glacier and moorland	1.3
2.	Highland moist forest	2.0
3.	Guineo-Congolean rain forest	0.1
4.	Highland dry forest	0.4
5.	Evergreen and semi-evergreen bush land	1.4
6.	Grassland	8.0
7.	Semi-arid wooded and bush-grassland	0.2
8.	Arid thorn bush land and woodland	41.7
9.	Semi-desert	16.8
10.	Coastal forest and woodland	0.1
11.	Groundwater and riverine forest	1.5
12.	Coastal evergreen bush land	0.4
13.	Coastal palm stands	0.1
14.	Permanent swamps	0.1
15.	Freshwater lakes	2.1
16.	Alkaline lakes	0.04
17.	Marine beaches and dunes	0.05
18.	Mangroves	0.2
19.	Coral reefs and islands	0.1

Source: Dean and Trump (1983)

2.5. Information Needs and Indicators

2.5.1. Information on Specific Ecosystems

Climate change is likely to impact on low-lying coastal areas, islands, arid and semi-arid areas, forested areas, areas prone to natural disasters, areas liable to drought and desertification, areas of high urban atmospheric pollution, and areas with fragile ecosystems, including mountainous ecosystems. Some of these likely concerns are summarised in table 2.4. Information on specific needs and concerns will be determined by the development of indicators on impacts of climate. Constraints to development of indicators include lack of access to multi-sectoral data and inappropriate technology for processing and sharing of existing data and/or information.

2.5.2. Indicators of Climate Change

Indicators of climate change include weather variability, floods, droughts, increased greenhouse gas emissions, temperature changes, etc. Potential use of indicators include fostering of a common understanding, facilitating policy formulation and alerting decision-makers in government, business, industry, research and civil organizations and global community to priority issues. Indicators will also be useful in determining mitigation options and capacity required.

Indicators would determine degree and causes of change. Assessing impacts would depend on data availability, technological know how and availability of financial and other resources. Indicators of specific impacts of climatic variabilities like droughts and floods, and levels of urban atmospheric pollution has not been developed. Kenya is just starting the process of developing indicators of sustainable development (ISD). The country is one among others being used by the Commission on Sustainable Development (CSD) to test the indicators. In the process, indicators related to climate change will be developed. Some key indicators on broad issues of climate change can be developed with available data and technical know-how (table 2.5). Constraints in developing ISD related to

climate change include:

a) Lack of a clear definition of sustainable development in the context of socio-economic status, and the relationship between the goal of mitigation and sustainable development.
b) Inadequate integration of climate change issues in national development priorities.
c) Assessment of sinks, emissions and related issues.
d) Inadequate information on characteristics of gases emitted and their impact on the environment, human health and climate.
e) Inadequate emission standards and regulations.
f) Underdeveloped early warning systems and mitigation options on the dangers of gaseous emissions and their management.
g) Indicators that are socially, politically, economically and environmentally accepted.
h) Inadequate institutional capacity (human, financial and technical) and coordination.

Table 2.4. Likely effects of climate change on specific ecosystems

Area	Likely Effects/Concerns
Low-lying Coastal Area	• Submergence of a large quantity of land and disruption of established ecosystems • Destruction of human settlements • Distribution of agriculture and industry • Complication of water supply • Loss of biodiversity • Siltation • Salanization of agricultural land and changing harvest times
Arid and Semi-arid Areas (Drought and Desertification)	• Deterioration of soil and vegetation cover • Disruption of hydrological cycle • Reduction of water supply • Disruption of livestock industry • Adverse effect on (distress, starvation, famine, and cessation of economic activity) • Dislocation or reduction of wildlife
Forests	• reduction of species diversity and distribution • Deforestation • Loss of forests products and biodiversity • Enhanced land degradation
Mountainous Ecosystems	• Extinction of fragile species
Areas of High Urban Atmospheric Pollution	• Environmentally induced diseases (ill health) • Increase waste (dumping)

Source: Adopted from *Potential Impact of Climate Change in Kenya* by Climate Change Africa (1997)

2.5.3. Disasters and Extreme Climatic Events

Extreme climatic events are associated with disasters, and increase in incidences of diseases. Incidences of vector and water borne diseases increase during periods of heavy rains and flooding. For example incidences of landslides, drowning and soil erosion increase. On the other hand droughts and high temperatures cause famine and malnutrition thereby weakening, resistance to diseases. Floods, which is a climatic, factor which impacts on many sectors. Floods are used to develop climate change related indicators (Box 2).

2.5.4. Systematic Observations, Monitoring, Processing and Exchange of Information

Systematic observations in Kenya are undertaken by meteorological and hydrological stations, which are distributed throughout the country. Private observing stations exist in various parts of the country. The Kenya Meteorological Department through its network of observatories and rain-gauge stations spread all over the country carries out systematic observations of a number of meteorological parameters, namely: rainfall, evaporation, temperature, cloud cover, sunshine, humidity, wind speed and direction, among others. The department maintains a large Climatological data bank dating from 1896. Archived meteorological and hydrological data are needed for monitoring climate with a view to detecting trends in climatic parameters.

Table 2.5. Key Indicators on Climate Change

Themes issues and objectives	**Key indicator**
Real economic Growth and poverty eradication	• Increase in potential incomes • Contribution to GDP and national development priorities • Multiplier effect on the national levels through poverty alleviation
Additional financial resources	• Time and ease of accessibility • New and additional financial resources • Non conditionalities
Technology transfer	• Appreciate to national economies and effective utilization of resources • Sustenance of the technology • Use of local skills/resources • Involvement of indigenous private companies/improved or new business as a result of projects
Avoidance of future emissions of GHG	• Measuring sinks and other emissions abatement to facilitate evaluation of real, measurable and long term benefits • Projects benefits from domestic incentives • Availability and accessibility of information to enable measurements.
Capacity building	• Capacity to assess real technology transfer, measure sinks and emissions • Understanding of climate change issues and inclusion of the same in national development planning
Energy Projects	• Efficient energy use • Utilization of renewable sources • Reduction indoor and urban air pollution • Job creation • Improvement in women's health and time use

The number of rainfall stations in the country has reduced in the past few years due to economic constraints, which has hampered regular station inspections and replacement of unserviceable equipment. Rain gauge stations, which run on voluntary basis, include those managed by schools, administration centres (provincial), national parks reserves, forest stations and individual farms. A Global Atmospheric Watch station has been established on Mt. Kenya. Most of these observation stations are concentrated in high potential areas, yet ASAL experience serious climatic variability situations.

The Central Bureau of Statistics, Department of Resource Survey and Remote Sensing and the Regional Centre for services in Surveying Mapping and Remote Sensing carry out observational/monitoring activities which gather data/information on vegetation index, species distribution and variability, human settlement patterns and socio-economic issues some of which are relevant to climate change. Some sector's specific data are also available.

Box 2: Impact of climate variation: Nyando River and its environment

A typical case of the vagaries of weather is given by the Kano and Nyando Plains of Nyanza Province and others in similar geographic regions in Kenya. When the rains come, it is in torrents, floods occur and some of the immediate impacts are:

- Destroyed homes, crops and property;
- Dislocated people;
- Contaminate water resources;
- Increase in incidences of waterborne diseases;
- Increased incidences of famine;
- Silted rivers;
- Enhanced soil erosion;
- Costly and complicated disaster management.

Impacts are economical, social, environmental and political. This is a pattern people in this region have come to dread year after year. What would happen if this pattern changes for the worse due to climate change? Mitigating this situation caused by climatic variability would need data and information for identifying causes, impacts and mitigation options from cross-sectoral actors and stakeholders; and determining ecological functions involved from water catchments to affected areas, etc.

2.5.5. Education, Research and Technological Development

A major concern of climate change in Kenya is the lack of adequate long period data and information to researchers, planners, policy-makers and the general public. There is need to develop, strengthen and harmonize national research institutions and programmes on issues regarding climate change impacts, adaptation and mitigation. Climate change research should lead to development of technological capacity to enable people reduce social impacts and poverty and improve investors knowledge and capacity to accommodate variations in and causal factors of climate change.

A number of research works have been carried out on weather variability and climate change and their impacts on agriculture, forestry water and aquatic resources, terrestrial ecosystems, human health, human settlement and socio economics, energy, transport, industry and waste management. Institutions involved in studies on weather variability and climate change impacts include public universities and other research institutions such as the Kenya Agricultural Research Institute (KARI), Kenya Forestry Research Institute (KEFRI), Kenya Industrial Research and Development Institute (KIRDI), Kenya Marine and Fisheries Research Institute (KEMFRI) and East African Institute of Meteorological Training and Research.

Research on natural resources and socio-economic issues such as agriculture, forestry, health, fisheries and industry is also undertaken by the same institutions. There are also several institutions researching and teaching on climate related issues. These include School of Environmental Studies of Moi University; Meteorological Department, of the University of Nairobi, and the Faculty of Environmental Studies at Kenyatta University. There are also other institutions like the Drought Monitoring Centre, and Department of Environmental Studies, Kenya Polytechnic. Furthermore, curricula for public schools, colleges and universities have aspects of environmental education, which in one way or another, touch on aspects of climate change.

2.5.6. Financial Resources

The bulk of research and development funding in Kenya is from the public sector. About 91% of total expenditure, which was equivalent to 0.6% of GDP for the year 1998/99, was funded by the

government through its various research institutions. Public research expenditure is heavily biased against industrial research, although the industrial sector is a major source of carbon dioxide.

Availability of financial resources is a major constraint in developing and implementing climate change mitigation measures. Nationally, the priority is on poverty eradication and provision of basic services. Some of the climate change priorities rank low within overall government priorities. Available funds are allocated to the highest government priorities. At the global level, there is competition among nations for limited resources. Mobilization of financial resources is critical and in this light, Kenya welcomes the Global Environment Facility (GEF) and the financial assistance received so far and the Clean Development Mechanism (CDM) of the Kyoto Protocol (Article 12) where the country looks to being able to leverage more foreign direct investment.

In Kenya, climate change related issues are funded by various ministries, which implement climate change related activities. Over and above this, there are several NGOs and Community Based Organisations (CBOs) who harness funds from various sources.

Private sector involvement in research and development including those related to climate change and technology transfer is minimal. Efforts will be made to interest the sector in this aspect of research. Efforts will also be made to relate climatic information to socio-economic factors.

2.6. Policy and Institutional Arrangements

Policy priorities for developing the above sectoral components focus on:

a) Developing industrial and technological capacities for eradicating poverty and reducing reliance on primary production. The national development plan for 1997 – 2001 says the country should achieve a newly industrialised country status by the year 2020.
b) Promoting environmental conservation and sustainable use of resources.
c) Adapting relevant (appropriate) and affordable technologies for efficient resource use.
d) Repaying debt.

2.6.1 Policy and Plans for Sustainable Development

Policies for sound environmental management and sustainable use of resources and appropriate responses to climate change are articulated in a number official documents. Steps are already being taken to develop a policy for guiding strategies for developing and implementing adaptation and mitigating impacts of climate variability and change. Some of the existing policies and plans are:

a) Sessional Paper No.6 of 1999 on Environment and Development.
b) The National Environmental Action Plan (NEAP) of 1994.
c) National Biodiversity Strategy and Action Plan.
d) Environmental impact assessment regulations, guidelines and procedures.

2.6.2 Sectoral Policies

The management of climate change issues is shared by a number of institutions that administer it from their sectoral concerns. The sector specific policies relevant to mitigation of climate change include:

a) Agricultural policies that emphasize sustainable agricultural production, prohibit clearing of catchments, river basins and cultivation on riverbanks.
b) Forestry policy: It protects indigenous (including catchments forests) and plantation forests, encourages re-forestation, sustainable forest cultivation for firewood, industry and construction, and prohibits extension of settlements into gazetted forests.
c) Sustainable population policy.
d) Energy policy which calls for energy use efficiency, utilization of renewable energy and cleaner

technologies, improved forestry management, etc.

e) Water policy that protects water catchments from deforestation.
f) The industrialization policy which promotes sustainable industrial development and development of technologies for clean production.

Some of the above policies provide for incentives. In particular, the Finance Act of 1994/95 allowed duty free importation of anti-pollution devices.

2.6.3. Legal measures and Administrative Framework

The Environmental Management and Co-ordination Act (EMCA) of 1999 has provisions for economic incentives, enforcement, protection and conservation of the environment, environmental quality standards including issues relating to emissions, impact assessment and modalities for implementing international treaties, conventions and agreements. Sectoral laws are expected to be reviewed and harmonized with this framework law.

Preparation of EIA guidelines and related institutional and legal framework for all future development projects in the country is at an advanced stage. The development and implementation of economic instruments for the promotion of climate change adaptation and mitigation are ongoing.

The National Environment Secretariat (NES) is the focal point for all national environmental issues, including climate change. NES has a climate change secretariat headed by a senior officer. Climate change issues are coordinated by the Inter-Ministerial Committee on Environment (IMCE) with representation from all key ministries/departments, academic and research institutions, NGOs and the private sector. IMCE has created eight technical sub-committees on priority areas. The technical sub-committee on climate change is called the National Climate Change Activities Coordination Committee (NCCACC). The terms of reference for the NCCACC are:

a) Advice on implications of the commitments under the UNFCCC and other international agreements related to climate change.
b) Establish a networked database on climate change impacts, response strategies and research activities.
c) Advice on issues pertaining to the Global Environment Facility (GEF) or any other international financial mechanisms.
d) Translate the objectives of the UNFCCC and related protocols into national development priorities.
e) Harness and coordinate available national expertise, sectoral initiatives, resources mobilization, and strengthen human and institutional capacities as well as develop and harmonize multi-sectoral programmes.

The NCCACC policy recommendations reach the grassroots through institutional representatives, including the District Environment Committees (DEC).

EMCA has created an appropriate institution framework for the effective management of the environment, which once in place will supercede the existing structure. The new structure is as follows:

a) National Environment Council (NEC), which will be the overall policy making organ in government.
b) National Environment Management Authority (NEMA) is the implementation arm, with the following organs:
    - Management Board;
    - National environment trust and restoration funds;
    - Provincial and district environment committees;

- Environmental planning committees – at national, provincial and district levels;
- Environmental inspectors;
- Technical advisory committee on EIA;
- Standards Review and Enforcement Review Committee.

c) Environmental Tribunal.
d) Public Complaints Committee.

2.7. Conclusion

About 80% of Kenya's population depends directly on land and natural resources for their livelihoods. The impact of weather variability and climate change on land and natural resources has potential to severely affect the lives and livelihoods of most Kenyans. In this regard, the government has initiated policy guidelines for guiding strategies for developing and implementing adaptation and mitigation measures. These have the potential to abate increase of emission of GHG and therefore, mitigate climate change.

There is a definite institutional structure for climate issues. However, it is constrained by inadequate capacity and weak linkages and networking at all levels. Gender roles make climatic variabilities impact more negatively on the female gender. There is an attempt to link policy and gender, in particular on the area of energy. Information to assess potential climate change impacts on various ecosystems is limited. Attempts are being made to develop indicators of climate change.

Kenya has a relatively long history of collecting climatic data through systematic observations however inadequate, but the network of observatories, especially in ASAL will be strengthened. Major constraining factors are inadequate financial resources and failure to fully incorporate climate change issues in the development planning processes.

3. SUSTAINABLE DEVELOPMENT AND PLANNING

3.1 Introduction

Climate change and resulting weather variations will have great influence on sustainable development, especially in poor countries. The impact on Kenya by the El Nino event of 1997/98 bears testimony to this. The cost of the 1997/98 El Nino phenomenon was estimated at over US$200million, excluding the number of people who lost their lives, and economic opportunities. The disaster resulted in the reorientation of public investment from economic development to rehabilitation of infrastructure and other immediate emergency requirements.

An interplay of many factors contributed to the severity of the impacts. For example, roads and bridges were in need of repair and were therefore vulnerable to heavy rains and floods, as did inadequate health facilities.

Global climate change is a result of the amount of greenhouse gases emitted in developed countries. Kenya's contribution to the global emission is negligible. Kenya is vulnerable to climate change, which could be exacerbated by the following national circumstances:

a) The country is already experiencing water stress.
b) Food security has suffered serious and frequent adverse impacts from climate variability.
c) Natural resources productivity, including biological diversity has been severely affected by poaching, indiscriminate use, and pollution.
d) Vast areas suffer serious incidences of vector and water-born diseases because of inadequate health infrastructure.
e) The coastal zone is vulnerable to sea level rise.
f) Some infrastructural facilities are exposed to extreme climatic events such as flooding.
g) Desertification is being exacerbated by changes in rainfall and intensification of land use.

Traditionally, the low-lying, semi-arid and arid zones of northern Kenya and the southern rangelands are recognized as drought prone. Climatic variations have increased vulnerability to drought of the dry areas near Lake Victoria and the heavily settled areas in the Rift Valley. The effects of floods on the environment and human settlements have been aggravated by deforestation on hill slopes and riverbanks, which increase run-off and speed of water during heavy rains. Flooding has been experienced in the Lake Victoria Basin (Kano Plains), along the Tana, Yala and Nzoia rivers. There is a danger of downstream flooding due to possible collapse of dams in areas prone to earthquakes. Floods worsen incidences of water-borne diseases such as cholera, typhoid, bilharzias, and diarrhea.

The impacts of the extreme events have potential to destabilize development activities with increases in their frequencies. It is expected that the existing industrial and economic gains will be eroded unless the country's resilience to climate variability and change is enhanced.

3.2 Challenges and Responses

In view of potential and real impacts of climate change, there is need to integrate climate change concerns into the national planning and development processes. This would require wide ranging changes in government policies. For example, policy makers and planners will have to re-think conventional approaches. Environmental issues will increasingly assume a higher priority ranking, while economic and institutional measures and arrangements would have to be sufficiently flexible in order to adapt relatively fast to emerging trends or events. Enhancing the adaptive capability requires significant increased capacity in science and technology and formulation of policies that are sufficiently flexible and receptive to constant change. A higher premium will need to be placed on social learning.

Other important national challenges to sustainable development are: high population growth, increasing levels of poverty, public debt, trade liberalization, and inadequate resources.

a) *Population Growth Rate:* Kenya's population has been growing at an average rate of 2.9% per annum, thereby exerting pressure on natural resources. Pressure has resulted in increased evidence of desertification and loss of genetic resources. Policies and programmes for managing population growth will emphasize achieving a balance between population growth and desired environment conservation.

b) *Poverty:* Over 50% of the Kenyan population lives in absolute poverty. Poverty leads to over-use and destruction of the environment where short-term needs are pursued at the expense of environmental sustainability.

c) *Public Debt:* The country currently suffers an enormous debt burden. The debt service requirement leads to increased pressure on environmental resources to enhance production and improve incomes and revenues needed for debt servicing. Therefore, to ease pressure on resources, the government will pursue both the traditional mechanisms for debt relief and the HIPC initiative.

d) *Trade Liberalization:* The continuing wave of trade liberalization has exacerbated environmental problems. There is need, therefore for treaties and regulations that vigorously regulate pollution arising from commercial activities locally and internationally.

e) *Inadequate Capacities and Funds:* The government will continue to collaborate with all stakeholders, development partners, the private sector and civil society organisation in mobilizing resources required to implement environmental policies and regulations in accordance with the principles of sustainable utilization.

3.3 Other Environmental Management Concerns

Poverty leads to over-use and destruction of natural resources as the poor are forced to fulfill their short-term needs often at the expense of environmental sustainability. Environmental degradation contributes to climatic change, which often adversely affect biodiversity and ecosystem management, accelerate desertification and environmental disasters, as well as weaken pollution and waste management.

3.3.1 Biodiversity, Desertification and Ecosystem Management

Kenya is a party to the Convention on Biological Biodiversity (CBD), the Cartagena Protocol on Biosafety and the United Nations Convention to Combat Desertification (UNCCD). The government has prepared a National Biodiversity Strategy and Action Plan (NBSAP), and a National Action Programme (NAP) to combat desertification. The government has also developed a national policy to address conservation and sustainable utilization of wetlands. However, it will be necessary to incorporate climate change concerns into these policies and plans, including strengthening of early warning systems and mechanisms for monitoring food security, weather and climate variations and the environment as well as formulation of response strategies.

3.3.2 Environmental Pollution and Waste Management

Studies indicate a high presence of oxides of sulphur, nitrogen, carbon monoxide particulates, hydrogen sulphide and other organic gaseous pollutants in the main urban centres of the country. Most local authorities are unable to cope with demands for collection, treatment and disposal of wastes due to inadequate capacity and financial constraints. The City of Nairobi alone produces 1000 tonnes each day of solid wastes, 20% of which is collected. Sewage and solid disposal systems have become seriously inadequate. In addition, agricultural activities, industrial processes, and service

providers have become major polluters of the environment. All these environmental problems have serious implications on public health. The government is developing mechanisms for increasing participation of the private sector in waste management. Policies have also been developed to ensure that sewerage and sanitation systems will be considered alongside the development of water supplies. The strategies identified to minimize environmental pollution and improve waste management include developing air quality standards; promoting technologies that minimize harmful emissions; developing and enforcing a waste management policy, and enforcing all provisions of the Environmental Management and Coordination Act.

The effects of climate change poses risks for the stability and survival of ecosystems especially when combined with other threats to the natural and human environment. The current high frequency of the El-Nino/La-Nina episodes may be associated with global warming.

3.4 Institutional Framework

The National Environment Secretariat (NES) was established in 1974 in response to national and international concerns about the quality of human environment which culminated in the creation of the United Nations Environment Programme (UNEP) following the historic United Nations Conference on Human Environment held in Stockholm, Sweden, in June 1972. This new spirit underscored the need for the human race to bring environmental matters to the centre of the development process.

NES was mandated to coordinate the formulation and development of policies for the conservation, protection, enhancement and management of the natural and man-made environments working through the Inter-ministerial Committee on Environment (IMCE). A number of sub-committees of IMCE deal with various thematic areas of environment. For example, climate issues are the responsibility of the National Climate Change Activities Coordinating Committee (NCCACC).

3.5. Environmental Policy Interventions

The Kenya National Environment Action Plan (NEAP) of 1994 was developed through a popular and participatory approach. It made fundamental recommendations, including proposal for a new institutional framework; review and harmonization of environmental legislation; and harmonization and implementation of environmental impact assessment (EIA). These recommendations led to the formulation of the environment policy contained in Sessional Paper No.6 of 1999 on Environment and Development, and the enactment of the Environmental Management and Coordination Act of 1999.

The goal of Sessional Paper No.6 of 1999 on Environment and Development is integration of environmental concerns into national planning and management processes. It provides guidelines for environmentally sustainable development. The objectives, which are to be met include:

a) To conserve and sustainably utilize the natural resources including air, water and water catchments, land, soil fertility, flora and fauna.
b) To enhance public awareness and appreciation of the essential linkages between development and environment.
c) To initiate and encourage well coordinated programmes of environmental education and training at all levels of society.
d) To involve civil society organisations, private sector and local communities in the management of natural resources.
e) To support a coordinated approach to policy formulation on environmental matters.
f) To ensure all development policies, programmes and projects take environmental considerations into account.
g) To ensure that an acceptable environmental impact assessment report is undertaken for all public and private projects and programmes.
h) To develop and enforce environmental standards.

i) To enhance, review regularly, harmonize, implement, and enforce laws for the management, sustainable utilization, and conservation of natural resources.
j) To apply market forces, taxation and other economic instruments, including incentives and sanctions to protect the environment and influence attitudes and behaviour towards sustainable utilization and management of natural resources.
k) To ensure adherence to the "polluter pays principle".
l) To develop adequate national laws regarding liability and compensation for the victims of population and other environmental damage.

The Kenya National Environment Action Plan (KNEAP) of 1994 and the Environmental Management and Coordination Act of 1999 provide a basis for directing efforts to achieving the goal of sustainable development.

3.6. Macro Economic Framework for Sustainable Development

The National Development Plan for 2002-2008 recognizes that environmental and natural resource degradation constitutes a major challenge to Kenya's development efforts. The immediate challenge for Kenya is to reduce poverty and achieve sustained economic growth, while ensuring that environmental considerations are integrated in all major national and sectoral policies, plans, programmes, and decision-making processes. This calls for development of appropriate capacities and tools for identifying constraints and opportunities for sustainable development, taking into consideration the following influencing factors:

a) The satisfaction of human needs;
b) Technological, social and other limitations affecting the ability of natural resources to meet present and future needs of Kenyans;
c) Recognition that environment and development are interrelated; and
d) Emphasis on the ecological responsibilities of the present generation toward future generations.

The National Development Plan for 2002-2008; and the Poverty Reduction Strategy Plan for 2001/2-2003/04 are intended to ensure macro economic stability. The macroeconomic framework aims to revamp growth, raise productivity, encourage private investment, and drastically reduce unemployment and poverty. Poverty leads to environmental degradation as people use the land and other natural resources without regard to their potential to meet their future needs or those of succeeding generations.

The monetary strategies include maintaining price and exchange rate stability, low interest rate and vibrant financial sector and increasing access to credit. Price stability will be achieved by maintaining the annual average inflation at no more than 5% but still able to stimulate the economy by promoting growth and employment. The government will also endeavour to maintain a competitive real exchange rate that ensures favourable balance of payment positions and increased exports. Maintaining low interest rates and creating and sustaining a vibrant financial sector will be achieved by a reduction in the level of non-performing loans, restructuring oligopolistic banking, strengthening supervisory and regulatory roles of the Central Bank of Kenya and restructuring the domestic debt from short to long term.

Kenya's fiscal strategy aims at increasing the level of economic activity by enhancing the role of the private sector. This will be achieved through four key objectives: sustainable reduction in the level of public expenditure relative to GDP; reduction in the level of domestic debt relative to GDP, changing the composition of expenditure to focus more on efficient public investment and operations in the long run; and strengthening the budgetary process.

Economic policy measures and public investments will focus on creating economic opportunities for the poor in marginal and vulnerable regions by providing incentives to small-scale producers, smallholder peasants and traders. The growth strategies contained in the PRSP aim to:-

a) Ease access to markets and market opportunities by the poor through provision, of infrastructure, attractive and affordable credit, etc.
b) Improve effectiveness of public resources geared towards poverty reduction.
c) Enhance protection of marginalized and vulnerable groups.
d) Allocate increased resources to human capital development.
e) Promote improved productivity.
f) Improve conditions in the labour market.

3.7 Conclusion

There is need to integrate climate change concerns and sustainable principles in all national development plans and programmes in order to ameliorate the negative effects of poverty, provide basic needs and meet peoples' aspirations for a better life and ensure effective environmental management. Kenya will continue addressing the challenges of poverty, population growth, debt, trade and capacity requirements among others in order to fully mitigate the impacts of climate change but would need assistance to achieve these objectives.

4. INVENTORY GREENHOUSE GAS EMISSIONS AND SINKS

4.1 Introduction

Paragraph 1 of Article 4 of the United Nations Framework Convention on Climate Change (UNFCCC) requires parties to develop, update periodically and submit to the Conference of the Parties (COP), national inventory of all anthropogenic greenhouse gases emissions not controlled by the Montreal Protocol by sources and removals by sinks, to the extent their capacities permit, using comparable methodologies agreed upon and promoted by the COP. Kenya being a signatory to the UNFCCC has already undertaken some studies related to climate. These include:

a) The United States Country Studies Programme (USCSP) in 1994; GHG emission inventory was carried out for land use change, energy, industry, agriculture and waste management
b) The UNDP/GEF Capacity Building in Sub-Sahara Africa to Respond to UNFCCC (1996-1998); GHG Inventory for the year 1992. This later inventory was updated to 1994 in order to meet the requirements of the UNFCCC guidelines. No further work has been carried out to address the gaps identified in these two studies.

Due to the time limitation in the UNDP/GEF Capacity Building Project, the GHG inventory could not take into account the great variations in climate, soils, topography, animal and crop species, especially at provincial and district levels. Most constraints and gaps identified were due to lack of comprehensive data storage and management systems on an annual basis. Furthermore, it was difficult to obtain information on many newly introduced industrial processes. However, the information can be obtained if sufficient time is allowed for studying these processes under the local conditions and establishing empirical values of emission factors.

The studies considered five major sectors in Kenya: energy (fossil fuels, lubricants and woody biomass); industrial processes (cement production, lime use, soda ash production); agriculture (rice cultivation and livestock production); land use change and forestry (forest clearing, biomass harvest, abandoned managed lands and burning of savannah including grasslands); and wastes (urban solid waste and wastewater). Revised 1996 IPCC Guidelines for National GHG inventories were applied in all.

The GHG which were considered in the study include; carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), oxides of nitrogen (NO_X) and non-methane volatile organic compounds (NMVOCS). Data were collected from records of various departments of the Kenya government and other sources.

4.2. Methodology and Sources

Greenhouse gas emissions and sources and removals by sinks was calculated following the revised 1996 IPCC Guidelines .The data used were collected from various sources including Ministry of Energy, Central Bureau of Statistics, Kenya Petroleum Refineries, Kenya Pipeline Company (KPC) and the National Oil Corporation of Kenya (NOCK), Ministry of Agriculture, Forest Department, DRSRS, FAO and private sector. IPCC default values were used to fill gaps. As local emissions factors have not yet been developed emission factors recommended by IPCC were adopted except in the case of cement and lime production processes

4.3. Emissions from Energy Sector

Various forms of energy are used in Kenya, the main ones being petroleum products, coal, lubricants and woody biomass (Table 4.1).

Greenhouse gases emissions from the energy sector include fuel combustion as well as fugitive fuel emissions, but exclude CO_2 emissions from combustion of biomass that are addressed in land use change and forestry sector. Such information could have been obtained if funds were allocated for

studying these processes under local conditions and establishing empirical emission factor values for proper estimation of GHG emissions.

Table 4.1. Fuel consumption (PJ) and emissions in 1994

Liquid Fuel	*Crude*	*Gasol.*	*Jet Kero sene*	*Gasoil*	*Lubri cation oil*	*Ref.Fd*	*Coal*	*TOTAL*
Apparent (ToE) Consumption	2107.90	139.72	490.07	139.94	10.68	101.54	76.00	
Conversion Factor	41.868	41.868	41.868	41.868	41.86	41.868	41.868	
App. Cons (PJ)	88253	5849.9	20518	5859.0	447.23	4251.2	3181.9	63905.9
Emission Factor	20.0	18.90	19.50	20.20	20.00	20.00	25.80	
Carbon Content (Gg C)	1765.0	110.56	-400.10	118.35	8.9947	85.025	82.094	1312.09
Carbon Stored (Gg C)	0	0	0	0	4.4723	0	61.571	66.0433
Net Emissions (Gg C)	1765.0	110.56	400.10	118.35	4.4723	85.025	20.523	1246.02
Carbon Oxidised (Fraction)	0.990	0.99	0.99	0.99	0.99	0.99	0.98	
Actual Emissions GgC)	1747.4	109.45	396.10	117.16	4.4276	84.175	20.113	1233.31
Actual Emissions (Gg CO_2)	6407.2	401.34	1452.3	429.61	16.234	308.64	73.748	4522.45

Source: Ministry of Energy

PJ = Petajoules; TOE = tons of oil equivalent; Ref.Fd = refined feedstock

4.3.1 Carbon Dioxide Emission Process from Energy Fuels

The quantity of carbon is based mainly on the supply of primary fuels and the net quantities of imported secondary fuels.

(a) *Stored Carbon:* Not all fuels supplied to an economy are burned for heat energy. Some is used as raw material for manufacture of products such as plastics or in a non-energy use, without oxidation of the carbon. This is termed stored carbon and is deducted from calculated carbon emission. Stored carbon was estimated from used fuel.

(b) *International Bunker Fuels*: Emissions from fuels used by international marine and air transport are excluded from national emission totals.

(c) *Biomass Fuels*: Biomass fuel is included in national energy and CO_2 emission accounts for information only. In the energy module, biomass consumption is assumed to equal its re-growth. The other forms of biomass are accounted for in the land use change and forestry sector.

Production and imports of each fuel were added together and the exports, bunkers and stock changes were subtracted in calculating the apparent consumption of fuels.

According to the IPCC guidelines carbon from the manufacture of secondary fuels are ignored in the main calculations as they are already accounted for in the supply of primary fuels. However, information on production of some secondary fuel products is needed to adjust carbon stored in these

products. The procedure calculates the supply of primary fuels to the economy with adjustments for net imports (imports-exports), bunkers and stock changes in secondary fuels.

4.3.2 Fugitive Emissions from Oil

The imported crude oil contains a certain amount of gas (mainly methane). Some of the gas evaporates or vents into the atmosphere during storage. During the refining process of crude oil into hydrocarbon products such as gasoline, diesel, LPG, etc, dissolved gases are separated, some of which leak into the atmosphere as CH_4. The emission factor used was that between 90 – 1,400kg/PJ* (for oil refinement) and between 20 – 250km/PJ (for storage tanks). An average of 880kg/PJ was calculated and used. Methane emissions in 1994 were only 0.076Gg/yr .

4.3.3 Emissions from Burning Traditional Biomass Fuels

Specific ratios of methane and CO to total carbon, N_2O, and NO_x were used to estimate trace gas emissions. Biomass fuel consumption estimates used were based on household surveys undertaken by the Ministry of Energy. The results of trace gas emissions are given in table 4.2.

Table 4.2. GHG emissions from biomass fuel consumption in Kenya (1990 – 1995)

Year	Biofuels	CH_4 Gg/Yr	CO Gg/Yr	N_2O Gg/Yr	NO_x Gg/Yr
1990	Fuel wood	121.309	1061.465	0.834	30.143
	Charcoal	4.475	335.575	0.264	9.529
1991	Fuel wood	126.349	1105.564	0.869	31.395
	Charcoal	4.659	349.435	0.275	9.923
1992	Fuel wood	131.629	1151.764	0.905	32.709
	Charcoal	4.853	363.995	0.286	10.337
1993	Fuel wood	137.117	1199.783	0.943	34.073
	Charcoal	5.057	379.255	0.299	10.771
1994	Fuel wood	142.876	1250.182	0.998	35.502
	Charcoal	5.268	395.074	0.311	11.221
1995	Fuel wood	148.876	1302.481	1.023	36.994
	Charcoal	5.489	411.734	0.324	11.694

* = t/t = tonne of pollutant per tonne of product
** = kg per hectalitre
*** = hectalitres (quantity of measurement used for beverage)

Sources and sink categories	Activity data	*Emission estimates*						*Aggregate emission factors*					
	A Production Quantity (kt) or hl	B Full Mass of Pollutant (Gg)						C Tonne of pollutant per tonne of Product (t/t)* or kg/hl**					
		CO	CO_2	CH_4	N_2O	NO_x	NMVOC	CO	CO_2	CH_4	N_2O	NO_x	NMVOC
D Organic Chemicals													
Beer Production	3027000***						0.106						0.035
Spirits	16740***						0.251						15.0
Bread Making	156.27						1.25						0.008
Sugar Processing	3038.70						3.04						0.01
E Non-Metallic Mineral Products													
Cement	1541.72		943.69						0.6121				
Lime	30.47		24.07						0.79				
Soda Ash	224.20		21.75										
Pulp and Paper	364.80	2.043				0.55	1.35	0.0056				0.0015	0.0037

Table 4.3. Estimated emissions and emission factors for industrial processes

4.3.4. Conclusion

The most significant GHG emitted from the energy sector in 1994 was CO_2, amounting to 4522.45 Gg. Emissions largely came from fossil fuel combustion. The other gases emitted were CO (1645.256 Gg), CH_4 (148.144 Gg), NO_x (46.723 Gg) and N_2O (1.309 Gg).

4.4. Industrial Processes

GHG emissions from industrial processes include those from cement production, Lime production, soda ash manufacture, and non-volatile organic compounds. Their emission factors and estimated emissions are presented in table 4.3.

4.4.1 Carbon Dioxide Emissions from Cement Production

Carbon dioxide emissions were estimated by applying an emission factor (a constant), in tonnes of CO_2 released per tonne of clinker produced to the total amount of clinker produced. The emission factor that was locally derived has a value of $0.6121tCO_2/t$ clinker. Carbon dioxide emissions from cement manufacturing were estimated as 943.69 Gg of CO_2.

4.4.2 Carbon Dioxide Emissions from Lime Manufacture

Lime is used in pulp and paper industry, construction materials, effluent treatment, water softening, pH control and soil stabilization. Lime production involves three main processes: quarrying the raw materials, crushing and sizing, and calcining at high temperatures of around 1100^oC to produce lime and calcium hydroxide. Carbon dioxide is generated during the calcination stage, when calcium carbonate or a combination of calcium carbonate materials is roasted at high temperatures. Carbon Dioxide is produced as a by-product of this process, just as CO_2 is released during clinker production.

An emission factor (EF Lime) of $0.79CO_2/t$ quicklime was used. This emission factor is for lime kiln-calcite feed, which is the one used in this case since most of the lime in Kenya is calcite based. In

1994, 24070.510 tonnes equivalent to 24.07 Gg of CO_2 were emitted from the manufacture of 30469 tonnes of lime in Kenya (table 4.4).

4.4.3 Carbon Dioxide Emissions from Soda Ash Manufacture

Soda ash (sodium carbonate, Na_2CO_3) is a white crystalline solid that is readily soluble in water and is strongly alkaline. Commercial soda ash is used as raw material in a variety of industrial processes, including glass manufacture or simply as an alkali material, which reacts with, and neutralizes acids or acidic substances. Kenya produces only natural soda ash.

During the production process, trona (the principal ore from which natural soda ash is made) is calcined in a rotary kiln and chemically transformed into a crude soda ash that requires further processing. Carbon dioxide and water are generated as by-products of the calcination of trona.

The Central Bureau of Statistics reported that 224200 tonnes of trona were mined for soda ash production in 1994. Using an emission factor of 0.097 tonnes CO_2/tonne of trona, approximately 21747.40 tonnes or 21.75 Gg of carbon dioxide was emitted.

4.4.4 Emission of Non-Methane Volatile Organic Compounds

In the absence of locally derived emission factors, the emission factors in the EMEP/CORINAIR guidebook were used.

a) Emissions from pulp and paper manufacture came mainly from three major processing steps, namely: pulping, bleaching, and paper production. The type of pulping and the amount of bleaching used depend on the nature of the feedstock and the desired quality of the end product. The only plant producing paper uses the Kraft process. In 1994, 364800 tonnes of pulp was produced, which resulted in emission of 550.200t (0.55Gg), 1350.760t (1.35 Gg) and 2040.880t (2.043Gg) of NO_x, NMVOC and CO, respectively.

b) Emission data from food and beverages manufacture was only obtained for beer and spirits. In 1994, 3027000 hl of beer were produced contributing 0.106 Gg NMVOC to the atmosphere. For spirits 16740 hl were produced contributing 0.251 Gg of NMVOC to the atmosphere.

c) Emissions data for only sugar and bread were available from manufacturer of bread and other foods. The emission factor of sugar is 10 kg/tonne of sugar produced and that of bread is 8 kg/tonne of bread. Sugar production in 1994 was 303870 tonnes contributing 3.04 Gg of NMVOC. Bread production for the same period was 156270 tonnes contributing 1.25 Gg of NMVOC to the atmosphere.

4.5. Agriculture including Livestock Production

Agriculture is the main economic activity in Kenya upon which over 80% of the population directly depend for their livelihoods. Over 75% of this agriculture is mostly smallholder peasantry that is characterized by low farm inputs, low yields and low-level crop and land husbandry. Fertilizer usage is low, at an average of 25 kg per hectare. As a result, direct GHG emissions from soil at 0.000648 is quite insignificant hence is currently a major concern in the inventories. Irrigation development remains low as it presently accounts for less than 3% of the country's agricultural produce. The study covered emissions from enteric fermentation in domestic livestock, animal wastes, flooded rice fields, burning of agricultural residues and use of nitrogenous fertilizers.

Agricultural statistics were obtained mainly from the Ministry of Agriculture and the Central Bureau of Statistics. Although the statistics for 1990 – 1994 they are had the following limitations:

a) National statistics for camel population are available only after 1993, consequently 1993 camel population were used; and

b) Upland rice production figures are available only after 1993. In this study the upland rice production has been assumed to be 10% of the total (which is the average for the period 1993 – 1995).

4.5.1 Methane Emissions from Enteric Fermentation and Wastes from Domestic Livestock

In Kenya, domestic livestock is mostly reared on the range and paddocks. Confinement in stalls is practiced in pig farming from which manure is often stored in solid form around stalls. Anaerobic lagoon systems for treating animal wastes are not practiced within the country. The GHG emissions from animal waste systems were negligible compared to that from enteric fermentation. Total CH_4 emissions from domestic livestock were 573 Gg for the year 1994. (Table 4.4).

4.5.2. Methane Emissions from Flooded Rice Fields

Anaerobic decomposition of organic matter in flooded rice fields produces methane, which escapes into the atmosphere. About 90% of rice grown in Kenya is paddy rice, which is grown under conditions of continuous flooding. However, at some 15,000 hectares, the acreage under rice in Kenya is small. Using IPCC methodology and default factors, total methane emission was 3 Gg in 1994 (table 4.4).

Table 4.4. Summary of emissions of gases from the agricultural sector for 1994 in Gg

Sub-sector	**Type of gases**			
	CH_4	CO	N_2O	NO_x
Enteric Fermentation	549.21			
Anima Wastes	23.42		0.036	
Rice Cultivation	3.0			
Burning of Agri. Resid.	0.0023	0.048	0.00010	0.0026
Synthetic Fertilizers			0.0006	
TOTAL	575.632	0.048	0.0367	0.0026

4.5.3 Emissions from Burning of Agricultural Residues

It is estimated that as much as 40% of agricultural residues produced in developing countries are burnt in the fields as a means of field clearing, a common practice in Kenya. However, some of the residues are removed and used as energy sources or as animal feed (e.g. maize cobs and stover, pigeon pea stems, etc.). Burning of these residues emits CO_2, CH_4 and N_2O. For Kenya, 25% is taken as the fraction of agricultural residue that is burned in the field for crops like rice, millet and sorghum, while 75% and 100% is the corresponding ratios for maize and sugar-cane respectively. The resulting emissions are in the range 0.0001-0.0023 Gg/year. The burning of agricultural residues is therefore not a major emitter of GHG in Kenya. According to IPCC guidelines an amount equal to the emissions is taken up by the crops that grow during the year.

4.5.4. Direct Nitrous Oxide Emissions from Agriculture

Only direct emissions of nitrous oxides due to the application of synthetic fertilizers whose statistics are available have been computed. The indirect emissions due to greenhouse farming, leaching into ground water and cultivation of organic soils have not been calculated, nor have the emission from manure application or nitrogen due to biological fixation. The computations show that the emissions

from this agricultural sub-sector were insignificant at 0.000648Gg/year. This may be explained by the fact that fertilizer usage is low at an average 25kg/year/hectare.

4. 6. Land Use, Land Use Change and Forestry

Land use change and forestry inventory used the 1996 IPCC guidelines. Unfortunately. the IPCC guidelines could not incorporate land users' data collection methods that are thought important and practicable in areas outside designated forests. The methodology adopted delineates appropriate emission and sink categories, describes the processes and identifies emission sources and sinks. The data was collected from the Forest Department, private sector, DRSRS, FAO, and IPCC documents. Average or IPCC default values were used to fill gaps.

They are few undisturbed primary forests in Kenya. Most indigenous vegetation has been altered through changes in land use and hence altering the forest cover. Changes in land use and alteration in forest has significant influence on GHG emissions because these activities lead to either retention or release of carbon as well as other elements. The extent to which these alterations have contributed to GHG emissions has not been fully established due to various uncertainties. GHG emissions associated with use change and forestry are carbon dioxide ($CO_{2)}$ and non-carbon dioxide, nitrous oxides (N_2O), carbon monoxide (CO), methane (CH_4) and oxides of nitrogen (NO_x).

4.6.1 Emission and Sink Processes

a) The least amount of carbon is released from commercial harvests and plantations. The total wood consumed was 25,526ktdm giving an annual carbon dioxide released of 26,416,555Gg. Total carbon dioxide released as a result of on-site burning and decay of biomass, was estimated at 6404.34Gg.

b) In the sink process, non-forest trees have the highest carbon uptake followed by natural forests due to the very large area it covers, being 87850 and 3386 kha (kilo hectares) respectively. Their carbon uptakes were 17570 and 1281 kt respectively. However, plantation forests have the highest carbon uptake per unit kha at 5.910kt whereas non-forest trees have the lowest at 0.2kt per kha, while natural forests have carbon uptake of 0.378kt per kilo hectare (table 4.5).

c) The area of CO_2 sink was determined and quantified for naturally re-growing forests, plantations and non-forest trees for the first 20 years. It was found that the total carbon uptake from abandoned lands is 2,250ktC.

d) Abandoned managed lands have minimal carbon uptake because fallowing periods have reduced significantly over time. Abandoned managed forests covered an area of 225kha and the Carbon uptake was estimated at 8250KtC (Table 4.6). Biomass growth exceeds biomass harvests because of abandoned forests, which tend to increase biomass during growth. Carbon intake by abandoned managed lands is lower than carbon release making them a net absorber of GHG. Similarly, carbon intake by the vegetated lands is higher than carbon release hence there is a net absorption of carbon dioxide making Kenya a net CO_2 sink.

Table 4.5. Sources and quantities of carbon sink in land use Kenya

Biomass type	Biomass area (kha)	Biomass uptake kt C	Carbon uptake per kha
Plantation	189.1	1117	5.91kt
Natural forest	3386.0	1281	0.38kt
Non-forest trees	87850	17570	0.20kt

Table 4.6. Net release of carbon dioxide

Carbon Activity	Uptake: Amount absorbed Gg CO_2	Carbon Activity Released Gg CO_2	Released Carbon Amount Released Net Gg CO_2
Annual growth	26416.555	Annual harvest	
Abandoned lands	8250	Forest conversion	6404.3357
Total	34666.555		

4.6.2. Non-Carbon Dioxide (Trace) Gases

Non-carbon dioxide gases (CH_4, CO, N_2O and NO_x) are released to the atmosphere as trace gases during forest clearing activities and subsequent burning of cleared biomass. Non carbon dioxide gases are also released as a result of changes in land use.

a) *Methane (CH_4):* Methane emission process involves anaerobic decomposition of vegetation, soil carbon and organic debris in a hydrological or other man-made water reservoirs during flooding. Methane sink process occurs during drainage and filling of wetlands. Methane emission and sink processes are difficult to assess because the emissions are highly variable and depend upon flooded ecosystem type and status; depth and length of flooding; and the rate of emission is controlled by temperature, seasonality or diurnal fluctuations. Methane uptake on the other hand, varies with soil water content and temperature. It is not clear if it is a significant process in Kenya.

b) *Carbon Monoxide (CO):* Carbon monoxide emission results from land flooding following construction of man-made reservoirs and aerobic decomposition of organic matter and vegetation accumulating at the bottom of reservoirs. Carbon monoxide is also emitted by dry soils during chemical decomposition of humus and by increases of soil temperature, moisture and pH. Wetlands therefore increase production of CO. Carbon monoxide destruction, however, outweighs production. Assessment is difficult and is of uncertain importance since CO eventually becomes CO_2. In Kenya, CO emission is considered to be insignificant.

c) *Nitrous Oxide N_2O:* IPCC describes emissions of N_2O as resulting from land flooding following construction of man-made dams for hydroelectric power. The flooding subsequently leads to anaerobic decomposition of vegetation and accumulated organic debris. IPCC recognises that net emissions of N_2O due to flooding are not well determined, difficult and of uncertain importance at global scale. In Kenya, they are also of uncertain importance since water bodies are not significantly many and data on extent of flooding is not available.

Natural dry land soils also emit N_2O during nitrification and denitrification process. A change in land use resulting from draining of wetlands increases emission possibilities. Again, the estimates are highly uncertain as emission measurements vary temporally and spatially. The measurements are not consistently correlated with soil temperature, moisture and vegetation composition and types. In Kenya wetland drainage is small.

4.6.3 Quantification of non-CO_2 Gases from Land Use Change

Data on the area of hydroelectric reserves and other man made reservoirs are not available, as are the number of days in a year that an area is flooded. The area of wetlands drained and the average daily CH_4, N_2O, CO emission rate before and after draining could not be obtained. Also the number of days in a year a wetland is emitting gases is not recorded. Default data are averaged growth rates for elements sited beyond territorial borders. They exhibit variability within regions and even from site to site. Future communications will attempt to quantify non-CO_2 gases from land-use change.

4.7. Waste Management

The main solid waste disposal method used in Kenya is open dumping. Some recycling is usually facilitated by uncontrolled scavenging. It is estimated that not more than 20% of solid waste generated in (large) urban areas is disposed off in the municipal solid waste disposal sites (SWDS). Such situation leads to aerobic decomposition with little methane (CH_4) emissions.

Total pollution was estimated by combining industrial and residential/commercial loads. Commercial and institutional loads were assumed to have been included in the non-industrial flows. There is little data on industrial sludge in Kenya. Wastewater is usually under the water and sanitation sections/departments where the main focus is on water management rather than wastewater management. The wastewater data consists of assessments of biochemical oxygen demand (BOD) and chemical oxygen demand (COD), which are not carried out on a consistent basis.

In rural areas, where settlements and/or homesteads are generally stand alones in agricultural areas. Refuse collection and disposal is informal and scattered. Wastewater treatment is virtually non-existent due to the predominant use of pit latrines, septic tanks and other informal methods of human waste disposal and the dispersed nature of settlements. For industries and institutions, a certain level of treatment is achieved. On the other hand, urban settlements are more nucleated with higher population concentrations. They therefore generate higher quantities of waste and have higher potential to generate greenhouse gases because of their concentration.

4.7.1. Emission of Methane from Solid Waste Management

Many urban centres in Kenya have established systems of waste management. The big towns on average have formal systems of municipal solid waste management and wastewater treatment. Most of these towns, however, predominantly use shallow, unmanaged and uncontrolled solid waste disposal sites (SWDS), which are neither covered nor compacted. The rate of generation of emission of methane gas (CH_4) from these sites is highly reduced due to the high rate of oxidation associated with their open nature. It was also observed that the existing solid waste management systems only covered small portions of urban areas. Most of the new and expanding residential and commercial sectors, and unplanned settlements are not served, while the main market areas are partially served, while.

This study considered only the wastes generated in urban areas. Waste generated in rural areas will be considered in subsequent communications.

4.7.2 Waste Water Handling

Water coverage in Kenya is estimated at 50% and 75% in the rural and urban areas respectively. Out of the 142-gazetted urban centres in Kenya, only 30% have sewerage systems with only 28% of them connected. Many of the systems suffer from constant breakage or leakage and inadequate capacity to handle their sewage load.

Many towns have anaerobic ponds, sewerage treatment systems with anaerobic treatment, and septic tanks. Most of these facilities however, serve relatively small sections of the central commercial zones and industrial areas as well as the high and medium income residential zones. Large sections of the towns, especially the unplanned informal residential zones do not have wastewater handling services.

The data required for estimation of GHG emissions in this sector include population covered, waste characteristics and handling. The total methane emission from the waste sector was estimated at 15.185 Gg.

4.8 Conclusions and Way Forward

The greatest problem encountered in developing the inventory of greenhouse gases included data unavailability or their unsuitability for inventories, particularly data on trends and rates of land use change. It was not possible to calculate carbon dioxide emissions from soils because of inadequate data and the high variability of soil carbon content. Available land use and forest data are in published literature, which emphasize scientific and not traditional usage of forests. The initial study to inventory GHG was carried out in 1992 under the UNDP/GEF funded project: Capacity Building to Sub-Sahara Africa to Respond to UNFCCC. The study did not take into account the great variations in climate, soils, topography, animals and crop species, especially at provincial and district levels. Most constraints and gaps identified were due to lack of comprehensive data storage and management systems on an annual basis, especially for industries. Additionally, there is lack of information on many newly introduced industrial processes. The quality of data and information reported can be improved if sufficient time and financial resources is allocated for studying these processes under local conditions and establishing empirical values of emission factors.

This study showed that Kenya is a net absorber of carbon dioxide (absorbing about 2,275 Gg of CO_2 per year). However, the role of farmland trees in carbon sequestration has not been fully quantified. Consequently, there is need to harmonize land use and forestry activities in order to facilitate data inventory.

Carbon dioxide is the major greenhouse gas emitted mainly from the energy sector (Table 4.7). In 1994, the energy sector emitted 4522.45 Gg of CO_2. These emissions largely came from fossil fuels, particularly from the transport sector, which is the largest consumer of petroleum products. The other gases emitted were carbon monoxide and methane estimated at 1645.3 and 344.8 Gg respectively. Oxides of nitrogen (NO_X) and nitrous oxide (N_2O) accounted for 46.7 and 2.61 Gg respectively. Sugar production was the most significant emitter of NMVOC, accounting for about 70% of total NMVOC emitted in 1994, followed by pulp and paper industry (about 29%) and beer production (1% of the total). Carbon dioxide (CO_2) emission during cement production processes represented the most significant non-energy source, being 944.0 Gg of CO_2 (95.3% of industrial carbon dioxide emissions) in 1994. Lime and soda ash production emitted 24.1 and 22.0 Gg respectively. Land use change and forestry absorbed from the atmosphere 28261 Gg of CO_2 making Kenya a net sink of CO_2. Significant emissions of nitrous oxides and oxides of nitrogen (NO_x) were from burning of biomass energy and pulp and paper industry. The greatest proportions of NMVOC were emitted from food and beverage production and some proportion from pulp and paper production. Carbon monoxide emission from pulp and paper production was 2.04 Gg in 1994. About 95.6 (573 Gg) of CH_4 emission was from enteric fermentation in herbivorous animals.

The country urgently needs to fund a programme to collect and analyses data regularly in all the five sectors, especially land use, forestry, agriculture and industry. It will also be necessary to build capacity of the national focal point as well as those of local authorities to collect and store data from the various sectors of the economy, especially baseline data. Further, there is need to develop and use national/regional emission factors that suit national circumstances better than IPCC default emission factors. The national focal point should, therefore develop an information management systems for archiving and updating inventory data. This will require acquisition of computing facilities using IPCC software and harmonization of data collection and storage and up dating of GHG emissions. Its establishment should be preceded by a detailed and systematic needs assessment exercise.

Table 4.7: National greenhouse gases emissions by sources and removals (for all greenhouse gases not controlled by the Montreal Protocol).

Greenhouse Gas Source and Sink Category	*Em. Factor*	*CO (Gg)*	*CO_2 (Gg)*	*CH_4*	*N_2O*	*NO_x*	*NMVOC*
Total (Net) National Emission (Gigagram per year)		***1656.8***	***-22751***	***750***	***1.4***	***50.9***	***6.0***
1. Energy	***0.000001***	***1645.3***	***6167.3***	***344.8***	***2.61***	***46.7***	***-***
Fuel Combustion			4522	148	1.30		
Energy and transformation industries			-	-	-		
Industry			-	-	-		
Transport				-	-		
Commercial-institutional			-	-	-		
Residential			-	-	-		
Other (please specify) - Storage			-	0.8	-		
Biomass burned for energy - Fuelwood - Charcoal			 1250.2 395.1	 143 5.3	 1.00 0.31	 35.5 11.2	
Fugitive Fuel Emission			-	0.1	-		
Oil and natural gas system			-	0.1	-		
Coal mining			-	-	-		
2. Indusrial Processes	***45.3341***	***2.04***	***990.1***	***-***	***-***	***0.55***	***5.997***
Cement Production	0.6121		944.0	-	-	-	-
Lime Production	0.79		24.1	-	-	-	-
Soda Ash Production	0.097		22.0	-	-	-	-
Pulp and Paper - Kraft NO_x Kraft NMVOC	1.5 3.7 5.6	 2.04				0.55	 1.35
Alcoholic Drinks - Beer - Spirits	 0.035 15.0						 0.106 0.251
Bread and Sugar Production - Bread - Sugar	 8.0 10.0						 1.250 3.040
3. Agriculture		***0.048***	***-***	***575.632***	***-***	***-***	***-***
Enteric Fermentation	*[1]		-	549.21	-		-
Animal Wastes	*[1]			23.42			
Rice Cultivation	*[1]		-	3.0	-	-	
Burning of Crop Residues	*[1]	0.048		0.0023			
Savanna Burning	*[1]		-	-	-		
Others (please specify)	*[1]		-	-	-		
4. Land Use Change and Forestry		***9.4***	***- 28261***	***11***	***0.1***	***2.7***	***-***
Changes in Forest and other woody biomass stock			+26417				
Forest and Grassland Conversion			+6406	11	0.1		
Abandonment of Managed Lands			-8250	-	-		
5. Wastes			***-***	***15.185***	***-***	***-***	***-***
Solid Waste Management				6.745			
Wastewater and Sludge Treament				8.440			

(+) Before a number means Convert to CO_2 Annual Emission (-) Means a Removal of CO_2 or a Sink *[1] The Emission factors are provided elsewhere Annex 1.

Research efforts will be used to identify other potential sinks of carbon dioxide such as coffee, tea, coconuts and cashew nuts that are excluded in the IPCC methodology. This is because Kenya has large areas under these crops that are major sinks of greenhouse gases. Efforts will be expanded to develop a more comprehensive list of data sources for the industrial sector, including medium and small-scale industries.

A deliberate effort to build capacity and create awareness in data collection, data storage, data management and data availability. Data sources should be identified by the type of GHG, amount emitted, emission processes and/or their potential to emit GHG. The inventories should ensure data quality through verification and validation, and establishment of some confidence levels.

There is need to build the institutional capacity to carry out research and training on climate change issues in support of the preparation and reporting of national GHG inventory.