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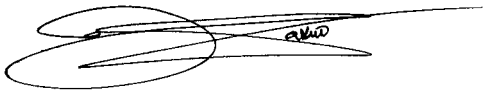
IIt is my sincere hope that the capacity which this process has developed has laid a solid foundation within the City Council of Nairobi to undertake regular assessment of its environmental performance to guide sustainable development planning of the city.

Thank you



John Gakuo
Town Clerk

FOREWORD

Nairobi, like many cities in Africa is experiencing rapid population growth. Combined with the fact that the city is also the economic hub of Kenya and, indeed, of the east and central African region, this means a higher number of inhabitants with lifestyles that demand high energy, more land for the built environment, and increasing consumption of natural resources. In order to mitigate the negative impacts of such growth, there is need for strategic planning which goes in tandem with the pace of development. This can only be achieved through a solid information base to support decision making.

The Government of Kenya believes that a well planned city is the foundation of a strong and adaptable regional economy. In addition to providing employment and shelter, the city is a centre of culture, learning and technological development, a link to the rest of the world, an industrial centre and a place for the generating of income. Proper management of Nairobi city is therefore an important strategy of my ministry in its mission to improve the livelihood of the citizens and maintain reasonable economic growth of the country. Decentralization of local governance has been fundamental in realizing the success that we have recorded thus far.

The transfer of certain responsibilities through subsidiary and decentralization is emerging as an effective way to ensure more timely policy development and implementation. Responsibility for many aspects of environmental and social health and safety lies at the local or municipal level, where action is crucial for poverty reduction, improvement of local environment and provision of early warning on issues of current or potential national and international prominence. For the local authorities like the City Council of Nairobi to perform these responsibilities, timely and up to date information is crucial.

The production of the City of Nairobi Environment Outlook Report is therefore very timely and its successful preparation is clear testimony to the Government's determination to strengthen the planning capacities of all its institutions at various levels. The report will enable us to take stock of the city's environmental performance, to look into the future and assess the various policy options for consideration in the formulation of the City's development strategy.

The process of producing the report largely owes its success to ¬– and merits special commendation for – its participatory nature. It has fostered the participation of different stakeholders in identifying and building consensus on the key issues of environmental concerns in the city, and cultivated a sense of ownership. The report has proposed actions, to which I expect the City Council of Nairobi to give due and timely attention.

It is also my sincere hope that the report will be useful to all who support the sustainable development of the city of Nairobi and maintenance of its position as a regional economic hub and the "African city in the sun".

Hon. Musikari Kombo, EGH, MP
Minister for Local Government

PREFACE

As we strive to enhance our capacity to deal with the emerging challenges of urbanization, it is our strong belief that evidence based planning is the key to sound management of the city of Nairobi. This can only be achieved through the availability of up-to-date and timely information on the social and economic dynamics and the environment of the city.

Preparation of the City of Nairobi Environment Outlook Report is one the strategic initiatives which we have mounted to improve the data and information base available to us as a support tool for decision-making in our day to day operations within the Council.

The protection of the environment is a priority activity of the City Council of Nairobi. In this connection, the Council is implementing a number of projects, all of which aim at controlling pollution, reducing incidences of environment-related diseases, increasing tree cover, landscaping open spaces and planting flowering plants and grass cover. In addition, we are collaborating with other government agencies to enforce laws that protect our forest reserves, the City Park, the Nairobi Arboretum, and the Nairobi National Park, among other equally important recreational and natural reserve areas within the city.

The City Council of Nairobi is fully aware that the success of its beautification programmes, as well as the sanitation programme, depends on information and data on the state of the city's environment. The preparation of the city's environment outlook report is thus a significant contribution to the Council's programmes in this respect. The Council therefore acknowledges with gratitude the support and contribution of the United Nations Environment Programme (UNEP) and the United Nations Human Settlements Programme (UN-Habitat) to the process of producing the City of Nairobi Environment Outlook Report.

The city faces serious challenges of physical and infrastructure planning; unsustainable migration into the city; poverty which is pushing many unemployed people to resort to informal business some of which are detrimental to health; the expanding agricultural activities which often uses unregulated chemicals and waste water, resulting in increased health problems; and encroachment and pollution of riparian reserves and wetlands. The City Council is fully aware of these problems and is dealing with them systematically and strategically.

Extensive consultations with experts through the report process have revealed that the management of the city requires a new thinking and vision. The Council is already responding to these challenges. Stakeholder involvement and public-private partnerships are some of the strategies that the Council has adopted to deal with the problems of services delivery and infrastructure development in the city in the short and medium term. It is, however, our strong convictions that all partnerships in the city must protect the rights of the urban poor to enjoy equitable access to basic urban services such as public parks and other public amenities.

In our endeavour to enhance public participation in the decision-making process in the city, we acknowledge that access to information by all stakeholders is vital as it will better inform decision-making. The City of Nairobi Environment Outlook Report is a very important tool in fostering our partnership with the stakeholders. The Council will therefore move with speed to address the fundamental issues and policy options recommended by this report.

Councillor Dick Wathika
Mayor of the City of Nairobi

CHAPTER 1: BACKGROUND AND INTRODUCTION

1.1 The process

The process of producing the City of Nairobi Environment Outlook Report was a participatory one and is a reflection of the institutional arrangements necessary for the sustainable management of the environment in Nairobi city. It was a joint effort of the Nairobi City Council, UNEP and UN-Habitat, and also involved the collaboration of stakeholders from the public and private sectors, academia and civil society.

Partnership and capacity building

One of the cornerstones of this assessment process was capacity building. The *AEO Cities Integrated Environmental Assessment and Reporting Guidelines* represent one of a set of training materials and support documents whose main objective is to build capacity in the region for environmental assessment and reporting. In addition, the guidelines aim to ensure that the reporting process conformed to agreed standards. Other guidelines that guided the process included the *Methodology for the Preparation of AEO Cities Reports, the Environment Outlook Report Production Manual and the Guide to the DPSIR and Opportunities Frameworks.*

Stakeholders' workshop

The stakeholders and partners in this process came together through a series of five thematic workshops. The first was held on 26 October 2005 at the Nairobi offices of the World Conservation Union (IUCN). Subsequent workshops were held at Kenyatta University. These workshops defined the issues for inclusion in the report, assessed progress, reviewed the outline and made comments on the draft document before its submission to UNEP.

Participants at these workshops included: Aquatech Industries, Department of Resources Surveys and Remote Sensing, Enterprise Professional Services Programme, HACO Industries, IUCN, Kenya Wildlife Service, Kenyatta University, Magadi Soda, Ministry of Lands and Housing, Nairobi City Council, Nairobi Water Company, National Environmental Management Authority, NETWAS, Planning Systems Services Limited, Society for Protection of Environment, Sustainable Development Environment Network for Kenya (SENKE), TARDA, UNEP, UN-Habitat, Unilever, University of Nairobi and Water Resources Management Authority.

Institutional framework

A technical steering committee composed of members from both public and private sectors was constituted to provide technical oversight and coordination of the report process.

1.2 Context to the City of Nairobi Environment Outlook Report (CNEOR)

The Africa Environment Outlook process is an initiative of the African Ministerial Conference on the Environment (AMCEN), which started in 2000. It is based on the Global Environment Outlook (GEO) process, which provides a global analysis of environmental issues and trends. The objective of the Africa Environment Outlook is to provide a framework for national and sub-regional environmental reporting in such a way that allows for the monitoring of key environmental and sustainable development targets in Africa. In so doing, the Africa Environment Outlook supports the policy initiatives of the New Partnership for Africa's Development (NEPAD), particularly the implementation of the NEPAD environmental action plan.

One of the upshots of the Africa Environment Outlook process has been a series of complementary initiatives that aim to promote integrated environmental assessment and reporting at different levels. One such programme is the Africa Environment Outlook cities initiative, under which the production of three city outlooks in Africa is being piloted. The three cities are Dakar, Lusaka and Nairobi. UN-Habitat and UNEP are supporting this initiative, which is being undertaken in the context of the Sustainable Cities Programme (SCP). SCP is a global programme aimed at promoting urban environmental planning and management. The overall objective is to support and strengthen local authorities and their partners in the public and private sectors to plan, and manage their city environment in a sustainable manner. This is through provision of technical and managerial knowhow, mobilization and sharing of expertise, experiences and information.

The production of the City of Nairobi Environment Outlook Report is timely and directly in line with the recommendations of the 1994 Kenyan National Environment Action Plan

Report, which recognizes that "information is a fundamental resource upon which organizations, countries and individuals depend in managing their affairs. It also feeds into the legal requirement for regular state-of-the-environment reporting as provided for by the Environment Management and Coordination Act of 1999.

With a population approaching 3 million people, Nairobi is rapidly urbanizing. This growth is bound to have a major influence on the urban environment. Already environmental degradation is becoming a major issue facing the policymakers. For Nairobi fully to realize the potential of its natural resources for development, the role of the environment in development and the social, economic and ecological impacts need to be fully understood.

1.3 The analytical framework

The analytical framework for the City of Nairobi Environment Outlook Report is the driver-pressure-state-impact-response (DPSIR) framework that has typically been used in integrated assessment and reporting processes. As described in UNEP 2002, *"pressures"* are the root causes of environmental change (natural or resulting from human activities). *"State"* reflects the current situation (and qualitative or quantitative trends over the past 30 years). *"Impacts"* are the consequences of environmental change on human and ecological systems, and on social and economic development potential. *"Responses"* include regional agreements and strategies for cooperation, national policies, awareness and education programmes, and community-level projects, aimed at addressing both the causes and impacts of environmental change. In analysing these elements the following questions are answered:

- What environmental resources are available in Nairobi **(resource state and trends)**?
- What types of opportunities exist in using the resources to promote poverty reduction and sustainable development **(value/opportunities and potential)**?
- What are the main challenges that face Nairobi faces in seizing the opportunities to utilize the resources **(demands/pressures)**?
- What policy and institutional actions should be taken in order to seize the opportunities **(policy actions)**?
- What would be the consequences if Nairobi fails to seize the opportunities **(outlook)**?
- How might the various forms of vulnerability in Nairobi be affected by the failures to seize the opportunities and effectively avert the environmental costs so far incurred?

This framework is well suited to demonstrating how the environment contributes to development, where there are policy gaps, and to providing recommendations on how to improve things. It allows positive indicators such as service delivery, increased livelihood options and reduced vulnerability issues to be highlighted. Examples and case studies are used to highlight particular issues of concern and instances of good practice, and to illustrate the links between environmental components and issues. Pressures, states, impacts, and responses are discussed in an integrated manner for each issue.

1.4 Format and content of the report

As indicated earlier, the City of Nairobi Environment Outlook Report presents trends in various aspects of the human-environment system of the city and looks forward to the year 2015. Contemporary issues such as gender and vulnerability issues are noted and these are included in the chapter discussions in an integrated way.

The report's six chapters cover the following areas: Chapter I provides a profile of the city of Nairobi, highlighting its characteristics, topography, natural systems and climate. It also provides an overview of the system of governance and considers how this relates to environment management. Chapter II looks at human demographic characteristics, education and health dynamics.

Chapter III examines land-use and the built and natural environment. This chapter discusses the use and conservation of natural resources including land and biodiversity, and the pressures that these resources face from increasing human population. It also deals with human settlement and infrastructure, and outlines issues on urban mobility, housing – including informal settlements, water supply and sanitation.

Chapter IV on pollution and waste management outlines the current state of water pollution, air pollution and solid wastes management. In chapter V the report presents an outlook to the year 2015 and provides some predictions on the way that a number of key issues, including human population

and health, land-use, generation of solid wastes and human settlement and infrastructure, will play out.

In the light of the observations of the five preceding chapters, Chapter VI proposes policy recommendations on ways to tackle the key challenges facing the city of Nairobi.

1.6 Overview of Nairobi

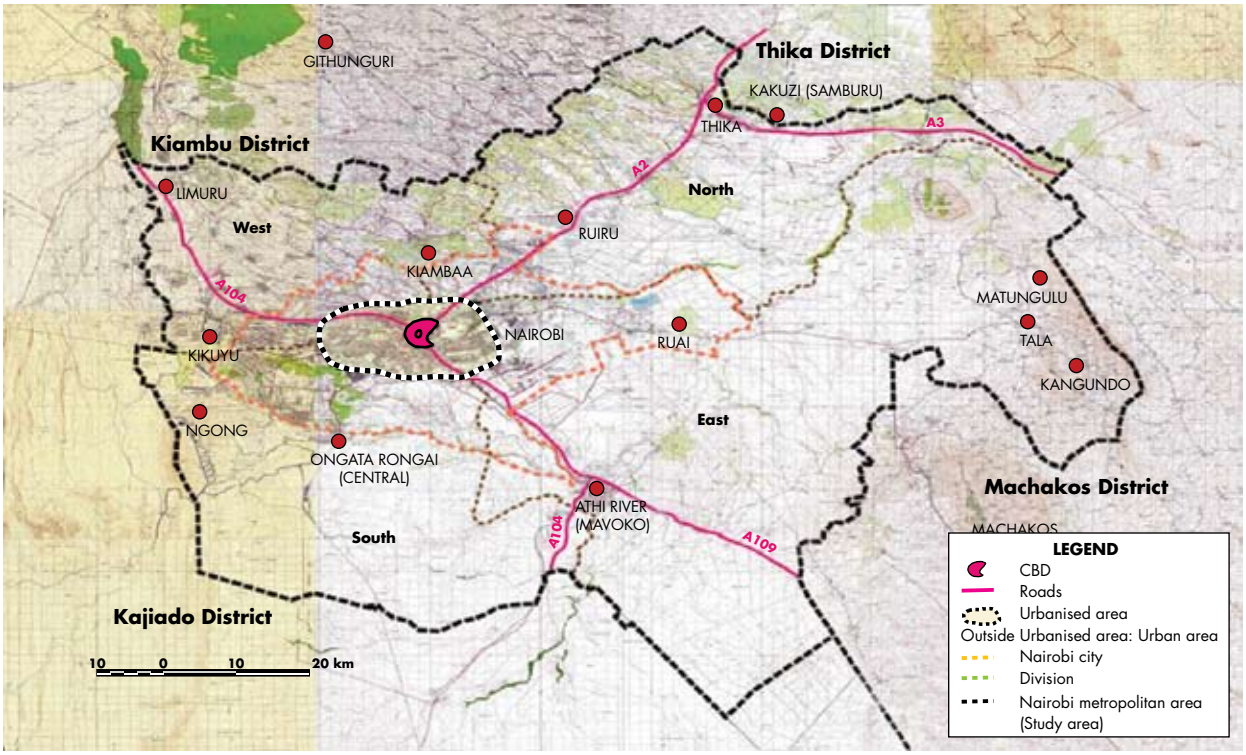
1.6.1 Historical background

Nairobi takes its name from the Maasai phrase "enkare nairobi", which means "a place of cold waters". The area was originally grazing land and a livestock watering point and there was no permanent African settlement. The city of Nairobi owes its early development and growth to the Kenya Uganda Railway. The railhead reached Nairobi in June 1899 and by July it had become the headquarters of the Kenya Uganda Railway (Rakodi 1997). This led to Nairobi's growth as a commercial and business hub of the British East Africa protectorate (Mitullah 2003). By 1900, Nairobi had become a large and flourishing place with the settlement consisting mainly of the railway buildings and separate areas for Europeans and Indians, the latter mainly comprising the labourers engaged in building the railway. Nairobi, as an urban centre was officially defined in 1900 under the Nairobi Municipal Community regulations and it became the capital of Kenya in 1907 (Mitullah 2003, Rakodi 1997). Figure 1.1 shows the larger Nairobi metropolitan area.

1.6.2 Location and physiographic features

Nairobi was previously known as *'the city in the sun'* because of its appealing environment. It is located at the south-eastern end of Kenya's agricultural heartland, at approximately 1° 9'S, 1° 28'S and 36° 4'E, 37° 10'E. It occupies an area of about 696km^2 (CBS 2001) and the altitude varies between 1,600 and 1,850 metres above sea level (Mitullah 2003). The western part of Nairobi is on high ground (approximately 1700–1800 msl) with rugged topography, the eastern side is generally low (approximately 1600 msl) and flat (Saggerson 1991). Key physical features include the Nairobi, Ngong and Mathare rivers and the indigenous Karura forest in northern Nairobi. The Ngong hills stand towards the west, Mount Kenya towards the north and Mount Kilimanjaro towards the south-east. As Nairobi is adjacent to the Rift Valley, minor earthquakes and tremors occasionally occur.

Figure 1.1: Nairobi metropolitan area



Source: JICA 2004

1.6.3 Functions

Nairobi, as the capital city of Kenya, is a centre of industry, education and culture. It is also the world headquarters of two United Nations agencies, the United Nations Environment Programme (UNEP) and the United Nations Centre for Human Settlements (UN-Habitat) and houses regional offices of other United Nations agencies such as the United Nations Children's Fund (UNICEF), the United Nations Scientific and Cultural Organization (UNESCO), the United Nations Industrial Development Organization (UNIDO) and the United Nations Development Programme (UNDP), reinforcing Nairobi's importance as a diplomatic, commercial and cultural centre in Africa. Its proximity to many tourist attractions both in Kenya and East Africa also puts it at the heart of the regional tourist industry.

Tourism

The city of Nairobi is a major centre of tourism in the region. Its relative proximity to many tourist attractions both in Kenya and East Africa makes it an asset of great importance in the tourism sector. As the capital city and a commercial centre, it attracts many businessmen and leisure tourists. This is partly because its airport – the Jomo Kenyatta International Airport – is the main port of entry to Kenya by air and many tourist safaris originate and end in the city. The tourism sector is dominated by nature-based tourism underpinned by the rich animal biodiversity in Kenya's national parks. Moreover, with its good conference facilities, Nairobi hosts many international conferences that have become an established facet of Kenyan tourism.

1.6.4 Climate

Nairobi has a temperate tropical climate with two rainy seasons. Highest rainfall is received between March and April and the short rainy season is between November and December. The mean annual rainfall ranges between 850-1050mm (Lakin undated). The mean daily temperature ranges between 12 and 26°C. It is usually dry and cold between July and August, but hot and dry in January and February (CBS 2003). The mean monthly relative humidity varies between 36 and 55 per cent. The mean daily sunshine hours varies between 3.4 and 9.5 hours (CBS 2003a). The cloudiest part of the year is just after the first rainy season, when, until September, conditions are usually overcast with drizzle.

1.6.5 Geophysical environment

Drainage

Nairobi's main drainage follows the regional slope of the volcanic rocks towards the east, while subsidiary internal drainage into the Rift region is confined to the western part. The lava plains east of the line Ruiru-Nairobi-Ngong are underlain by a succession of lava flows alternating with lakebeds, streams deposits, tuffs and volcanic ash. These plains, comprising mainly the Athi plains and the northern section of the Kapiti plain, extend westwards, rising from 4900 feet (1493 m) at the Athi River to 6000 feet (1829 m) in the faulted region near Ngong. The lava plains are crisscrossed with steep-walled gullies and canyon-like gorges, such as those along the Mbagathi valley. Further east this valley widens slightly where soft material is being actively eroded (Saggerson, 1991).

Water draining eastward from the hill area accumulates on the low-lying ground between Parklands in the north and Nairobi South estate, forming a perched water table above the Nairobi phonolite. The Kerichwa Valley Tuffs lying to the east of the highway function like a sponge and the contact between them and the underlying impermeable phonolite thus forms a perfect aquifer, so much so that a number of channels containing water occur beneath Nairobi.

Soils

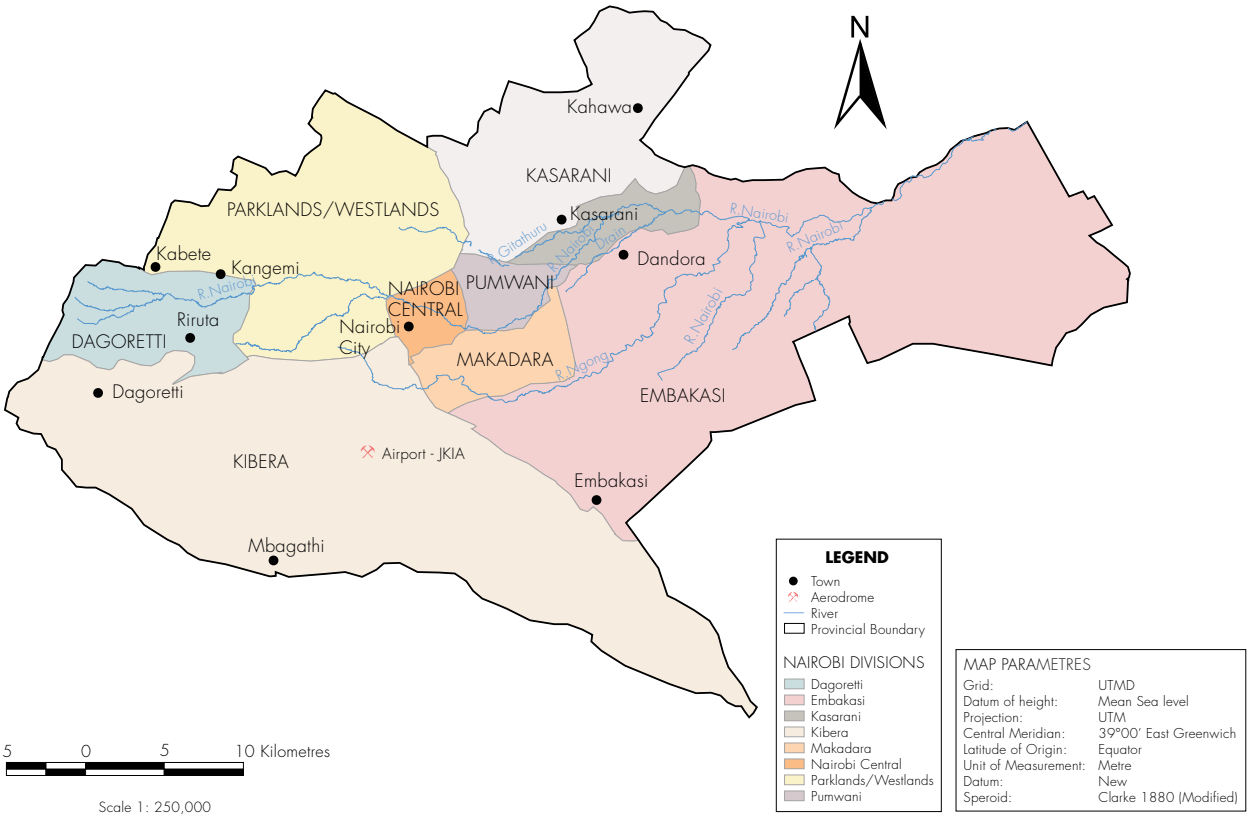
The rocks in the Nairobi area mainly comprise a succession of lavas and Pyroclastics of the Cainozoic age and overlying the foundation of folded Precambrian schist's and gneisses of the Mozambique belt (Saggerson, 1991). The crystalline rocks are rarely exposed but occasionally fragments are found as agglomerates derived from former Ngong volcano.

The soils of the Nairobi area are products of weathering of mainly volcanic rocks. Weathering has produced red soils that reach more than 50 feet (15m) in thickness (Saggerson, 1991). A number of subdivisions are recognized in the Nairobi area according to drainage, climatic regions and slopes, and other categories have been introduced for lithosols and regosols.

1.7 The structure and system of governance

Nairobi province is one of eight provinces in Kenya. It is synonymous with Nairobi city, but functions as a State unit. It is the smallest province and is entirely urban. It has only one local authority – Nairobi city – and only one district – Nairobi district. The district is divided into eight administrative divisions and some 50 subdivisions (or locations). Subdivisions are generally named after residential estates. Similarly, divisions are often named after residential estates, but cover a much larger area. For example, Kibera division includes Kibera (the largest slum in Kenya), as well as the affluent estates of Karen and Langata. Provinces are divided into districts, divisions, locations and sublocations. Table 1.1 and figure 1.2 show the divisions and subdivisions of Nairobi.

Figure 1.2: Divisions of Nairobi province



Map production: RCMRD

Table 1.1: Divisions and subdivisions of Nairobi

Division	Subdivision	Division	Subdivision	Division	Subdivision
Central	Huruma Kariokor Mathare Ngara Starehe Dagoretti Kawangware Kenyatta/Golf Club Mutuini Riruta Uthiru/Ruthmitu Waithaka	Kibera	Karen Kibera Laini Saba Langata Mugumoini Nairobi West Sera Ngombe	Westlands	Highridge Kangemi Kilimani Kitisuru Lavington Parklands
Embakasi	Dandora Embakasi Kariobangi South Kayole Mukuru Kwa Njenga Njiru Ruai Umoja	Kasarani	Githurai Kahawa Kariobangi North Kasarani Korogocho Roysambu Ruaraka	Pumwani	Bahati Eastleigh North Eastleigh South Kamukunji Pumwani
Makadara	Makadara Makongeni Maringo Mukumu Nyayo Viwandani	Dagoretti	Kangemi Kawangware Mutuini Riruta Waithaka		

IIn terms of governance, Nairobi falls under the City Council of Nairobi, which is supervised by the central Government through the Ministry of Local Government. The 1977 Local Government Act is the main legal statute that governs the operations of the council.

The council is composed of 55 elected members. Its day-to-day operations are carried out by the mayor and his elected councillors. There are also 18 nominated councillors who are co opted on to the council. Political developments have strongly influenced the delivery of services to urban dwellers.

The council has several departments, including the Department of Environment, whose objective is to ensure that Nairobi residents enjoy a clean, healthy environment through the provision of services such as cleansing and beautification of the city, enforcement and implementation of deterrent laws and by-laws, maintenance of existing parks, improvement of Council-administered open space, control of leisure parks development and selling of selected plants and flowers. Other functions include pollution control, solid and liquid waste disposal and cleaner production initiatives. The department is divided into an administration section and two operational sections, the cleansing section and the parks section and is headed by a director. Other departments closely involved in environment management are health, planning and inspectorate.

The City Council of Nairobi is responsible for providing services such as health, primary education, refuse collection, water and sanitation and fire protection services, among others. Over the years, however, its service delivery capacity has deteriorated. The reasons for this include the fact that existing facilities were not planned to cater for the numbers of people now residing in the municipal areas; population

growth rates are high; the resource base is low; there are problems with management; the technical and institutional capacity needed to increase service coverage is lacking; and there is a lack of planning and foresight (Hagerlund 2006).

The principal sources of revenue are water charges, land rates, house rents, sewerage fees, grants for teachers' salaries, bus park fees, slaughterhouse revenues, and intake from the Nairobi National Park. In 1998, the central Government established the Local Authority Transfer Fund, which allocates 5 per cent of the national income tax to all local authorities in Kenya. These allocations come with performance conditions.

There is an increasing shift towards partnerships in implementing urban policy. Examples of these include the Nairobi Informal Settlements Coordinating Committee and the Nairobi Central Business District Association. Such partnerships have evolved from concerns over increasing poverty, lack of funding by the City Council of Nairobi; the deteriorating housing situation in the informal settlements; and recognition of the need to incorporate local communities in prioritizing poverty reduction activities.

Through the Local Government Reform Programme, the Government has committed itself to reforming local governments with a view to giving local authorities more autonomy and enhancing their capacity to perform their role and remove conflict with the central Government. Service delivery within Nairobi would be greatly helped, however, if local governments were given real executive power in the areas of finance and decision making. Under the Local Government Act, executive power is vested in the Minister for Local Government and his appointees. The result is that the City Council of Nairobi is sometimes not very responsive to the needs of the people in the city.

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CHAPTER 2: DEMOGRAPHIC CHARACTERISTICS AND IMPACTS ON THE ENVIRONMENT

2.1 Introduction

According to the United Nations Population Fund (UNFPA), human impact on the environment is a function of population size, per capita consumption and the environmental damage caused by the technology used to produce what is consumed (UNFPA 2001). The environmental consequences of population growth are amplified by the growth in numbers. Rapid increase in population, as has been witnessed in Nairobi since independence, has led to unprecedented sprawl of informal settlements; outstripped the city's delivery of social services (education, health care, water supply and sanitation); increased the motorization rate (both personal and public service vehicles) and attendant air pollution; and increased poverty levels within the city.

Demographic parameters that will be discussed in this chapter include population growth, densities, distribution and age structure; education; the economy; poverty and health.

2.2 Population dynamics

2.2.1 Population growth

Population is a major driver of environmental change in Nairobi and as such is a determinant of other parameters such as solid-waste-generation rates, land-use patterns and settlement, and water consumption.

The population of Nairobi grew from 8,000 in 1901 to 118,579 in 1948 (Rakodi 1997). By 1962, the city had a population of 343,500 people, although some of this could be attributed to extension of the city's boundaries (see table 2.1 and figure 2.1 below). Between the 1948 and 1962 censuses, the population grew at an average rate of 5.9 per cent per annum, compared with 7.6 per cent in the previous 12-year period. Taking the 1999 census figures as a baseline, it is projected that the city's population by the next census in 2009 will be about 3.1 million, and 3.8 million by 2015 (CBS 2001). This increase will put even more pressure on the available resources. Although it covers only 0.1 per cent of Kenya's total surface area, Nairobi already has about 8 per cent of the country's total population (CBS 2001) and 25 per cent of Kenya's urban population (UN-Habitat 2001).

In 1962, there were over twice as many adult males as females. While the city's population has grown significantly since then (table 2.1), the continued predominance of men in Nairobi can be attributed to the fact that the majority of migrants to the city are men.

Factors affecting population growth

Fertility is one of the principal components of population dynamics, the others being mortality and migration (UN 1973 in CBS *et al.* 2004). Fertility reduction became the thrust of the country's population policy as early as 1967. This underlines the deliberate efforts by the Government to contain population growth (CBS *et al.* 2004). Indeed, the total fertility rate in Nairobi fell from 4.6 in 1989 to 2.6 in 1998 and is currently 2.7 (CBS *et al.* 2004). One of the targets of the National Population Policy for Sustainable Development is to stabilize the fertility rate at 2.1 by 2010 (CBS *et al.* 2004).

Population growth is partly explained by net migration into the city. The net immigration flow into the city between 1979 and 1989 was 772,624 (NEMA, 2003). The forces motivating rural-urban migration to Nairobi include better economic prospects, opportunities for higher education and higher wage employment, and the attraction of Nairobi as a market for goods and services. But there is also the phenomenon of diurnal migration of people from the environs who commute daily into Nairobi for purposes of employment, education or trade. Projections are that diurnal migration will continue unless deliberate efforts are made to develop satellite towns and employ strategies to reduce the daily influx of people to the city. For instance, universities could be established at regional levels so that higher education opportunities are taken closer to people in the countryside. In order adequately to tackle these problems, however, diurnal migration first needs to be quantified and factored into the city development policies.

Table 2.1 : Population trends (1906-2005)

Year	Population	Increase in population %	Area (km²)	Density (people/ km²)	Kenya	Nairobi as % of Kenya population
1906	11 512	-	18.13	635	n.a.	-
1928	29 864	159.4	25.37	1 177	n.a.	-
1931	47 919	60.5	25.37	1 889	3 073 947	1.6
1936	49 600	3.5	25.37	1 955	n.a.	-
1944	108 900	119.6	25.37	4 292	n.a.	-
1962	343 500	124.2	684	390	8 636 263	3.1
1969	509 286	90.9	684	745	10 942 705	4.7
1979	827 775	62.5	684	1 210	15 327 000	5.4
1989	1 324 570	60.0	684	1 937	21 445 000	6.2
1999	2 143 254	61.8	696	3 079	28 686 607	7.5
2000	2 290 049	6.8	696	3 290	30 208 365	7.6
2001	2 379 741	3.9	696	3 419	30 864 544	7.7
2002	2 470 850	3.8	696	3 550	31 517 142	7.8
2003	2 563 297	3.7	696	3 683	32 165 328	8.0
2004	2 656 997	3.7	696	3 818	32 808 269	8.1
2005	2 751 860	3.6	696	3 954	33 445 119	8.2

Sources: Olima 2001

2.2.2 Population distribution

The other feature of Nairobi's population is its distribution. In some areas of the city, the population density is quite high. The city's overall population density is 3,079 people per square kilometre (CBS 2001), but, as shown in table 2.2 and figure 2.2, this varies significantly across the different divisions. For instance, Central division is the most densely populated with 22,164 persons per square kilometre, while Kibera division has 1,284 people per square kilometre (CBS 2001). Even within divisions, there are differences. Some areas of Kibera division have extremely high densities, especially in the slum areas. This affects the ability of the City Council of Nairobi to deliver services such as health, education, transport and housing, and also to provide recreational facilities. Box 2.1 gives an idea of population density from satellite imagery.

Box 2.1: Satellite images of Kibera and Muthaiga areas in Nairobi

Satellite images give a good impression of the population density in different areas of Nairobi. The image on the left shows Muthaiga in Westlands division, an upmarket residential area; while the image on the right is of Kibera, a slum area in Kibera division.

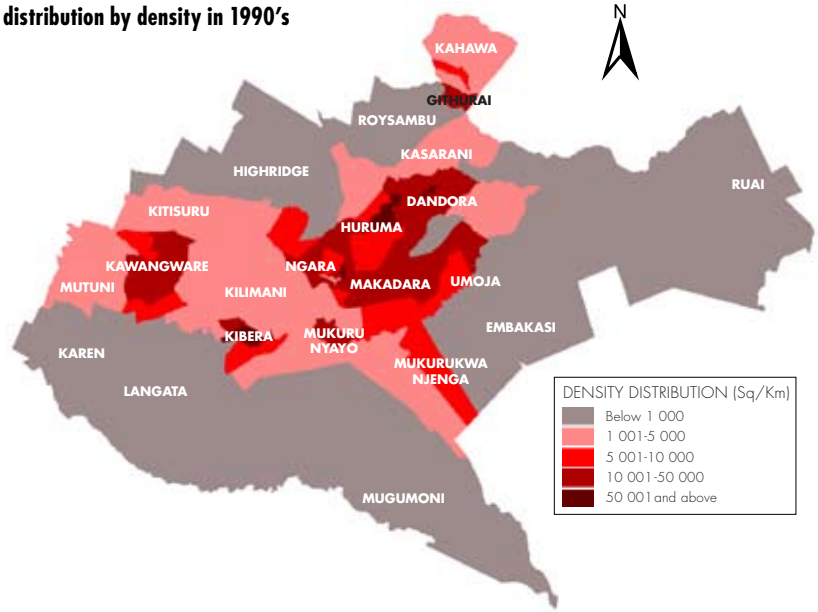
Source: RCMRD

Table 2.2: Population size and density by administrative areas and gender in Nairobi, 1999

Division	Male	Female	Total	% of total	Households	Area (km²)	Density (pop/km²)
Central	129 464	105 478	234 942	11.0	69 958	10.6	22 164
Makadara	108 773	88 661	197 434	9.2	58 032	20.1	9 823
Kasarani	183 320	155 605	338 925	15.8	109 149	85.7	3 955
Embakasi	227 098	207 786	434 884	20.3	133 472	208.3	2 088
Pumwani	109 809	92 402	202 211	9.4	54 801	11.7	7 283
Westlands	111 209	96 401	207 610	9.7	61 258	97.6	2 127
Dagoretti	125 072	115 437	240 509	11.2	73 670	38.7	6 215
Kibera	159 083	127 656	286 739	13.4	89 086	223.4	1 284
Nairobi	1 153 828	989 426	2 142 254		649 426	696.1	3 079
Kenya	14 205 589	14 481 018	28 686 607		6 371 370	58 167 720	49

Source: CBS 2001

Figure 2.2: Population distribution by density in 1990's



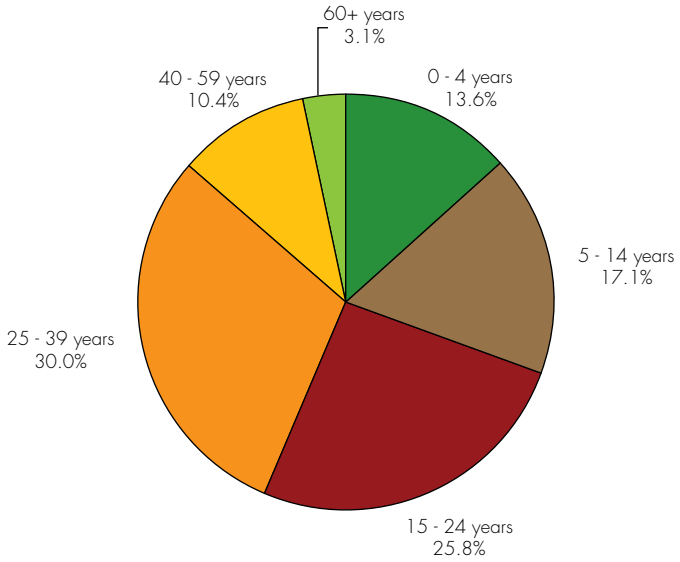
Source: CBS 2001

2.2.3 Age structure

As shown in figure 2.3, Nairobi's population is young, with 56.5 per cent of the population below the age of 24 years (CBS 1999). The youthful structure of the population causes high dependency ratios and is responsible for high unemployment rates and demands for education, housing, health, transport and other social amenities.

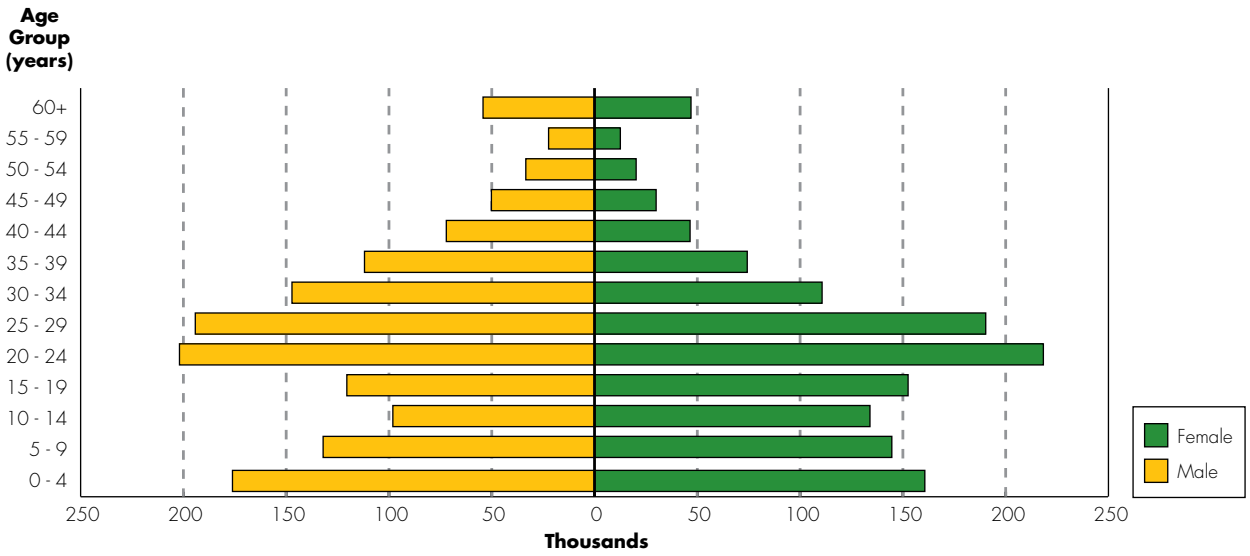
The population pyramid of Nairobi does not reflect a normal structure (figure 2.4). The figure shows that between the ages of 6 and 19, both sexes decline in numbers but pick up rapidly between the ages of 20 and 29. From then on the pyramid exhibits a normal trend, with a gradual decrease of numbers with age but more rapidly for females than males.

Figure 2.3: Percentage distribution of Nairobi's population by age



Source: CBS 2001

Figure 2.4: Population pyramid of Nairobi



Source: CBS 2001

Controlling population

To deal with these demographic pressures, the Government is implementing the 2000 National Population Policy for Sustainable Development. This policy outlines ways of implementing the programme of action developed at the 1994 International Conference on Population and Development in Cairo. It also takes up issues of environment, gender and poverty, and also problems facing certain segments of the population, such as young people, the elderly and those with disabilities. Its implementation is being guided by the national and district plans of action formulated by the National Council for Population and Development.

2.3 Education

Illiteracy rates in Nairobi for the 15–54 age group are 7.8 per cent for women and 5.8 per cent for men. Illiteracy levels are lowest in Nairobi, compared to the rest of the country: 21 per cent for women and 12 per cent for males. 56.4 per cent of women and 67.3 of men have attended secondary school and above, compared with 48.2 and 57.7 per centre respectively for urban areas in general in Kenya (CBS 2003a). Table 2.3 shows school attendance by 10-year age groups for Nairobi.

The Government introduced free primary education in 2003. This was intended to broaden access to primary schooling especially among poor households. In all, 85 per cent of children of primary school age (6–13 years) are attending school. Figure 2.5 shows trends in primary school enrolment between 1997 and 2003. The gender gap at this level is quite small, with 85.9 per cent of girls and 84.1 per cent of boys in primary school. The abolition in 2004 of compulsory school uniforms was a policy initiative intended to enhance school enrolment (Oxfam 2004). At secondary level (14–17 years), the net attendance ratio is 32.1 per cent. This is much lower than that for primary schools. Secondary school attendance is higher for females (35.5) than for males (28.9). To address gender concerns in education, the Government is promoting a gender-friendly learning environment with special focus on the provision of water and sanitation. Water and sanitation are discussed in greater detail in chapter 3.

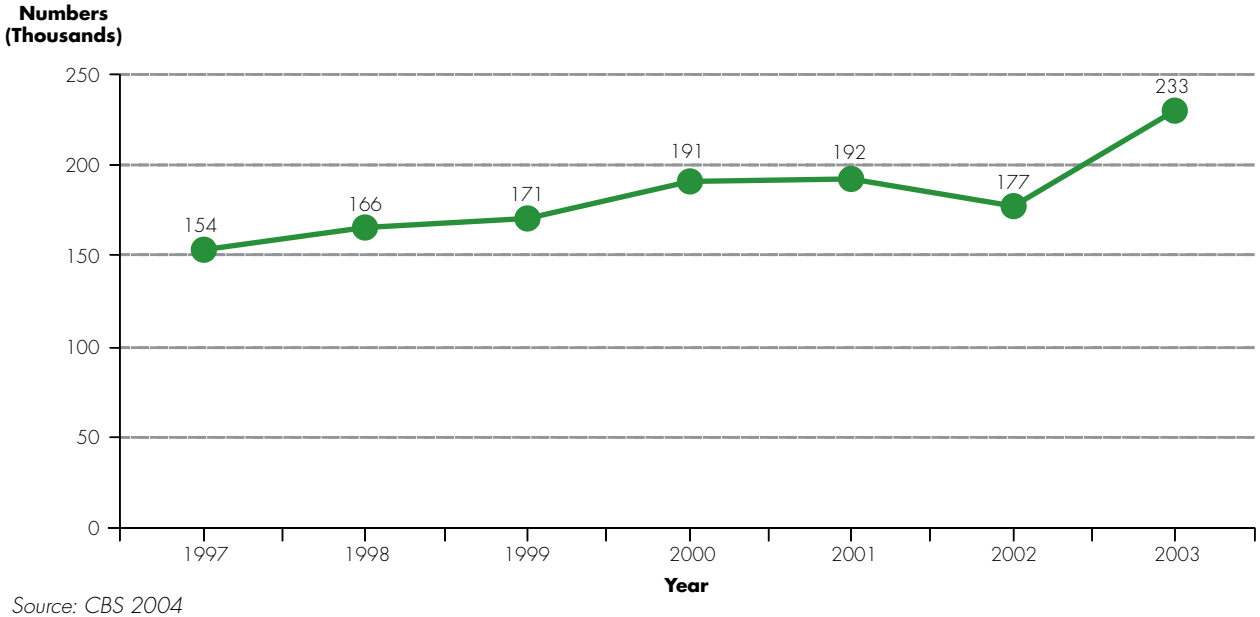
Non-formal schools, especially those that cater for children in urban slums, are important if the millennium development goal of Universal Primary Education by 2015 is to be achieved. The 2004 Draft Non-Formal Education Policy Guidelines defines non-formal education (for school age children) as "flexible complementary delivery channels of quality basic education to children in especially difficult circumstances, in particular those in need of special care and protection, or those who live or work in circumstances which make it impossible for them to access education through existing conventional formal school arrangements in terms of time, space, and entry requirements" (MOEST 2004 in Gathenya 2004). In Nairobi, 91.4 per cent of non-formal education schools are supported by various civil society groups, 6 per cent by the Government and only 2 per cent by the local authority (Thompson 2001 in Ogachi 2002). The efforts by civil society groups go a long way in complementing the Government's efforts towards free education and need to be encouraged.

Table 2.3: Nairobi population by gender, 10-year age groups and school attendance, 1999 census

Age groups in years and gender		At school	Left school	Not started/ never attended
5-10	Male	144 384	12 279	19 991
	Female	149 483	17 106	22 366
15-24	Male	57 819	186 608	12 558
	Female	54 860	218 979	16 033
25-34	Male	7 503	269 210	11 739
	Female	4 220	188 661	10 989
35-44	Male	2 226	134 726	6 219
	Female	1 312	74 289	8 412
45-54	Male	877	65 611	5 275
	Female	452	28 234	6 710
55+	Male	631	26 430	10 199
	Female	580	12 306	13 525
Age NS	Male	65	543	149
	Female	77	399	151

Source: CBS 2001

Figure 2.4: Primary school enrolment in Nairobi city (1997-2003)



Source: CBS 2004

The main challenges include the low quality of education, lack of linkages with the formal education system, lack of teaching and learning resources, and low prioritization by the Government in terms of allocation of resources (Gathenya 2004). The Government has put in place a policy framework and appropriate legislation that ensures provision of education for all children regardless of their circumstances. These include the Children's Act of 2001 and sessional paper No.1 of 2005 on a policy framework for education, training and research. The Ministry of Education has also developed the Kenya Education Sector Support Programme for the period 2005–2010.

Coordination of this programme has been structured in a manner that provides for provincial and district coordination through the provincial and district education boards. A strategy on education for sustainable development for Kenya was developed in 2005. The strategy identifies the local sustainable development issues, priorities and existing capacities. Its mission is to provide an enabling environment and capacity for sectors and stakeholders to effectively contribute towards achieving the objectives of the Decade of Education for Sustainable Development.

Providing educational opportunities to both men and women is a means of ensuring cultural, social and economic development. It can be used as a vehicle to bring about desirable changes of attitudes and practices, vital for sustainable environmental management. Education, particularly of females, is also an important factor in influencing fertility behaviour and therefore controlling population growth (CBS *et al.* 2004). It therefore follows that strategies for improved literacy and access to educational opportunities will do much to improve the well-being of the people and the environment. Literate individuals are better equipped to participate in solutions to everyday personal and community problems. They are more likely to play a meaningful part in environmental decision-making and to take advantage of opportunities for environmental justice.

2.4 The economy

Kenya's real gross domestic product (GDP) grew by 5.8 per cent in 2005 against a revised growth of 4.9 per cent in 2004 (CBS 2006). The major growth sectors were agriculture and forestry; transport and communications; manufacturing; and wholesale and retail trade. Economic growth is expected to be sustained in 2006. Nairobi is a major contributor to Kenya's economy: it generates over 45 per cent of GDP, employs 25 per cent of Kenyans and 43 per cent of the country's urban workers (UN-Habitat 2006). The paradox is that the financial capacity of the City Council of Nairobi is extremely limited, largely because of poor resource management and a weak revenue collection system. As a result, there is a 200 per cent shortfall between the revenue collected per capita ($7 on average) and per capita expenditure ($21) (UN Habitat 2006).

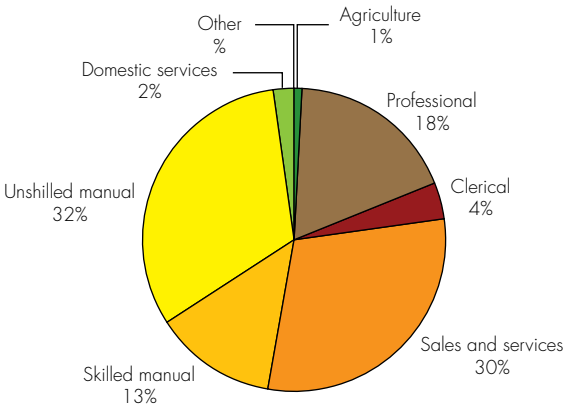
Although foreign direct investment is small, it plays a key role in Kenya, particularly as a means for technology and knowledge transfer, such as in horticulture and floriculture. Nairobi and Mombasa accounted for 89 per cent of the total number of regional projects registered with the Investment Promotion Centre during 2000–2004 (WTO 2006).

The average annual inflation rate in Nairobi decreased from 13.2 per cent in 2004 to 11.4 per cent in 2005 (CBS 2006). The fall in inflation rate was more pronounced in the lower income group, where the inflation rate decreased from 14.4 to 11.7 per cent over the same period. The lower income group constitutes about 80 per cent of the population in Nairobi. For the middle and upper income group, the inflation rate rose from 8.0 in 2004 to 10.1 per cent in 2005. Inflation is a persistent cause of the rise in consumer prices or decline in the purchasing power of money, caused by an increase in available currency and credit beyond the proportion of available goods and services (Answers.com 2007).

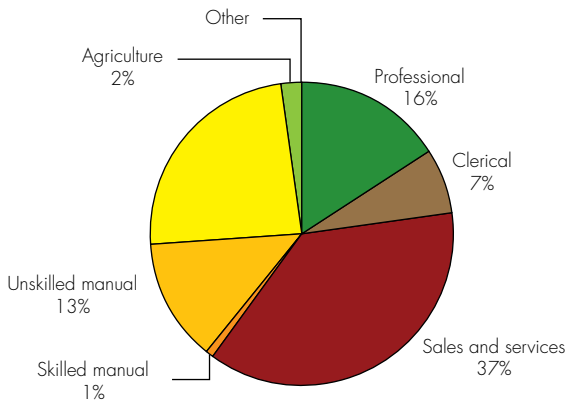
As Nairobi's population increases, so does the demand for jobs. Currently, 56.6 per cent of women and 68.6 per cent of men aged between 15 and 50 are economically active (CBS *et al.* 2004). Between 1989 and 1997, the combined formal and informal sector employment growth in Nairobi was 2.3 per cent per annum, less than half that of the rate of population growth (Post Buckley International Inc. 1998). It is estimated that about 500,000 people join the labour force annually. Most of these are unable to secure employment and thus remain unemployed or end up in traditional agriculture and in the informal sector (Odhiambo and Manda 2003). The 1997–1998 labour force survey showed that 9 per cent of people in Nairobi were employed and 24 per cent unemployed (CBS 2003b). Figure 2.6 shows the major areas of occupation.

Figure 2.5: Per cent distribution of men and women employed by occupation

Men



Women



Source: CBS et.al. 2004.

Nairobi commands the largest share of modern sector wage employment in Kenya, with a total of 453,000 people in 2005 (CBS 2006). In 2005, the distribution of the labour force in wage employment was as follows: 83,100 were in manufacturing industry; 40,300 in construction; 64,700 in trade, restaurants, and hotels; 34,700 in transport and communications; 38,600 in finance, insurance, real estate and business services; while community, social, and personal services employed 168,100 people (CBS 2006). The main formal employment zones in Nairobi are the central business district and the industrial area, along Jogoo and Mombasa Road, Ruaraka and Thika Road and Dandora. Although there have been efforts to decentralize employment concentration from the central areas to satellite centres, the central business district and the central industrial area (Jogoo Mombasa Road) still remain the core employment zones. It is for this reason that the city is often described as being a mono-polar centre.

The informal or "jua kali" (from Swahili: "hot sun") sector plays an important role in absorbing the unemployed in the labour force that are not able to get into the modern sector. Over the period 1991–1992, the number of people engaged in the informal sector increased by 27 per cent (Rakodi 1997); and from 2001 to 2005, by 38 per cent (CBS 2006). By 2005, 1,548,100 people were engaged in this sector (CBS 2006), about 3.5 times those in wage employment. The informal sector covers small-scale activities that are semi-organized, unregulated and uses low and simple technologies while employing few people. Activities range from auto-repair shops, painting, carpentry, shoe making, crafts, hair-dressing, driving and domestic service to petty trading and hawking of various food commodities. Urban agriculture is discussed in greater detail in chapter 3.

Employment in the informal sector grew by 38 per cent between 2001 and 2005 (CBS 2006). Of those employed in the informal sector in Kenya, 24.2 per cent are in Nairobi. Given the shrinking of public sector employment and job cuts in the private sector, the informal sector has provided the necessary employment interface between modern sector and other small-scale activities. Women are key players in the informal sector.

The ease of entry and exit into the informal sector, coupled with the use of low level or no technology, makes it an avenue for employment creation. It must be borne in mind, however, that the pollution effects of such small-scale enterprises – while small at the individual firm level – taken together, may have considerable impacts on the environment. The Government and the City Council therefore need to engage with the informal sector to develop and implement enabling policies and programmes to ensure a dynamic informal sector, while preventing or mitigating any impacts on the environment. Box 2.2 highlights some of the linkages between unemployment and sustainable economic growth.

Box 2.2: Unemployment and economic growth

Employment is a major source of income and an important determinant of social and economic outcomes (DEAT 1999). The unemployed have no opportunity to earn income and are almost certainly poor. The phenomenon of growth based on a society with high unemployment (jobless growth) is not sustainable and is contributing to the expansion of the informal sector (DEAT 1999). Available evidence in Kenya shows, however, that earnings in the informal sector are typically low and not enough to push people out of poverty (Odhiambo and Manda 2003).

Jobless growth also encourages uneven distribution of wealth (DEAT 1999). In other words, the rich get richer and the poor become poorer, if benefits of employment are not distributed through the social welfare systems. Jobless growth will exacerbate already high levels of poverty, and encourage criminal activities. Already the gap between the rich and the poor is an issue. In Nairobi for example, the top 1 per cent of the households command about 45 per cent of the total income while the bottom 10 per cent command less than 2 per cent (SID 2004).

Analysis of key social and economic indicators shows that this inequality also affects access to resources and services such as land, water, education and health. In other cases, the natural resources themselves, such as land, can be a source of inequality, especially depending on the land type or productivity (SID 2004).

There is growing evidence that greater equity is associated with faster economic growth (SID 2004). Lower inequality can create faster growth. Indeed this is the premise on which Kenya's development strategy is based.

2.4.1 Economic growth and the environment

The economy and the environment are closely linked, as natural resources are the basis of production, manufacturing and waste disposal. Environmental resources such as forests, water and land have a vital role to play in boosting economic growth and reducing poverty. While it may be argued that economic growth brings many benefits to people, the attendant pollution loading and resource depletion poses great risks to human health and the environment. If not managed properly this may even jeopardize the viability of the economic activities being supported.

The Kenyan Government is convinced that employment creation is the most effective strategy for reducing poverty and for achieving such key targets as the Millennium Development Goals. The 2003 Economic Recovery Strategy for Wealth and Employment Creation aims to encourage economic growth, generate employment opportunities and reduce poverty levels. This is the major driving force behind economic activity and consequent environmental impacts. In addition, the Government has established a constituency development fund to be used for various projects and programmes that create employment at the constituency level.

2.5 Poverty

In 1997 Nairobi had 51 per cent of its population living in absolute poverty (Republic of Kenya, 2000). Currently, about 44 per cent of the city's population lives below the poverty line, with the poorest 20 per cent accounting for one half of the city's poor population (CBS 2003c, CBS 2005). The eight divisions contribute 6 per cent to total national poverty. Almost half of them are concentrated in only three divisions: the Embakasi (19.1 per cent), Kasarani (17.3 per cent) and Makadara (12.5 per cent) divisions (CBS 2005).

In Kenya, the poverty line is estimated at 2,648 Kenya shillings per adult per month for urban households (CBS 2003c). The poverty gap in Nairobi ranges between 11 and 24 per cent across the different divisions (see table 2.4). Taking the district as a whole, a poor person in Nairobi would require about KSh 413 per month to be regarded as no longer poor. With 886,000 people living below the poverty line, an expenditure of about KSh 366 million per month would be needed to lift everyone above the poverty line (CBS 2003c). Figure 2.7 shows the contribution of different sublocations to Nairobi's urban poor population.

Table 2.4: Poverty rates summary table for Nairobi

Division	Population ('000)	Poverty incidence (% of individuals below poverty line)	Poverty gap as % of poverty line	Estimated number of poor individuals ('000)
Central	205	45	15	92
Dagoretti	230	46	15	106
Embakasi	409	42	14	170
Kasarani	321	48	16	153
Kibera	271	41	14	111
Makadara	185	59	24	108
Pumwani	183	46	16	85
Westlands	188	32	11	61
Total				**886**

CBS 2003c

2.5.1 Poverty and the environment

The link between environment and poverty is strong and has been gaining momentum since the Earth Summit in Rio de Janeiro in 1992. As our understanding of these linkages has grown, major development institutions, donors, Governments and even local authorities have begun to make the environment a more central feature of their efforts to tackle poverty (WRI 2005).

In recent studies to find out where the poor were, the Government of Kenya focused on monetary measures of poverty (CBS 2003c). But poverty is more than that. Indeed the conceptual definition of poverty has been widening and now includes more subjective definitions such as vulnerability, entitlements and social exclusion (Odhiambo and Manda 2003). It means ill health, social exclusion, insecurity and powerlessness, a lack of access to information and institutions, and often a lack of self-confidence and voice (WRI 2005). In other words, poverty is more than just the lack of income; but also the lack of the means to meet basic social needs; the inability to break out of the cycle of poverty; and a feeling of insecurity of persons and property.

This multi-dimensional perception is borne out by Kenya's Millennium Development Goal progress report, which cites unemployment and underemployment, landlessness, climate variability, low education and inadequate sanitation, health facilities and clean water as contributing towards poverty (MNDP 2005). Many of these basic necessities are derived either directly from the environment and the natural resource base or indirectly from ecosystem services. This dependence means that the city, and especially the urban poor, is vulnerable to sudden shocks and changes in the environment such as water and air pollution, floods, prolonged droughts, crop losses through diseases and pests, and conflicts.

These concepts have been useful for analysing what increases the risk of poverty and the reasons why people remain poor.

Poverty

Source: Njenga, B., (2007)

The linkages between poverty and the environment must be at the core of efforts for sustained economic growth and poverty reduction. It is not enough, however, to focus on the urban poverty-environment linkages alone. Most of the goods and services on which the city depends for survival come from outside the city boundaries. The forests, fisheries, grasslands, agricultural fields and rivers that provision Nairobi and the rest of the country exist primarily in rural areas. And much urban poverty begins as rural poverty exported from the countryside through rural-to-urban migration (WRI 2005). It thus follows that working for a healthier rural environment is likely to reduce this migration and reduce on the incidence of urban poverty. On the other hand, the flow of remittances from Nairobi back to family members in the countryside is critical in supporting the rural economy (WRI 2005).

Odhiambo and Manda (2003) recommend that strategies to reduce urban poverty should aim at improving the productivity and incomes of the workers, particularly in the informal sector where the majority of the urban poor are engaged. This should, however, go hand-in-hand with other efforts such as service provision and improving urban governance. As there are wide gender disparities in labour force participation and, by implication, in the distribution of poverty, there is a case for special attention to be given to women. Accordingly environmental management programmes designed by the City Council of Nairobi need to take all these issues into consideration.

2.6 Health

Good health is a basic component of human well being and a necessity for earning a livelihood. The main health issues in Nairobi include access to health facilities, child and maternal mortality and the incidences of certain diseases such as HIV/AIDS, tuberculosis and malaria, among others. Most of these diseases are related to the state of the environment.

Available data show that the leading cause of death is respiratory ailments. In 2000, respiratory disease and malaria accounted for over 50 per cent of all deaths in the city (CBS 2003d).

The five most important causes of death in children under five include acute respiratory infection (ARI), diarrhoea, measles, malaria, malnutrition and anaemia. All these are related to the living environment. For instance, owing to poor sanitation and lack of safe drinking water, many children living in Nairobi die before their fifth year, many even before their first birthday. The mortality rate is particularly high in informal settlements. Diarrhoea accounts for more than 4 per cent of all outpatient visits and 60 per cent of admissions in children (Practical Action 2005). Other diseases like tuberculosis, typhoid, intestinal parasites, meningitis and tapeworm are all associated with the lack of safe drinking water. The prevalence of ARI and diarrhoeal disease in Nairobi was 16.4 and 13.9 per cent respectively in the two-weeks preceding the 2003 Kenya demographic and health survey (CBS et al. 2004).

Table 2.5: Top ten major causes of mortality in Nairobi (1998- 2000)

Disease	Year		
	1998	1999	2000
	%		
Respiratory symptoms	37.0	27	35.5
Malaria	23.1	18.8	14.7
Accidents	-	14.2	10.0
Skin disease	14.4	6.6	7.7
Diarrhoea	9.3	8.3	9.5
Urinary tract disease	4.6	Not indicated	6.0
Intestinal worms	4.1	Not indicated	Not indicated
Disease of puerperium and childbirth	3.9	7.3	Not indicated
Eye infections	3.2	7.9	6.7
Ear infections	-	9.4	0.8

Source: CBS 2003d

More needs to be done both to ensure better enforcement of air quality standards, thereby reducing the prevalence of respiratory diseases, and to improve sanitation and health in Nairobi.

To tackle the problem of child mortality, the Government adopted the Integrated Management of Childhood Illness strategy in 1998. The core actions under the strategy are geared towards the integrated management of the five most important causes of death among children under five. The National Population Policy is also concerned with infant and child mortality. Activities of the Kenya Expanded Programme on Immunization (KEPI) target tuberculosis, whooping cough, tetanus, poliomyelitis, measles and diphtheria, none of which now feature among the top ten conditions of outpatient morbidity.

In 2002, there were 356 health institutions in Nairobi. By 2005, this had risen by 8.8 per cent to 389 health institutions. At the same time, however, the number of doctors per 100,000 population decreased from 16 to 15 – a drop of 6.25 per cent – between 2004 and 2005 (CBS 2006).

In 2003, the ministries of health and local government formed the Nairobi Health Services Board to manage and oversee health services provision in Nairobi, so as to decongest the Kenyatta National Hospital, the largest referral hospital in Kenya. Existing first and second level health facilities were renovated, equipped and staffed. This considerably reduced outpatient daily attendance at Kenyatta National Hospital. Many non-governmental and faith based organizations are engaged, with the support of United Nations agencies and bilateral donors, in health programmes in Nairobi informal settlements. Their activities entail then provision of curative, rehabilitative and preventative health services to slum dwellers.

The 2005–2010 Health Sector Strategic Plan encourages partnership with public and private health sector players. Currently, health services are provided almost equally by the public and private sectors.

2.6.1 HIV/AIDS

The HIV prevalence rate for Nairobi is 9.9 per cent, some 50 per cent higher than the national rate (CBS *et al.* 2004, MOH 2005). Compared with other provinces, Nairobi has the second highest rate in the country, after Nyanza province (15.1 per cent) in adults, while Eastern and Northeastern provinces (less than 1 per cent) have the lowest rates (CBS *et al.* 2004, MOH 2005). Persistent poverty and inadequate basic social services, notably health and education, economic inequality, and poor access to information provide an environment conducive to the spread of HIV/AIDS. Table 2.6 shows the status of HIV/AIDs in Nairobi compared with the rest of the country.

HIV/AIDS has social and economic consequences extending far beyond just health. They undermine productive capacities, perpetuate poverty, exacerbate social problems, overwhelm health services and divert resources from national development, including environmental management. For instance, in Kenya, households with at least one HIV positive person spend four times more on health care than unaffected households (UNAIDS 2004). It is estimated that between 1996 and 2005, Kenya's GDP was 14.5 per cent lower as a consequence of the effects of HIV/AIDs (MOH 2005).

Table 2.6: HIV prevalence among adults tested, age 15-49 (%)

	Women	Men	Total
Nairobi	11.9	7.8	9.9
Central	7.6	2.0	4.9
Coast	6.6	4.8	5.6
Eastern	6.1	1.5	4.0
North Eastern	<1.0	<1.0	<1.0
Nyanza	18.3	11.6	15.1
Rift Valley	6.9	3.6	5.3
Western	5.8	3.8	4.9
Urban	12.3	7.5	10.0
Rural	7.5	3.6	5.6
Kenya	8.7	4.6	6.7

MOH 2005

2.6.2 Health and the environment

It has been argued that the most important and immediate consequence of environmental degradation in the developing world is damage to human health (Franz and Fitzroy 2006). The contribution of environmental factors to human health is well documented. For example, diseases such as diarrhoea, malaria, tuberculosis and respiratory disease are all related to environmental factors such as poor sanitation and waste management, access to water, air quality, and malnutrition. These easily preventable illnesses hold back development because of the health burden and the loss of

time and opportunities for economic development. Other conditions, such as HIV/AIDS, have impacts on sectors such as agriculture, health, literacy and economic development, by virtue of the fact that they attack the productive segment of the population.

From a monitoring point of view, key health indicators such as mortality and other variables can be used as indicators of the well-being of the population and health of the ecosystem. For instance, infant and child mortality are widely accepted as indicators of well-being (Franz and Fitzroy 2006). Infants and children are highly susceptible to negative externalities associated with environmental degradation, thus making the indicator useful in exploring the link between environmental and population health outcomes. The prevalence of tuberculosis can also be used as a general environmental health indicator. Tuberculosis is a leading cause of death and its reduction is one of the MDG targets. It is positively correlated with poverty, malnutrition and poor housing (Franz and Fitzroy 2006).

The main laws in force in Kenya intended to improve human and environmental health include: the Local Government Act (cap. 265); the Public Health Act (cap. 242); the 1999 Environment Management and Coordination Act; the Food, Drugs and Chemical Substances Act (cap. 254); the Physical Planning Act; the Factories Act (cap. 514); and the 2002 Water Act. These statutes are fairly comprehensive, however, penalties in the older ones are too low to deter contraveners and thus require review. Another weakness in the existing environmental laws is lack of adequate and consistent enforcement.

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CHAPTER 3: LAND, SETTLEMENTS & INFRASTRUCTURE

3.1 Introduction

Land resources in Nairobi include forests, freshwater systems and a rich biodiversity, all of which hold vast potential for development if managed sustainably. Many of the opportunities that they provide, such as agriculture, tourism, human settlements and a carbon sink for the city, are vital for the well-being of the residents of the city.

Infrastructure and the provision of services, such as energy, transport, provision of water and sanitation and safe disposal of waste, underpin growth, the improvement of livelihoods and urban development. Infrastructure development has in the past been the preserve of the Government. Provision and maintenance of infrastructure has been a major problem, especially within low-income urban areas. Poor infrastructure is a major constraint on economic performance and a major factor compounding poverty. Components of infrastructure and services discussed in this section are energy supply, transport (access roads), information and communication technology, water supply, sanitation, health and education.

3.2 Land tenure and land use

3.2.1 Land tenure and ownership

Most land in Nairobi, including the central business district (CBD), is publicly owned and leased for 99 year periods to private owners (Ondiege 1989 in Rakodi 1997). Government leasehold covers most of the legalized residential areas, and corporate ownership of land in these areas is becoming more common. Freehold land is privately owned either by individuals or by groups of individuals and can be sold without limits to the period of ownership. This covers a small portion of land mainly to the west and north-west of Nairobi and includes suburbs such as Dagoretti, Mwimuto, Runda, Gigiri and part of the Kahawa area in the north. Over 50 per cent of Nairobi is estimated to be under private ownership (Karuga 1993 in Rakodi 1997).

By 1993, 40 per cent of Nairobi's land was owned by the Government. This included Nairobi National Park and other major parks and forest areas, airports, Kenyatta and Nairobi universities, and Kamiti prison. Of the total, only about 5 per cent, mainly in the east, is owned by the City Council of Nairobi (Karuga 1993 in Rakodi 1997). In practice, the public sector has little direct control over land available for development (Macoloo and Maina 1994 in Rakodi 1997).

Land use planning

The first comprehensive urban plan of Nairobi city was commissioned in 1926, to recommend zoning arrangements. The 1948 master plan study was the basis for the development of guidelines for residential, industrial and other public purposes for the next 20 years (Thornwhite, Silberman and Anderson 1948). Most of the current statutory planning rules and regulations originate from the 1948 master plan, while the by-laws are mainly patchworks of the various pre-1948 rules and regulations, prepared largely in conformity with the 1932 United Kingdom Town Planning Ordinance and 1932 British Planning Act (Akach 1998). The 1948 master plan introduced the principles of neighbourhood units and is wholly responsible for the present layout of the industrial area. It also proposed important extensions to the road networks, including the relocation of the railway line and its replacement with the present dual Uhuru Highway. It recommended the institutionalization of an autonomous town-planning department within the City Council of Nairobi (Akach 1998).

The Metropolitan Growth Strategy of 1973 for the development of Nairobi up to the year 2000 made ambitious development proposals, which have only been implemented in a piecemeal fashion over the last 30 years (Nairobi Urban Study Group 1973). The strategy aimed at maximizing land use in the CBD, utilizing existing infrastructure and public services, harmonizing the then prevailing haphazard zoning system, creating a balanced urban environment and creating incentives for development and redevelopment of derelict areas in the CBD. The strategy also made the following recommendations on the CBD:

- That maximum employment be limited to 100,000 jobs;
- That the industrial area be limited to its location and occupied predominantly by capital intensive enterprises;
- That government functions unrelated to policy and legislation or business administration be located outside the CBD;

- That a car parking policy be formulated for the CBD. This eliminated all free parking in the CBD and provided for more surface parking lots and reduced peak hour congestion in the CBD by staggering working hours.

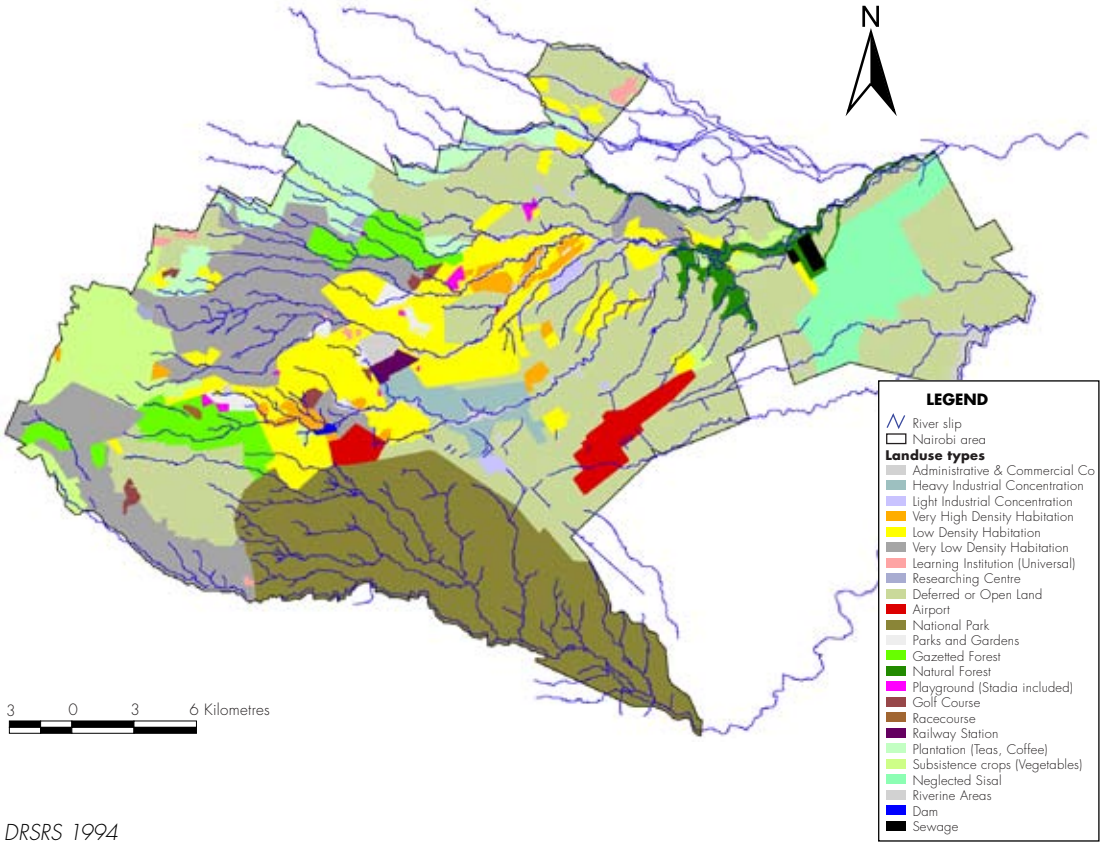
The 1979 rezoning strategy was prepared as a land use rationalization and rezoning strategy for the CBD up to the year 2000. In 1995, the City Council of Nairobi, in consultation with the Ministry of Lands, approved a re-planning and rezoning policy for the Upper Hill and Kilimani areas. This land-use policy designated and expanded commercial centres in the Upper Hill, Hurlingham, Yaya, Valley Arcade and Lavington shopping areas. It further outlined policy guidelines on granting change-of-use permission to residential hotels and professional offices integrated with the principal residential developments. This predominantly affected residential properties situated in development zones 3, 4 and 5 (comprising Upper Parklands/Highridge, Kilimani/ Thompson, Lower Parklands, Lavington, Benard, Loresho, and Kyuna residential areas). The foregoing had been preceded by the Westlands and Museum Hill rezoning policy approved in May 1988 to extend Westlands commercial centre.

The strategy allowed for higher densities and greater vertical development (taller buildings) within the centre and its peripheries. No attempt has yet been made to re-examine, evaluate or improve the urban infrastructure services and utilities, hence the present environmental concerns.

3.2.2 Land use

Urban land use refers to spatial distribution of social and economic activities. Accordingly, an up-to-date land use inventory is frequently required to facilitate urban planning and growth patterns as well as monitoring of urban expansion. A study by the Department of Resource Surveys and Remote Sensing (DRSRS 1994) identified eight major land-use classes in Nairobi (table 3.1 and figure 3.1). Each of these is discussed in the sections that follow.

Figure 3.1: Land use map of Nairobi



Source: DRSRS 1994

Table 3.1: Land use types of Nairobi Metropolitan in 1994 Source: DRSRS, Land Use of Nairobi Metropolitan Area in 1994

Land use type	Area (Km²)	Cover (%)
Residential areas	**175.6**	**25.22**
Very High Dense Habitation	11.3	1.62
High Dense Habitation	10.8	1.55
Medium Dense Habitation	10.9	1.57
Low Dense Habitation	52.5	7.54
Very Low Dense Habitation	90.1	12.94
Industrial/commercial/service centres	**31.8**	**4.57**
Heavy Industrial Concentration	7.9	1.13
Light Industrial Concentration	10.4	1.49
Quarry	4.4	0.63
Administration & Commercial (or CBD)	**2.8**	**0.40**
Research Centres	1.1	0.16
Learning Institutions	3.9	0.56
Hospital(s)	1.3	0.19
Infrastructure	**15.9**	**2.28**
Airport	9.7	1.39
Railway Station	1.7	0.24
Sewage Plants	1.4	0.20
Roads	3.1	0.45
Recreation	**12**	**1.72**
Parks/gardens	5.6	0.80
Golf Course	2.7	0.39
Play Grounds	2.2	0.32
Race Course	0.9	0.13
Drive-in Cinema	0.6	0.09
Water Bodies and Riverine Areas	**11.8**	**1.69**
Dams	0.4	0.06
Riverine Areas	11.4	1.64
Urban Agriculture	**96.8**	**13.90**
Subsistence Crops	30.8	4.42
Plantations (Tea, Coffee)	35.7	5.13
Neglected Sisal/Rangelands	30.2	4.34
Open Lands	**198.8**	**28.55**
Others	**153.6**	**22.06**
National Park	116.4	16.72
Gazetted Forest	24.8	3.56
Ungazetted Forest	12.1	1.74

Source: DRSRS, Land Use of Nairobi Metropolitan Area, 1994

Quarrying in residential zones

Source: Situma C. and Barreh K.J.

Residential use

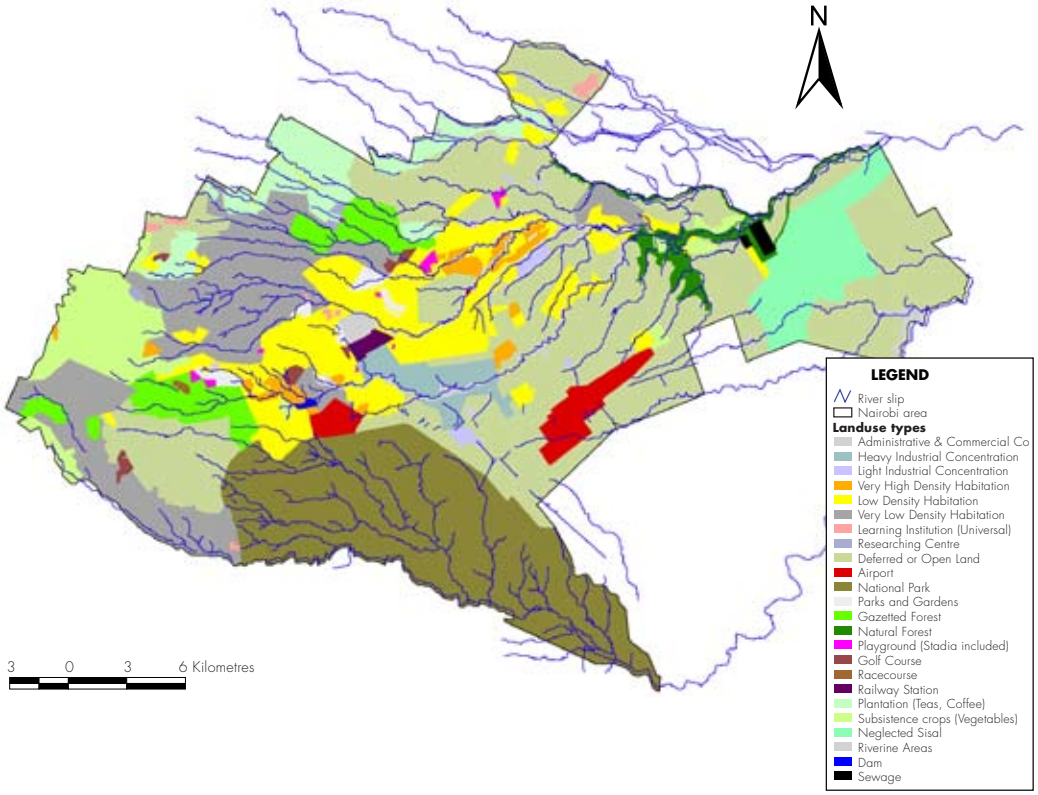
After open land, this is the second most dominant land-use type, covering 25.2 per cent of the city area (DRSRS 1994). Of this, informal settlements housing 65 per cent of the city's population occupy just 5 per cent of the total area used for residential purposes (Practical Action 2005). A detailed analysis of trends and impacts of residential uses is given in section 3.4, on human settlements.

Industrial, commercial and service centres

Commercial land use: In 1948 commercial land use covered about 2.01 per cent of the city's land area, but fell to 0.4 per cent in 1994. The city's commercial hub, the CBD, has been declining as secondary commercial centres have been growing (Thornwhite, Silberman, and Anderson 1948, Humphreys 1985). Currently, the main CBD has extended to Westlands, Capital Hill and Ngara areas. Other commercial centres are situated at Eastleigh, Eastlands, Buru Buru, Kayole, Karen, Dagoretti Corner, Kawangware and Kangemi. That said, however, the health and environmental management of both old and new commercial developments and services is inadequate.

Industrial land use: The city's area used for industrial purposes has grown phenomenally in real terms, but has decreased slightly in relative terms. Industrial use entails both heavy manufacturing as well as light industries such as warehouses, workshops, "jua kali" workshops, garages and stores. Since the 1970s, the industrial area has expanded to Dandora, Kariobangi, off Mombasa Road up to North Airport road and off Outer Ring road. Some of these extensions have been uncoordinated, leading to incompatible mixed land uses that have merged with or encroached into residential use. Industrial developments and activities are regulated by several laws, including the Public Health Act, the Factories and Other Places of Work Act and the Environmental Management and Coordination Act. Enforcement of these legal instruments has been inadequate, however, resulting in poor sanitation and environmental conditions.

Quarrying is one industrial land use of emerging concern. A vibrant construction sector has led to increased demand for building stones, resulting in more excavated quarry sites, ruining the natural environment. It is carried out mostly in the eastern parts and western outskirts of the city. Wasted quarries usually have low aesthetic beauty and landscape value and are a danger to public health and safety. The quarrying process uses explosives such as dynamite and produces much noise, smoke and dust. Accordingly, in accordance with the requirements of the Physical Planning Act, the Environmental Management and Coordination Act 1999 and other related statutes, a conservation strategy to reclaim abandoned quarry sites should be pursued.



Industrial area when viewed from Mukuru slums

Source: Oningo and Barreh

Infrastructure land use and development

Infrastructure comprises road and railway networks, water supply, power supply and telecommunication systems, sewerage networks and treatment works and airports. These are discussed in the sections on transport and telecommunication; and water and sanitation.

Recreational areas

In the 1990s large areas of public recreational land were indiscriminately grabbed by politically well-connected individuals and private developers. The hitherto elaborately planned open spaces have been built up and currently the city lacks recreational open spaces. This has significantly lowered the city's environmental quality and aesthetic value.

Urban open spaces generally permit many uses, such as aquatic recreation (swimming, fishing) and other outdoor pursuits, park land, municipal depots, playing fields, golf courses, parks, picnic sites, scout halls, landscape buffers and community paths. The aim of protecting open spaces is to meet the recreational and social needs of urban dwellers; to provide facilities for outdoor passive and active recreation; to enhance the aesthetic value of urban areas and improve quality of life; and to enhance the environmental qualities of the urban landscape.

Farming along river courses in Mwiki, Nairobi
Source: C. Situma

Water bodies and riverine areas

Water bodies and riverine areas cover 1.69 per cent of the city land area. Increasingly, pollution from municipal, industrial, mining and agricultural sources continue undermining water supplies, causing water-borne diseases and exacerbating the incidence of poverty and social inequality. Issues relating to this land use are described in more detail in the section on water and sanitation.

Urban agriculture

About 13.9 per cent of land in Nairobi is under urban agriculture. By the late 1990s about 150,000 households were involved in urban farming (Foeken and Mwangi 1998). It is steadily becoming an alternative livelihood in the city. The benefits of urban agriculture include food security, use of underutilized urban resources, use of urban waste and income-generation. Urban agriculture has been linked to the improved nutritional status of households (UN-Habitat 2001b). In Nairobi, farming takes place in backyards, along roadsides, rivers and railways, and in parks and industrial areas (Foeken and Mwangi 1998). It is estimated that crops worth over $3.2 million are produced in the city annually from irrigated urban agriculture (Ayaga *et al.* 2004). Women play a vital role in urban agriculture, many of whom engage in cultivation as a survival strategy.

Currently, urban agriculture does not feature in the comprehensive urban development plan. And although most assume it is illegal, a close look at the Local Government and Public Health Acts and the Nairobi By laws indicates that urban farming may be practised under certain restrictions (Ayaga *et al.* 2004).

Impact of urban agriculture on the environment

While urban agriculture presents opportunities in support of alternative livelihood strategies, it is not without environmental impacts. The risks range from an upsurge of zoonotic diseases to chemical poisoning and environmental damage.

Unattended livestock (both those allowed to graze, often on refuse, and also strays) are likely to consume industrial effluents or waste products containing heavy metals. These are hazardous to the animals and can end up in the human food chain. Low-income farmers in Nairobi also block sewers to get the water and nutrients for irrigating their crops, causing risks from pathogens as well as any heavy metals in the wastewater.

Livestock rearing is also an emerging issue. Chicken, goats and cattle are reared and are a familiar sight in Kibera, Mathare Valley and Korogocho areas. Cow dung and animal droppings are abundant, contribute to the volumes of waste and contaminate watercourses.

According to Ayaga *et al.* (2004) urban and peri-urban flower farms, which are increasingly being favoured by urban farmers, present a specific set of problems. They consume a great deal of water, which contributes to urban water shortages. In peri-urban areas, where people rely on boreholes or shallow wells for domestic water supply, these may be contaminated by the large amounts of agrochemicals used by flower farmers. There is adequate legislation in Kenya governing public health that can be invoked to tackle the above mentioned issues, but the problem is enforcement.

The importance of urban and peri-urban agriculture is growing because of its ability to assist, resolve or cope with diverse development challenges. For instance it has been shown that urban agriculture provides up to 20 per cent of the food needs of Chinese cities (Badcock 2000). Urban agriculture is most viable where it is mainstreamed into robust strategies for land use poverty alleviations, economic development and sound environmental management (UN-Habitat 2001b). Opportunities to improve urban farming in Nairobi and make it more sustainable should be explored by the city authorities. Strategies could include better farming practices and more conducive policies by the Government.

Kenya is a signatory to the Harare Declaration of 2003 on urban and peri-urban agriculture in eastern and southern Africa, which recommends the development of policies to create an enabling environment for integrating urban agriculture into the urban economies. Against that background, there are calls for the development of an appropriate policy framework for urban agriculture in Kenya (Ayaga *et al.* 2004). In addition,

Replanting of reclaimed area in Karura forest

Source: Oningo and Barreh

the draft national land policy provides for the promotion of multi-functional urban land use and the creation of an appropriate legal framework to regulate and govern urban agriculture.

Open lands and others

The Nairobi area has a unique habitat, dissected by numerous rivers and streams, which ultimately flow into the Athi River. It has a great diversity of local ecological conditions of different altitudes, rainfall levels and soil types within a relatively small area. The array of ecosystems and constituent biodiversity allows people to enjoy good health, social organization, economic activities, the built environment and life itself. A number of sites still have substantial biodiversity, but these are being threatened by land fragmentation, degradation, or outright loss of habitat; overexploitation; the introduction of non-native species; pollution; and climate change (WHO 2005).

Protected areas

The protected areas in Nairobi include the Nairobi National Park, City Park and four forest reserves: Karura, Ngong Road, Ololua and the Arboretum. Key characteristics of these are presented in table 3.2.

Nairobi National Park has vegetation cover that is predominantly dry savannah, open grass plains with scattered acacia bushes (KWS 2006). The park also has a permanent river with a riverine forest. It is located within the city of Nairobi – the only city in the world with a large assemblage of wildlife in its environs. The park is a major rhino sanctuary, supports the second largest animal migration after the Masai Mara, and is a dry season refuge for most wildlife. The benefits of the park include recreation, environment education, employment and income generation. The park is also an important carbon sink for Nairobi.

Nairobi National Park is separated from the city by a fence on its northern, eastern and western borders, while the southern border is open and allows the in and out-migration of wildlife to Amboseli and the Serengeti through the Kitengela and Athi-Kapiti Plains (Kajiado district), which forms a dispersal area of around 2,500 km^2 (Gichohi 2000 in Rodriguez *et al.* undated). The importance of Kitengela dispersal area for the sustainability of the national park is well documented (Nkedianye 2004 in Rodriguez *et al.* undated). Based on its importance, the Kitengela plains (390 km^2) were declared a conservation area in order to provide protection for migratory wildlife. His status was never legalized, however, and the area has no land-use constraints (Gichohi 2000 in Rodriguez *et al.* undated).

In recent years land in that area has been sold to private land owners. Changing land use (settlements, agriculture, industry) and subdivision of land are affecting the integrity of the dispersal area, declining primary productivity, diminishing animal biodiversity and reducing wildlife migratory corridors (Nkedianye 2004 in Rodriguez *et al.* undated). Human-wildlife conflicts are on the increase (Gichohi 2000 in Rodriguez et al. undated) and air pollution and poor waste management from human activity are compounding the situation. In March 2006, the Kenya Wildlife Service (KWS), working through a participatory process with key stakeholders, produced a land-use zonation map for Isinya-Kitengela area for inclusion into a master plan.

Nairobi National Park is managed in line with the KWS strategic plan for the period 2005–2010. One of its objectives is to improve management of protected areas, important wildlife areas and endangered species. This is achieved, first, by securing wildlife dispersal areas and wildlife migratory corridors; second, by managing the livestock-wildlife interface and developing community wildlife benefit programmes; and, third, by developing conservation education programmes for communities and collaborative institutions.

Nairobi City Park is located between Limuru road and Forest road. It was carved out of Karura forest and preserved as a recreation facility. Part of the city park was landscaped with ornamental trees, lawns and flower gardens with a stream running through the park. The rest of the land, a remnant of the forest, provides a habitat for many plants and animals.

Forests

When Nairobi was established, the landscape was a mosaic of open grassland, montane closed forest and moist woodland swampy areas (Ndungu *et al.* 1995). The natural vegetation in the city area has thus been greatly modified. Small and steadily shrinking pockets of indigenous vegetation still remain undisturbed in parts of the Karura and Ngong forests, however. Other forested areas include Ololua and the Nairobi Arboretum. The forests provide a vital carbon sink for Nairobi's industrial activities and are important as water catchments and have great potential value for recreation.

Box 3.1: Overview of the forests in Nairobi

Karura forest is a dry upland forest and is the water catchment for Thigiri, Karura, Ruaraka and Gitathura river systems. It supports plantation trees, indigenous trees and grasslands. Planted and indigenous trees are the main source of timber, with the latter being the source of highly valued hardwood used for domestic furniture and wood carvings. It has unique indigenous plant species that provide shelter to various fauna and below ground biodiversity.

Over the years **Ngong road forest** has been excised, leaving it highly fragmented. The forest supports planted trees, indigenous trees and grasslands. The plantation area consists of exotic trees, with eucalyptus species occupying 148 ha, pine species 2.7 ha and cypress species 6.8 ha. Indigenous trees planted include *Croton* and *Cordia* species grown on 11.3 ha. The indigenous natural habitat and grassland occupy 504 ha of the sanctuary. The forest has had several excisions since being gazetted, most of these occurring between 1963 and 1994.

A quarter of **Ololua forest** is set aside as nature reserve with nature trails on the forest for public education and awareness. The forest has been threatened by frequent mining activities, which have contributed to high biodiversity loss. In fact, in conjunction with stakeholders such as the Forest Working Group and East African Wildlife Society, the Government has banned any further mining activity in the forest.

The **Nairobi Arboretum** has been used mainly for trials of plant species introduced in the country. Some notable species were those introduced from tropical regions of the world, especially Australia.

Source: JICA, 2005 (a)

The main causes of forest loss include deforestation, illegal logging and irregular allocation of forest land. Illegal loggers usually target high-value tree species, resulting in the degradation of the quality of protected forest reserves. For instance the *Muhugu* tree *(Brachylaena huillensis)* that is highly valued for wood carving is being extensively harvested from the Ngong forest (IUCN 2003). Forests are also being lost to clearing by the Government for development, settlements and land speculation or for political reasons (Kigenyi *et al.* 2002).

Allocations of parts of Karura, Ngong Road forests and parts of City Park to residential and other related developments have significantly reduced the city's forests cover and green spaces. This is likely to affect the city's microclimatic conditions and its subsoil and subsurface water courses. In addition, implementation of the proposed 60-meter wide southern by-pass through Ngong Road forest will clear about 30 hectares of forest. This will reduce the city's forest cover against a backdrop of increased emissions into the atmosphere (Barreh 2004, JICA 2005b). Current excisions have reduced the area of Karura forest by 46.8 per cent to 564.1 ha; and Ngong Road forest by 54.6 per cent to 1,328.2 ha (KNCHR/KLA 2006). At current market value, these excisions are worth about KSh 8,015 million and KSh 9,173 million from Karura and Ngong Road forests respectively (KNCHR/KLA 2006).

Forests are also disappearing because of weak law enforcement, budgetary constraints in the institutions responsible for forest management, corruption and outdated forest policies. For instance, the previous Forest Act (Cap. 385) permitted the minister to gazette and de-gazette forest reserves. This section was often abused, with the minister taking unilateral decisions without consultation or prior environmental assessment (Gachanja 2003). The current Forest Act (2005) makes the process of conversion of a forest area into alternative land use more stringent.

Table 3.2: Characteristics and biodiversity of key protected areas in Nairobi

Name	Managing Authority	Area (ha)	Common Species	
			Plants	Animals
Nairobi National Park; Established 1966	Kenya Wildlife Service (KWS)	11 640.0	*Olea africana, Croton dichogamus calodendrum, Themeda, Cyprus, Digitaria, Cynodon, Acacia, xanthophloea, Euphobia candelabrum, Apodytes dimidiata, Canthium schimperanum, Elaeodendron buchananii, Newtonia sp., Ficus eriocarpa, Aspilia mossambicensis, Rhus natalensis, Euphobia brevitorta, Drimia calcarata, Murdannia clarkeana* and Crassula sp.	Giraffes, lions, gazelles, buffaloes, hartebeest, wild pigs, wildebeest, warthogs, crocodiles, hippos, and about 400 species of birds
Karura Forest; (Gazetted 1932)	Forest Department	1 063.0	*Olea europeae var. africana, Croton megalocarpus, Warburgia ugandansis, Brachyleana huillensis* and *Uvaridendron anisatum*	Monkeys, bush baby, bush bucks, bush pigs, porcupines, duikers, genets, dikdik, epauletted bat, African civet
Ng'ong Forest	Forest Department & KWS	638.4	*Eucalyptus, Pine, Cyprus, Croton* and *Cordia species*	Over 120 species of birds, Over 35 mammals such as leopards, monkeys, reptiles, insects, and amphibians
Ololua Forest	Nairobi City Council and The National Museums of Kenya	667.0	*Olea africana, Eleodendron buchananii, Akokanthera schimperi, Brancylaena species, Croton megalocarpus, Carisa edual and Rhus natalensis. Others include aloe, Acacia* species	Olive baboons, monkeys, yellow baboons, porcupines, bush baby, bush bucks, bush pig, dikdik, epauletted bat, duikers, African civet, and genets, grey wagtail, Eurasian cuckoo, willow warbler
The Nairobi Arboretum	Forest Department; Established 1907	25.0		Chameleon, skunks, butterflies, dragonflies, ants, bees and beetles, Ayres's hawk eagle
Nairobi City Park	Nairobi City Council	60.0	*Olea europeae var. africana, Croton megalocarpus* and *Warburgia ugandansis*	Hundreds of bird species, butterflies and baboons

Source: KWS 2006, JICA 2005 (a)

Table 3.3: Number of visitors to parks and other conservation areas in Nairobi

Name	2001	2002	2003	2004	2005
	Number of visitors ('000)				
Nairobi	101.6	90.4	71.3	92.5	99.9
Nairobi Safari Park	113.5	114.4	66.3	88.0	127.5
Animal Orphanage	151.1	254.5	205.3	239.4	257.8
National Museum (main gate)	251.6	202.7	275.4	223.9	242.4
National Museum (snake park)	83.6	76.2	84.2	97.9	105.1
Karen Blixen Musemu	51.3	46.4	34.0	47.4	59.1
Swahili House	0.8	0.5	0.5	0.6	0.8

Source: CBS 2006

The protected areas and forests in Nairobi are an asset of great importance to the tourism sector. As the capital city and commercial centre and with a location close to many tourist attractions both in Kenya and East Africa, Nairobi attracts many businessmen and leisure tourists. This is partly because Jomo Kenyatta International Airport, the main port of entry to Kenya by air is in Nairobi and many tourist safaris originate and conclude in the city. The sector is dominated by nature-based tourism underpinned by the rich animal biodiversity in Kenya's national parks. Other tourist products also promote the city's cultural heritage, history, folk arts and crafts, and the natural environment (ecotourism). Moreover, with its good conference facilities, Nairobi hosts many international conferences that have become an established facet of Kenyan tourism. Table 3.3 shows trends in the number of visitors to conservation areas in Nairobi.

Tourism is a growth industry and its growth potential is likely to continue. It contributes to economic diversification through linkages to other sectors (like transport, agriculture, fishery, forestry, construction, and handicraft), and potential multiplier effects on the local, regional and national economy.

Tourism can have major environmental effects, particularly in view of the growing demand for land for human settlement and the demands for the same resources that sustain the tourism industry. Massive development and the generation of waste without heed to the environmental consequences pose a growing problem. The impact of tourism on the environment is largest where visitation is concentrated. Promoting mass tourism and increasing numbers of tourists presents a management dilemma for park planners and often compromises wildlife conservation and environmental values. The National Park visitor carrying capacity may be exceeded resulting in over-use of park resources, visitor or vehicle overcrowding, reduction of the park's natural beauty and visitor dissatisfaction (Ondicho 2000).

Tourism as an asset for development has certainly not been undervalued; however the challenge is how to maximize the growth of the industry, while at the same time minimizing the impact on the environment. Mitigation efforts need to tackle the following issues: the disregard of environmental regulations by tour operators; inadequate coordination of institutions dealing with tourism; inadequate political and administrative capacity; policy failures, including the lack of an effective land-use policy; inadequate incentives to stimulate interest of local people in conservation; inadequate marketing resources; insecurity, rampant poaching and the high cost of changing these practices (NEMA 2003). The 1999 Environment Management and Coordination Act sets out regulations relating to the use and management of environmental resources. In addition, a new approach promoting ecotourism and other forms of alternative tourism has been outlined in the tourism policy framework and emphasized in the National Tourism Development Master Plan (Ondicho 2000).

Interlinkages between the natural environment, Nairobi city and development

The interlinkages between cities, ecosystems, biodiversity and forests at local and regional levels are well documented. Biodiversity provides the base for economic and social development, including poverty reduction. It forms the foundation of ecosystems, which provide important ecological services. Cities rely heavily on these ecosystem services for their existence and growth, especially the urban poor who cannot afford to purchase services. Such ecosystem services

include water, food, fuel, construction material, clean air, reduced vulnerability to environmental changes and natural disasters and other services. In contrast, poorly managed and degraded urban ecosystems can lead to air, water and soil pollution, which increases input prices and operating costs for industry as well as for the provision of basic urban services by local governments. Depleted natural resources in and around a city can deter new investments and reduce human well-being with negative implications for their ability to earn a livelihood.

Cities are neither ecologically self- contained nor self-sufficient. And with growing populations and rising consumption levels they put a strain on the natural resources base within – and most especially outside ¬– the city boundaries (Rees 2003). This can best be illustrated by the concept of "ecological footprint" (box 4.6).

Nairobi occupies an area of 696.1 km^2 (0.1 per cent of Kenya's total surface area) and has almost 25 per cent of the country's urban population (UN-Habitat 2001b), who all depend on natural resources and ecosystem services for their survival while generating various kinds of waste. Now, assuming that Nairobi residents enjoy the average Kenyan footprint of 0.8 ha/person (GFN 2006), with a population of 2.8 million in 2005, it can be estimated that the aggregate footprint for Nairobi is 2,240,000 ha or 32 times its area. While this may be low compared to cities elsewhere in the world, it still means that, at current levels of economic production and consumption, the human load exceeds the long-term carrying capacity of the city (Rees 2003).

It may be argued that the relationship between cities and the rural hinterland is a mutualistic one. It is important, however, to note that rural populations can survive without cities, but the ecological dependence of city residents on the biodiversity and ecosystem services of the rural environment is absolute. In other words there can be no urban sustainability without rural sustainability (Rees 2003).

Given the above interlinkages and interdependencies, local leaders must ensure that biodiversity and ecosystems are appropriately valued and recognized and that the opportunities and benefits of conservation are realized. The policy implication is that the City Council of Nairobi should strive to reduce Nairobi's footprint by using natural resources more efficiently and innovatively. For instance, waste reuse, as is already happening in urban agriculture, could be an excellent means of reducing Nairobi's spreading ecological footprint by feeding resources back into the countryside, thereby reducing the city's impact on the surrounding environment.

3.3 Human Settlements

In 1948, about 51.95 km^2 (58.43 per cent) of the city's area was covered with residential areas ranging from very low to very high density. In 1979 residential land use had increased to 217.6 km^2, constituting about 31.81 per cent of the city's 684 km^2, but by 1994 the planned residential land area decreased to about 175.6 km^2 out of 696.27 km^2, covering approximately 25.22 per cent of the city. This was due to the re-zoning of various residential neighbourhoods to commercial and other institutional uses, particularly around Capital Hill and Kilimani areas, Ngara, Forest road, Westlands and Parklands areas.

Box 3.2: Ecological footprint

A city's ecological footprint is the area of productive land and aquatic ecosystems required to produce the resources used and to assimilate the wastes produced at a specific material standard of living, wherever that land may be located (Rees 2003). For Kenya this was 0.8 ha/person in 2003, which is the average for low income countries (GFN 2006). The average for Africa is 1.1 ha/person (GFN 2006).

Many factors influence the area of a given population's ecological footprint, including the population size, the average material standard of living, the productivity of the land and water base, and the (technological) efficiency of resource harvesting, processing, and use (Rees 2003).

Source:

The existing environmental problems in human settlements are the result of current urban policies. These problems are exacerbated by locating settlements on fragile land; inadequate infrastructure and services provision such as solid waste management, water supply and sanitation; and inadequate development control.

3.3.1 Trends in housing development

Housing constitutes a major dilemma for Nairobi. The housing deficit has resulted in the proliferation of informal settlements, construction of unauthorized extensions in existing estates, poor standards of construction of housing units and increasing conflicts between tenants and landlords, especially in low-income housing estates and informal settlements. Housing development problems in Nairobi are the result of high rates of urban growth; lagging development of the urban infrastructure that supports housing development; the low purchasing power of the majority of urban households; and restrictive building by laws. There is also a limited supply of serviced land for public purposes and restrictions on access to formal housing finance, because of the strict lending criteria of financial institutions.

The current urban housing needs are estimated at about 150,000 per year, but only 30,000 are being built, resulting in an annual shortfall of over 120,000 units (Kusienya 2004). The response by the public sector in building houses has not kept pace with the increase in population, leading to a shortage of affordable housing. Public investment in housing development has dwindled, owing to inadequate budgetary provision and the emerging economic trend towards increasing private sector involvement in various sectors. For instance, approved government expenditure on housing decreased by 10.2 per cent from KSh 542.64 million in 2004/05 to KSh 487.19 million in 2005/06 (CBS 2006). This has exposed the sector to market forces which are not sensitive to the needs of the middle and low-income population, hence the continued mushrooming of informal settlements and haphazard extension of housing developments. Such housing extension has been witnessed in various estates, such as Buru Buru and Ngumo. In addition, single family dwellings have been converted to multi-family dwellings in estates in the Kilimani, Kileleshwa and Lavington areas in contravention of the permitted zone classification requirements.

Only 11.5 per cent of households live in publicly owned dwellings, meaning that the rest are catered for by the private sector. There is therefore need for a review of the current policy where the public sector only plays a facilitative role in housing development.

Quality of housing

Almost 7 per cent (722,000) of the total housing units in Kenya are found in Nairobi (CBS 2002b). Most of these (67 per cent) are one-room dwelling units (CBS 2002b). In such conditions overcrowding – particularly in poorly ventilated accommodation – is a cause of environmental health problems. Thus, reports indicate that most single rooms in Mathare Valley and Korogocho have an occupancy rate of 6–8 people (Hayombe 1997). Housing units which have 2.5 or more people per habitable room are considered overcrowded. The housing quality index developed by the Central Bureau of Statistics (see box 3.3) indicates that 74.9 per cent of Nairobi residents have housing of a quality that ranges from good to high, and 25.2 per cent housing of average quality (CBS 2002b). The paradox is that, despite having fairly good quality housing, a significant proportion of households in the slums and informal settlements are exposed to poor sanitary conditions, inadequate water supply and overcrowding.

Iron sheets, tiles and concrete are the main roofing materials, while cement and earth are the main materials used to finish the floors. In Nairobi, 77.2 per cent of the floor finish is made of cement. The main wall materials used are stone (41 per cent), iron sheets (19.84 per cent) and bricks or blocks (14.34 per cent). In all, 67 per cent of housing units are roofed with iron sheets, and 11.8 and 16.4 per cent with tiles and concrete respectively. Of concern, however, is the 3.2 per cent of houses roofed with asbestos (CBS 2002b). The health implications of asbestos are very well documented.

Box 3.3: Housing quality index

Kenya's housing quality index provides a quick way of analysing the quality of the living environment in the country. It uses the following elements in its assessment of adequate shelter: construction materials (roof, wall, and floor) and access to basic social amenities (water, human waste disposal, cooking fuel and lighting.). Ranks are then awarded ranging from high quality to poor quality.

Source: CBS 2002b.

The types of building materials used can have environmental impacts. For instance, roofing materials combine with other paved surfaces to increase the city's paved surface area. This may constrain the ability of the underlying soil to absorb rainwater and other surface run-off. Roofing sheets made of corrugated iron can also contribute to heavy metal pollution. Over time these iron sheets may corrode and the zinc oxide and iron oxide formed may end up in the soil or river water. This may have health implications for those who harvest rain or river water for domestic use.

3.3.2 Informal settlements

Informal settlements in Nairobi have grown gradually since 1902, when Nairobi was officially founded. When European settlers appropriated large tracts of land in Kiambu, Limuru, Mbagathi, Ruiru and other areas, many people were displaced. The colonialists made little provision for accommodation for the Africans and this led to the emergence of squatter settlements (Rakodi 1997). With independence, the Africanization policy led to even more people coming to the city. Consequently, temporary dwellings began to spring up. Shihembesta (1989) reports that the Kenyatta administration allowed migrants who could not find accommodation in the formal low-cost estates like Kariokor, Bahati and others to put up shacks within the city, as long as these were not too close to the CBD.

Some of the drivers leading to the development of informal settlements include rapid increase in urban population, high cost of land and land speculation, inadequate housing, lack of proper forward planning preceding actual development, declining modern sector employment and urban poverty among others. Other factors leading to the proliferation of informal settlements are listed in box 3.4.

By 1993, about 55 per cent of the city's population was living in unplanned settlements (Matrix Development Consultants1993). These settlements are variously called squatter settlements, unauthorized subdivisions, substandard inner-city housing, custom-built slums, and boarding houses (World Bank 2000). Between 1971 and 1995 the number of informal settlements within Nairobi rose from 50 to 133, while the estimated total population of these settlements increased from 167,000 to 1,886,000 (UN-Habitat 2003a). Table 3.4 and figure 3.2 show the distribution of informal settlements by division.

Most informal settlements are found in Dagoretti, Langata, Kasarani, and Makadara divisions (Rakodi 1997). There is great disparity, however, in the spatial occurrence and size of the informal settlements. For instance, Kibera (Langata division) and Kawangware (Dagoretti division) cover areas of 225.6 and 111 ha respectively; while others like Spring Valley (Parklands division) and Mitumba (Langata division) cover areas of just 1.29 and 1.5 ha respectively (Matrix Development Consultants 1993). Table 3.5 highlights some of the differences between the informal settlements.

Box 3.4: Causes of slums and informal settlements

- The deficit in housing supply as a result of a combination of factors including high population and urbanization growth rates, coupled with high incidence of poverty among the population.
- The inability of the country's economy to cater for the housing needs of low income groups who form the majority.
- Failure to give the housing sector its due priority in the general economic development.
- Housing and urban development policies that tend to favour production of formal housing.
- Prohibitive building standards and regulatory requirements making the production of formal housing unaffordable to low income households. The poor have no alternative but to live in cheap shelters available in slums and informal settlements.
- Lack of effective land policy that tends to allow manipulation in land tenure and alienation.
- Poor urban governance leading to ineffective and inefficient development and delivery of urban services
- Politicization of development, land and shelter issues.

Source: COHRE 2006

Table 3.3: Breakdown of informal settlement per division, 1995

Division	No. of villages	No. of structures	Approx. no. of rooms	Total population
Makadara	7	5 013	11 496	68 976
Pumwani	11	3 136	10 418	52 090
Embakasi	14	3 865	14 865	44 595
Kasarani	43	26 530	97 715	390 860
Parklands	7	2 190	9 310	37 240
Dagoretti	34	15 240	97 320	389 280
Langata	17	21 615	180 625	903 125
Total	**134**	**77 589**	**421 749**	**1 886 166**

Source: Ngau 1995 in UN-Habitat 2001a

Table 3.4: Informal settlements in Nairobi, area covered and number of persons per unit

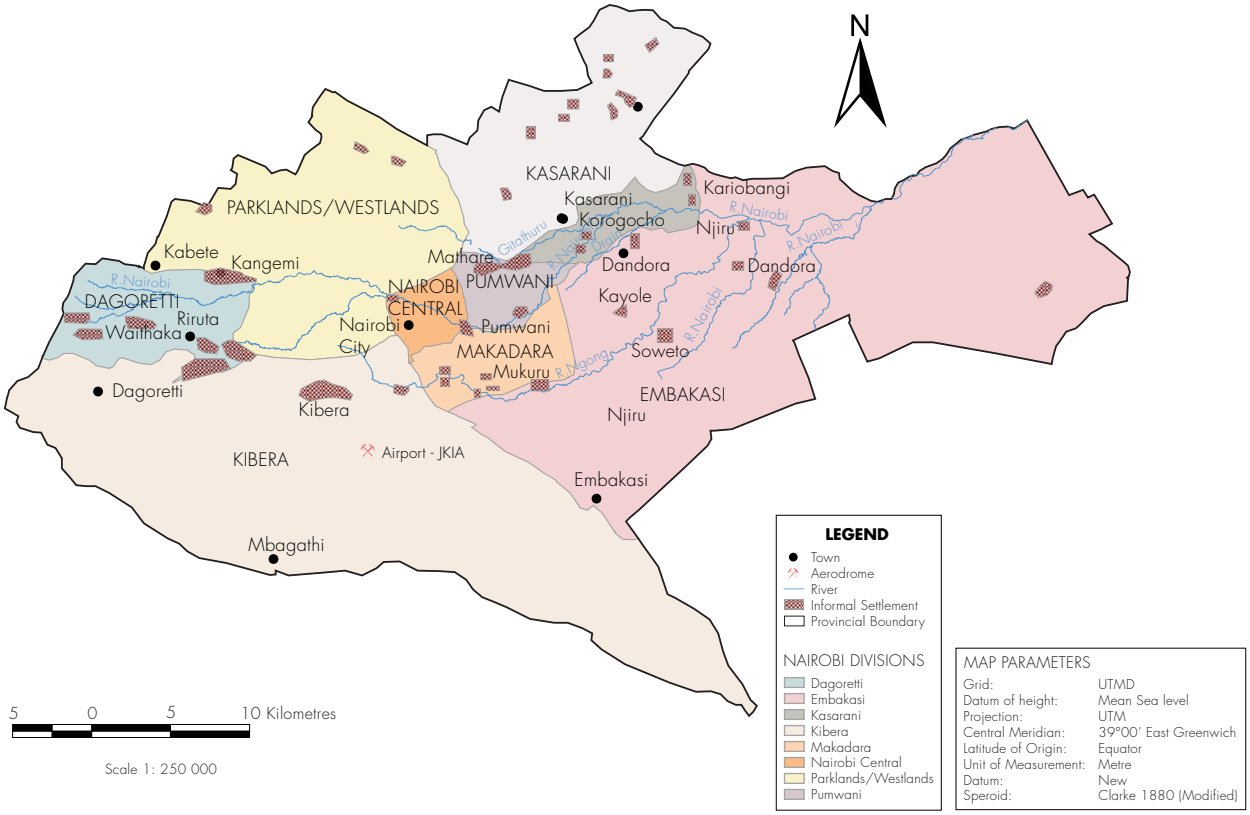
Name of Settlement	Area (ha)	Average no. of dwelling units per acre	Average no. of persons per unit	Estimated population
Makadara division				
Mariguini	14.2	300	4	17 040
Express	16.8	300	4	20 160
Mukuru	54.4	300	4	65 280
Langata division				
Kibera	225.6	220	5	248 160
Mitumba	1.5	200	4	1 200
Bomas	2.1	200	4	1 680
Kasarani division				
Mathare	73.7	200	4	58 960
Korogocho/Kinyago	49.2	230	5	56 580
Thome	7.3	100	5	2 190
Njathini	8.75	100	3	2 624
Garba	13.75	100	3	4 125
Githurai	21.8	100	3	6 540
Kahawa	30.5	100	3	9 150
Kamae	9.95	100	3	2 985
Dagoretti division				
Ngando	12	100	5	6 000
Riruta	15	100	5	7 500
Karandini	23	100	5	11 500
Kawangware	111	100	5	55 000
Muslim village	37	100	5	18 500
Village	75	100	5	37 500
Kangemi	14.5	100	5	7 250

Table 3.4: Informal settlements in Nairobi, area covered and number of persons per unit *(continued)*

Name of Settlement	Area (ha)	Average no. of dwelling units per acre	Average no. of persons per unit	Estimated population
Dagoretti	41	100	5	20 500
Waithaka	45	100	5	22 500
Embakasi division				
Maili Saba	39.7	100	3	11 910
Kayole	23.3	200	3	13 980
Soweto	10.0	200	3	6 000
Pumwani division				
Buru Buru	4.5	140	3	1 890
Pumwani Village	10	250	4	10 000
Parklands division				
Runda	11.5	100	3	3 450
Kitisuru	11.25	100	3	3 375
Spring Valley	1.67	100	3	501

Source: Matrix Development Consultants 1993

Figure 3.2: Informal settlements in Nairobi



Map production: RCMRD

Emerging issues in the informal areas

Rapid growth of the population of Nairobi has increased demand for land, leading to land speculation and forcing the poor to settle on fragile land zones (Hayombe 1997), where they are increasingly vulnerable to environmental change. These fragile areas include flood plains, steep slopes, river valleys and areas adjacent to sewers or dump sites. The poor who live in these fragile areas are at the mercy of environmental vagaries, especially flooding. For instance, the areas of Mathare Valley and Kibera (near Nairobi Dam) were affected by the El Niño floods of 1997 that led to devastating loss of human life, structures and properties. Apart from risks from floods, settlements on contaminated and derelicts lands or near dumping sites face health risks.

Other problems faced by those in informal settlements include: overcrowding and high population densities; poor sanitation and lack of other infrastructure; buildings in poor structural condition and made of temporary and semi-permanent materials; breakdown of social networks; and a high degree of tenure insecurity. Most of these settlements are illegal and this exposes them to the constant threat of eviction and harassment. Slum demolition is justified by the Public Health Act and, unless the issue of adequate housing is properly dealt with, such evictions will remain largely ineffective since they only displace, but do not solve, the underlying problems. Box 3.5 discusses the problem of forced evictions.

In 1997, the Nairobi Informal Settlements Coordination Committee recommended a framework for recognition of informal settlements. This has never been adopted.

3.3.3 Addressing the housing challenges

The land question underpins the development of adequate housing. Land speculation and high prices have been a major impediment for housing, especially for low-income sectors in Nairobi. The demand for houses has pushed up land prices, leading to land speculation and often corruption in land allocation and appropriation process. Equity issues in land distribution, appropriate land use and management practices are fundamental to sustained economic growth and thus poverty eradication. Sustained livelihood and poverty eradication will definitely result in enhanced environmental quality. It is clear that poverty, which manifests itself in filth and squalor, lack of basic infrastructure and services, poor health and high mortality rates in informal settlements could be solved if the land question is solved.

In an attempt to reduce some of the problems of informal settlements, slum upgrading and site and service schemes have been encouraged. The Government has established the Slum Upgrading and Low Cost Housing and Infrastructure Trust Fund to serve as a depository for funds mobilized for the Slum Upgrading Programme. In the financial year 2005/06 the Government allocated US$ 6 million for the Kenya Slum Upgrading Programme (UNDP 2005). This programme is described in box 3.6. Some successful upgrading programmes have also been undertaken by non-governmental and faith-based organizations and various development partners. For example, Undugu Society of Kenya, working with provincial administrations and the community, upgraded the Pumwani settlements of Kitui, Kinyago and Kanuku.

Box 3.5: Forced evictions in Nairobi

Forced evictions are a re-emerging issue in Nairobi's informal settlements. These were originally sanctioned by laws like the Vagrancy Act and the Public Health Act. For example, Kileleshwa was demolished in 1927 after European settlers in surrounding areas complained that it was a "breeding ground" for crime and disease. The same fate befell Kariokor in 1931 and Pangani in 1938. More recently in early 2004, the Government announced its intention to evict people illegally settled on land reserved for future road construction or on public land that was considered dangerous, like rail reserves and electrical wayleaves. Such demolitions have disastrous effects on the residents. The internal displacement can lead to increased violence, insecurity, loss of livelihoods, community structures and consequently greater poverty for those affected. For instance, the Kenya Railways Corporation issued a notice on 29 January 2004 that it would demolish all structures located within 100 feet on either side of the railway line in Kibera. Studies showed that over 20,000 structures along the line would be demolished and over 108,000 people rendered homeless and internally displaced. The broader Kibera community would also be affected, as the demolitions would destroy 13 primary schools, two churches, a health centre and three meeting halls.

Source: COHRE 2006

Box 3.6: The Kenya Slum Upgrading Programme (KENSUP)

The Kenya Slum Upgrading Programme is a nationwide programme being implemented in collaboration with UN-Habitat and other development partners. The programme comprises of causing systematic improvement of living conditions and working conditions for people in slums and informal settlements with minimal displacement. It is currently on-going in Kibera under the *'Cities Without Slums'* Programme of UN-Habitat. This is a global campaign to promote secure forms of tenure for the poorest populations, especially those living in informal settlements and slums in the cities.

The main activities proposed are to:

- Create a slum upgrading, low cost housing and infrastructure trust fund (KENSUP)
- Provide physical and social infrastructure
- Rehabilitate existing housing structures and development of new ones
- Provide security of land tenure
- Provide facilities for income generation
- Mainstream HIV/AIDS programme in to slum upgrading

Source:

The National Cooperative Housing Union (NACHU) was involved in the upgrading of Kariobangi Community Development Project and, more recently, in the Bellevue Upgrading projects, while the Catholic Church and the German bank KFW upgraded Mathare 4A.

The Government formulated a national housing policy in 2004 and a national housing development programme for the period 2003–2007 to operationalize the policy. The housing development programme aims to satisfy the projected housing needs in the country by adopting innovative strategies and by mobilizing financial and other resources. Some of the key elements of the NHDP include: slum upgrading; site and service schemes; urban renewal and redevelopment; rental housing; tenant purchase; mortgage housing programme; and the civil servants housing scheme.

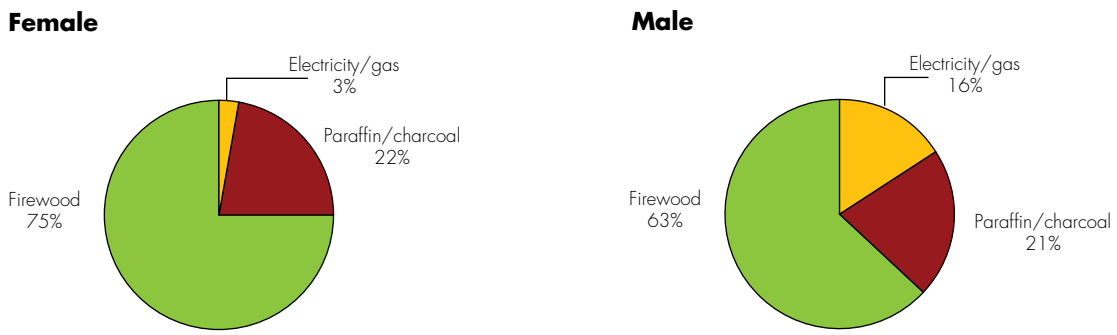
A draft housing bill was also prepared in 2006. It aims to improve access to adequate housing and makes provision for the development of evictions guidelines and for the establishment of a tribunal to adjudicate complaints. The bill also proposes the establishment of a National Housing Fund to aid future housing development. In 2006, the Ministry of Lands also drew up draft guidelines on forced evictions and plans to formulate a comprehensive legal framework on evictions in Kenya.

3.4 Energy

The provision of energy services is essential to economic and social development and improved quality of life. Energy is needed for cooking, heating and lighting of households, power for industry and transportation. Households, commerce and industry in Nairobi use a combination of fuels. Energy sources used include biomass, fossil fuels, hydro and geothermal energy. Every type of energy generates varying degrees of environmental externalities that affect human health, ecological stability, and economic development. These effects can occur at the household community, regional, national or transnational levels.

The factors determining choice of energy use depend on its relative price and the appliances that it will use; income levels; the availability of the fuel and related appliances in the market; and cultural preferences. Biomass is by far the most predominant fuel, providing over 74 per cent of energy consumed in the country (NEMA 2003). Baseline surveys reveal that Nairobi consumes approximately 91,250 tons of charcoal annually, equivalent to the destruction of over 900,000 tons of green wood each year (Barnett and Ndanyi 2003).Data show that 71.4 per cent of Nairobi households have electricity (CBS et al. 2004). For cooking, however, 68.3 per cent of households use kerosene, 19.8 per cent liquid petroleum gas (LPG), 7.4 per cent charcoal and only 1.8 per cent electricity (CBS et al. 2004). When disaggregated by gender, the data show some interesting differences with 16 per cent of men using LPG or electricity compared to 3 per cent of women (JICA 2005b).This is shown in figure 3.3.

Figure 3.3: Type of fuel used for cooking by gender



Source: JICA 2005a

Renewable energy used includes solar, wind and hydropower. Other energy sources commonly used include power alcohol, biogas and municipal solid waste. These have not been well developed because of the pricing structure and the high initial investment cost. Human power is used to drive the handcarts known as "mkokoteni". The Local Government Act requires the licensing of handcarts used in urban areas. Dry cells and vehicle batteries are also used at the household level as a source of energy, in flashlights, radios, television sets and clocks. As more households in the lower income bracket acquire electronic equipment, the use of car batteries to power them is growing. Their use is slightly higher in the urban households. Table 3.5 shows the use of various types of fuel used for cooking in Nairobi in 1989 and 1999, compared with urban and rural areas in the country. Choice of energy source is dictated by its relative price and the appliances to be used; income levels; the availability of the fuel and related appliances in the market; and cultural preferences.

3.4.1 Tackling the energy challenges

In 2004, Kenya adopted a draft national energy policy, which is now before Parliament. Appropriate legislation on biomass energy and technology development is also in the pipeline, to streamline the institutional and policy barriers that have in the past hindered progress towards energy efficiency and biomass conservation in the sector. The large concentration of people in Nairobi provides the economies of scale to diversify into modern renewable energy supply solutions, such as electricity, LPG or other modern biomass fuels like briquettes. This is unlikely, however, to satisfy the energy demands of low-income households.

The Energy Act 2006 adopted in December 2006 provides for the establishment of the Electricity Regulatory Commission (ERC). The regulation of all energy sectors will be the responsibility of ERC. The Commission will advise the Minister of Energy on policy formulation and oversee environmental, health and safety in the energy sector. Other functions include formulation of regulations, codes and standards and developing a national energy conservation programme, among others.

Table 3.5: Distribution of households by main type of cooking fuels in 1989 and 1999

	Firewood		Paraffin		Charcoal		Others	
	1989	1999	1989	1999	1989	1999	1989	1999
Kenya	73	68.6	15.5	17.1	7.2	9.6	4.3	4.7
Rural	90.1	88.4	4.2	4	3.6	5.8	2.1	1.8
Urban	13.1	10	54.9	56	19.8	20.8	12.2	13.2
Nairobi	2.9	1.8	68.4	75.5	8.7	4.0	20	18.7

Source: CBS 2003

3.5 Mobility and transport

Nairobi acts as the central point where journeys begin to destinations all round the country and is itself the country's primary destination. Transport in Nairobi can be divided into five categories: private vehicles, buses, matatus (minibuses), commuter trains and taxis. Sometimes ignored, but equally important are the non-motorized forms of transport, such as walking and cycling. Dealing with urban mobility issues is an economic, social and environmental priority. The city's traffic jams, pollution and inadequate pedestrian facilities and cycle lanes represent a major setback to the productive capacity of the economy, affecting all segments of society.

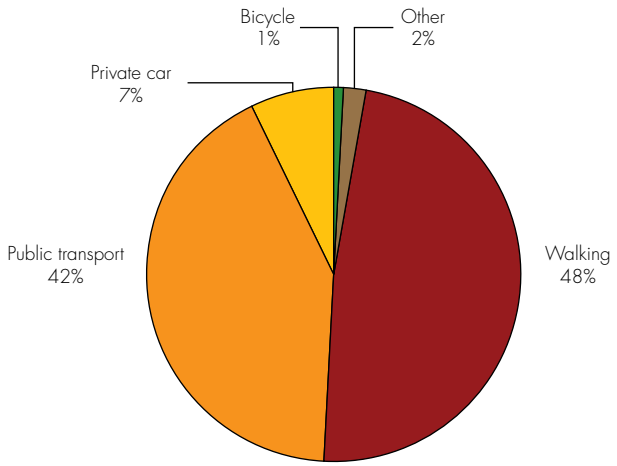
3.5.1 Non-motorised transport

Walking was particularly popularized by the establishment of the "landhies" (barrack-like accommodation initially built for the railway track maintenance staff during the colonial period) that were established close to key suburbs and the CBD, so that workers would not have too far to walk to work. Examples of these landhies are found in Mathare, Kangemi, Kibera and Kawangware. Even today most of the low-income segment of the population walks to work every day, covering distances of 7–15 km (Replogle 1990). This is because of the inadequacy of public transport, the unavailability of alternative forms of transport such as bicycles, and the fact that they cannot afford the daily bus-fare. Research in Nairobi found that on average 47 per cent of trips by adults are made on foot (Howe and Bryceson 2000). For specific destinations there are significant variations. For instance for trips from Eastlands to the CBD, walking represented 47 per cent of trips as a household average; to the industrial area it represented 65 per cent; and locally 70 per cent (Howe and Bryceson 2000). Figure 3.4 and table 3.6 show the modal share of transport in Nairobi.

While walking may be a cheap alternative, pedestrians face a number of hazards. Many roads are only designed for motorized transport and sidewalks for pedestrians are almost non- existent. Waste, parked vehicles or informal businesses often obstruct walking routes, making them generally unsafe and inconvenient (Howe and Bryceson 2000). During the rainy season pools of water also present a major problem. Women are especially concerned with the security aspect of walking and the risk of attack. As result some women are forced to incur the expense of public transport, even for short distances, or take long detours. For most women mobility is severely restricted by insecurity, especially in and around the informal settlements. This even extends to inhibiting their use of bicycles, because they fear that they would easily be stolen (Howe and Bryceson 2000).

For the majority of the population, the only practical alternative to walking or use of public transport is the bicycle. But usage is quite low, with most preferring to walk to work because the roads are too dangerous for cyclists (Replogle 1990). Only about 11 per cent of households own one or more bicycles

Figure 3.4: Modal share of transport in Nairobi



Source: Howe and Bryceson 2000

Table 3.6: Modal transport share by trip purpose

	Home	Work	School	Others	Total
Walking	1 060 324	347 110	273 457	586 388	2 267 280
Two-wheel mode	23 701	22 314	2 052	7 344	55 411
Private car/taxi truck	321 594	259 471	30 917	125 720	737 702
Matatu	662 547	473 796	106 656	153 406	1 396 405
Bus	87 232	60 085	14 066	17 684	179 068
School bus	72 094	29 241	43 545	5 415	150 296
KR/Railway	9 998	10 158	759	617	21 533
Others	3 202	2 750	209	1 600	7 762
Total	**2 240 692**	**1 204 026**	**471 665**	**898 174**	**4 815 457**

Source: JICA 2005b

3.5.1 Non-motorized transport

Nairobi needs to think seriously about supporting sustainable forms of transport. Apart from being non-polluting to the environment, some forms of non-motorized transport, such as bicycles, serve a dual purpose. They provide a means of transport and also livelihood support when used as commodities of trade or facilitating service occupations such as deliveries. There are also backward linkages related to creation of employment opportunities in the informal sector, such as spare parts production and repairs, thus facilitating technological transfer in the transport sector (Kasuku 2002). Despite these advantages, a number of factors appear to be responsible for their lack of widespread use: the roads are not safe to ride on, the required infrastructure is not available, bicycles and costly and cyclists have a low status (Kasuku 2002).

So far much of the emphasis has been on facilitating technology and knowledge options for motorized transport such as the building of by-passes and bridges for motorized transport. It is only recently that non-motorized transport was identified in a key government policy instrument – the 1994–1996 national development plan (Kasuku 2002). The latest national development plan, for 2002–2008, also recognizes the need to provide for non-motorized infrastructure and vehicles. Local authorities are currently providing non-motorized transport facilities in their areas of jurisdiction. For example, the City Council of Nairobi has recently constructed new pedestrian paths across Uhuru park and another one connecting Kenyatta Market and Nyayo High-rise with Madaraka (Kasuku 2002). Also in 2002, the Government announced the elimination of bicycle import duties in an attempt to encourage more widespread bicycle ownership among commuters and bike-taxi operators.

3.5.2 Motorised transport

Private vehicles are mainly used by the middle and upper-income groups, owing to the high cost of purchase and maintenance. City officials estimate that the number of private cars registered in Nairobi has tripled in the past five years to nearly 1 million (Ryu 2005). Mass transportation is provided by trains, buses and matatus. The matatus are small motor vehicles, usually pick-ups or minibuses, which ply for hire along public bus routes (Memon and Lee Smith 1989). Table 3.7 summarizes the public transport facilities in Nairobi. It is estimated that the Kenya Bus Service and matatus make a total of one million trips per day (Bultynck 2001). Overall, more than 500,000 vehicles drive in and out of Nairobi every day (NMS 2006).

The CBD has for a long time been subjected to numerous traffic problems, which are exacerbated by a lack of space in its vicinity, weak enforcement of traffic regulations, parking restrictions, land-use control, type of transport available and the failure to develop an adequate policy and planning framework. The crowding and jostling at most of the city's transport terminals, especially during the rush hours, provide a clear manifestation that the transport needs remain unsatisfied. Congestion at peak hours is causing significant financial losses for the city. If each of the 1 million registered private cars burns one litre of petrol in traffic every day, at current costs of KSh 75 per litre, this translates into a loss of more than KSh 75 million per day.

Table 3.7: Summary of the public transport system

Transport type	Existing conditions	Problems
Bus and Matatu	Major public transport mode is matatu with 14-seat capacity. Matatu cater for about 85% of total public transport and, 15% is bus	Small matatus concentrate on major transport corridors causing serious traffic congestion and traffic accidents
Taxi and others	Taxi, tuk-tuk and bicycle taxi operate. But no taxis have taxi meters	Inconvenience for taxi-users
Railway	3-commuter lines are operated by Kenya Railway Corporation with 350,000 monthly passengers	Station facilities and train coaches are in poor condition
Model Choice	Only high-income people use private cars	Increase in the number of private cars leads to traffic jams and deterioration of urban activities and environment

Source: JICA 2005b

A traffic jam in Central Nairobi

Source: J. Ndegwa

The Urban Transport Master Plan Study of 2005 prepared by JICA, the Ministry of Roads and Public Works and the City Council has made various proposals meant to solve urban transport concerns (JICA 2005b). Notable is a proposal to phase out matatus. But, for various reasons, industry actors are opposed to the proposals.

3.5.3 Roads infrastructure

The transport sector is an important pillar of the economic growth and development of Kenya. A sound transport network enables efficient movement of people, goods and services and facilitates trade between different regions. In Kenya, road transport is the lifeline of the nation's development, since 80 per cent of the commercial freight transport relies on roads (Kibaki 2004). Furthermore, good roads are essential for the development of commerce, tourism and other services (Kibaki 2004).

Nairobi's transport infrastructure is ill-equipped to handle the additional travel generated mainly by the increasing population, and other service activities in the CBD and industrial area. Inventories in 1992 and 1998 found that there are 300kms of main roads and 850kms of access roads, including unpaved earth tracks, much in deteriorated condition (Kenya Roads Board 2003) (Table 3.8). The survey found that only 39 per cent of the network surfaces were in good or adequate condition, the remainder being poor or very poor requiring resurfacing or reconstruction. Drainage conditions were worse with 56 per cent poor (under design) or very poor (non functional) and 17 per cent having no roadside drains or culverts. Often, some areas planned for infrastructure are encroached upon by informal settlements and business activities. The poor state of the roads is often compounded by the amount of traffic on them. Table 3.9 shows the daily traffic volumes on key roads in Nairobi.

Table 3.8: Classified roads and surface conditions

	Fair	Good	Poor	Total (km)	Percentage
A	16.58	64.06	0.00	80.64	31.51
B	0.00	3.96	0.00	3.96	1.55
C	56.46	51.63	12.71	120.80	47.20
D	33.68	7.29	0.00	40.97	16.01
U	6.59	2.95	0.00	9.54	3.73
Total (km)	113.30	129.89	12.71	255.90	100
Percentage	44.28	50.76	4.96	100.00	

Source: Kenya Roads Board 2003

Table 3.9: Daily traffic volumes of both directions

Road	Observation Point	Vehicle Per Day
Jogoo Road	Makongeni	73 000
Thika Road	Pangani	57 900
Mombasa Road	Nairobi South Primary	54 800
Haile Selassie Avenue	Kenya Polytechnic	46 800
Mbagathi Road	Armed Forces Hospital	43 200
Langata Road	Wilson Airport	42 900
Waiyaki Way	ABC Cinema	41 700

Source: JICA 2005b

Infrastructure development: A section of the railway serving the Kibera slums and part of Uhuru Highway

Source: Oningo, Z and Barreh, K.J.

3.6 Water supply and sanitation

3.6.1 Fresh water resources

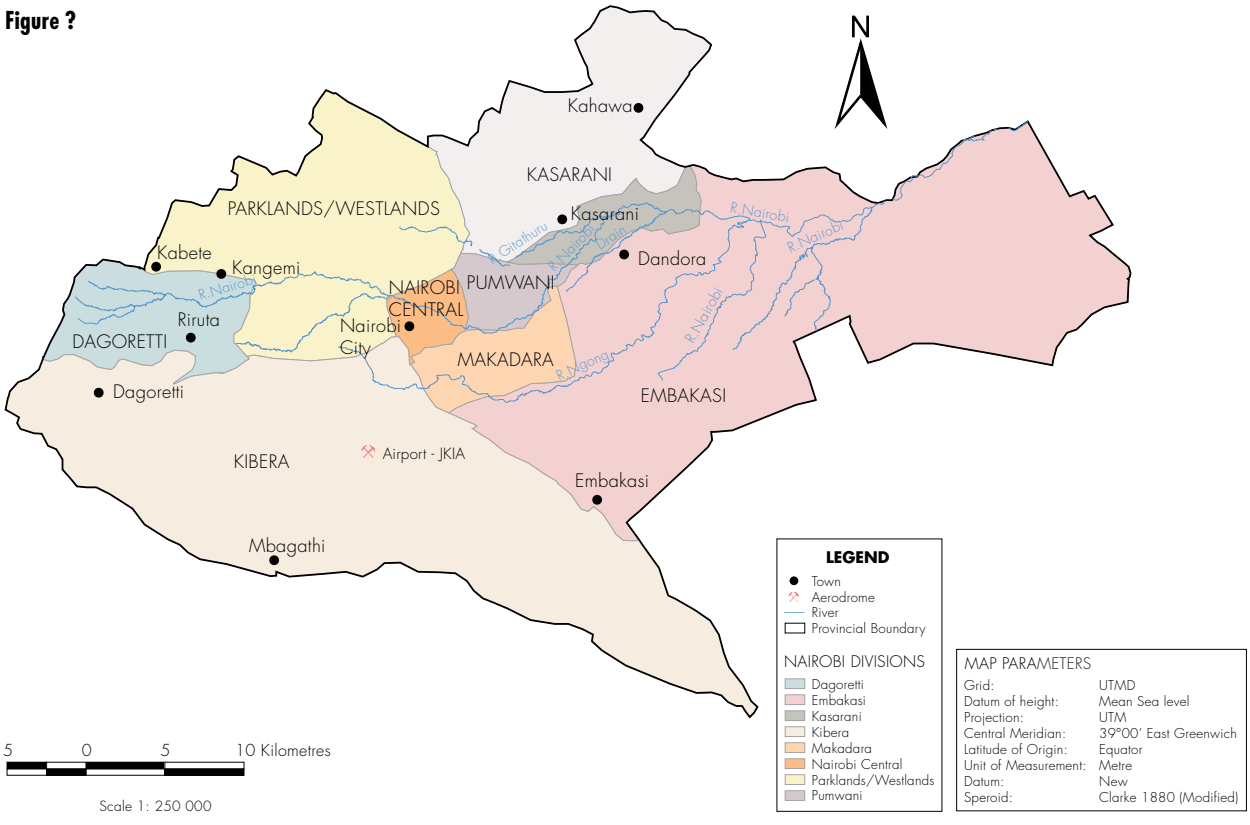
Ground and surface water both play an important role in water supply for Nairobi. The principal source of water for Nairobi is surface water from the Tana River drainage basin (Foster and Tuinhof 2005). Freshwater is also found in the three main rivers that flow through Nairobi, but quality is a problem. These are the Nairobi, Mathare and Ngong rivers, and their tributaries – Gitathuru, Kasarani, Riara, Kamiti, Mbagathi, Mutuari and Ruiruaka. Unfortunately, they are the major sources for the majority of people in the poor suburbs. There are other sources of fresh water for the city, such as the Nairobi dam, but this is now polluted and infested with water hyacinth. Figure 3.5 shows the drainage in Nairobi.

Consumption of water in the city is about 350 000 m^3 a day and production is 392 000 m^3 per day (MWI/WSP 2005). Optimum production capacity is 592 000m^3 a day and at this rate, NWSC has the potential of supplying water comfortably up to the year 2010 (MWI/WSP 2005). Consumption of water in the city is about 350,000 cubic metres a day and production is 392,000 m^3 per day (MWI/WSP 2005). Optimum production capacity is 592,000 m^3 a day and, at this rate, NWSC has the potential of supplying water comfortably up to the year 2010 (MWI/WSP 2005). Per capita water usage varies according to socio-economic groups. The national standard water consumption per person daily is 50 litres (0.05 mv). In some of the informal settlements such as Maili Saba, daily per capita water usage ranges from 1.7–30 litres, depending on the poverty status (Practical Action 2005).

The WHO-UNICEF Joint Monitoring Programme describes reasonable access as being "the availability of at least 20 litres per person per day from a source within one kilometre of the users' dwelling". It should be noted, however, that this definition relates primarily to access and should not necessarily be taken as evidence that 20 litres per capita per day is a recommended quantity of water for domestic use (Howard and Bartram 2003).

The city has a growing water supply problem, which has its roots in the original choice of the site. Nairobi was not originally planned to be a large metropolis and the available water resource was sufficient only for a smaller population.

Figure ?



Source: ?

To meet the growing demand, water has to be pumped from distances of around 50 km outside the city (Rakodi 1997, Foster and Tuinhof 2005). Apart from occasional water shortages, however, especially during the dry seasons, the basic problem has been one of distribution.

3.6.2 Groundwater

The Nairobi groundwater basin extends from the zone of north-south rift faulting west of the city (with an elevation of about 2400 m ASL) towards the Athi river floodplain (with an elevation of 1500 m ASL) east of the city centre. Volcanic activity has controlled the geomorphologic evolution – the rocks of the Nairobi basin mainly comprising a succession of volcanic lavas and ashes (tuffs), whose thickness reaches some 400 m underneath the city itself and which to the east gradually merge into the tertiary deposits of the Athi floodplain. The volcanic rocks show a wide range of porosity and permeability and have developed aquifer units separated by lower permeability strata. The aquifers mainly comprise the Kerisha Valley Series and Upper Athi Series (transmissivity of 5–50 m^2/d and low storativity) (Foster and Tuinhof 2005).

Groundwater, from water wells, is mainly used by large private operators such as industry and hotels to supplement Nairobi Water and Sewerage Company (NWSC) supply (Foster and Tuinhof 2005). They are also used in parts of the city that receive intermittent supply like Langata and Karen. The wells for commercial, industrial and residential water-supply are metered. Annual reading is the responsibility of NWSC and is used as a basis for levying wastewater charges.

The current policy of NWSC is to rely solely on surface water, but it is likely that the use of groundwater will in future be critical in providing adequate service levels for the growing urban population and as a strategic reserve in times of drought (Foster and Tuinhof 2005). The drilling of boreholes started in the 1930s – and the number of water wells in greater Nairobi increased from fewer than 10 in 1940 to almost 2,000 in 1997 and further increased to 2,250 in 2001 as a result of the drought (Foster and Tuinhof 2005).

Over-exploitation of groundwater resources is likely to become an emerging issue. The increase in demand for water has led to unregulated exploitation of groundwater and it is thought this might lead to undesirable effects such as the lowering of the water table. For instance, during the 1999/2000 drought the criteria of 800 m-separation distance for sinking boreholes was ignored and this could have long lasting effects (UNEP/DRSRS undated). While there might not be any immediate threat of land subsidence, there is the potential risk of local infrastructure and building damage. Nairobi was once a swampy area and the presence of clay and silt layers in the shallow subsoil, and of unconsolidated fractures and cooling joints, may be potential sources of subsidence (Foster and Tuinhof 2005). The problem has occurred elsewhere in the world: thus, Mexico City sunk by more than 10 metres in the last 70 years from overexploitation of groundwater (UN-Habitat 2000 in UNEP/DRSRS undated).

3.6.3 Access to safe water

Despite the fact that production exceeds demand, only about 187,000 (or 42 per cent) of households in Nairobi have proper water connections (MWI/WSP 2005). The poor state of the distribution system results in up to 50 per cent losses due to leakages and illegal connections (UNEP/DRSRS undated). The urban poor and slum dwellers are the ones who suffer most from the lack of piped water supply. Water vendors charge much more than the tarri from the lack of piped water supply. They obtain water from water vendors, by making illegal connections or directly from the water bodies. Water vendors charge much more than the tariff paid by those who are directly connected to the Nairobi water supply (see box 3.7). In times of drought, or when city water supply is diverted elsewhere, this price is driven even higher. For instance, in the more well-to-do parts of the city, water distributed by tankers costs KSh 4 000 per cubic metre ($53) (Foster and Tuinhof 2005). In the Kibera slum, when there is a water shortage, a 20-litre jerry-can of water that normally costs KSh2 shillings ($0.03) goes up to KSh20 shillings ($0.27), and yet the majority of residents live below the poverty line and spend less than one dollar a day (IRIN 2006).

Box 3.7: Water tariff structure

The Nairobi Water and Sewerage Company has a graduated tariff structure. The tariffs by September 2000 were:

- Up to 10 m^3 pay Ksh12 ($0.16)/$m^3$
- Up to 30 m^3 pay Ksh18 ($0.24) /$m^3$
- Up to 60 m^3 pay Ksh27.5 ($0.37) /$m^3$
- Above 60 m^3 (large consumers) pay Ksh34.50 ($0.46) /$m^3$

Source: Bayliss and Hall 2000.

Table 3.10: Availability of water supply and sanitation in the informal settlements by division

Division	Water	Water price (K.Shs)/20 litres	Sanitation	Solid waste disposal
Makadara	Water points (kiosks) Piped water-own	1-5	Pit-latrines Sharing (30-40)	No collection Dump in nearest site
Langata	Water points (kiosk) Nairobi Dam	1-5	Pit-latrines (50-500)	No collection Dump in nearest site
Kasarani	Communal taps Water points (kiosk)	1-5 Piped water-own	Pit-latrines Conservancy tanks Trunk sewer (few)	No collection Dump in nearest site, river, roads
Dagoretti	Water points (kiosk) Stand pipes Well-water	Included in rent	Pit-latrines Trunk sewer (few)	No collection Dump in nearest site Composting
Pumwani	Communal water Water-vending/kiosks Rain harvesting	1-5	Trunk sewer Pit-latrines	Dump in nearest site River, roads
Parklands	-	-	-	-

Source: Matrix Development Consultants 1993

Lack of access to water forces these communities to spend a large proportion of their income on water leading to household poverty. Table 3.10 highlights the water supply and sanitation situation among selected informal settlements in Nairobi.

3.6.4 Reform of the water sector

The Water Act 2002 provides for water resources management and development in Kenya. It has proposed reforms that separate water management and service provision, thus providing for better regulation of the water and sanitation sector. The Water Resources Management Authority (WRMA) is the national body responsible for water resources management and development. The Water Services Regulatory Board (WSRB) deals with regulation. At regional level, there are seven catchment advisory boards. The Nairobi Catchment Advisory Board is responsible for water allocation, source protection and conservation, water quality management and pollution control in the city. Other players in catchment management include the City Council's Department of Environmental Management and NEMA through its provincial and district offices.

Privatisation of water services

The City Council of Nairobi has privatized water services under the National Water Sewerage Company in order to improve on water supply and demand management. It was officially launched on 19 August 2004 and operates as a private sector enterprise with an autonomous board of directors. Privatization of water services is emerging as an additional burden on the urban poor, however, as water vendors push for maximum profits. In response, local non-governmental and community based organizations have come forward to fill the void in service provision. Communal water supply systems are being encouraged, especially in the informal settlements, where water standpipes are communally owned. WSRB also intends to regulate the tariff regime to enable the poor get water at affordable prices.

3.6.5 Access to sanitation

Another area of concern in urban environmental infrastructure is the provision of sanitary facilities, especially refuse collection and sewage disposal. As the population increases, so does the amount of waste that needs to be managed.

Sanitation facilities

The Kenya 1999 population and housing census showed access to sanitation facilities to be at the level of 95.2 per cent in Nairobi, compared to 83.2 per cent for the country as a whole. The Ministry of Health does not consider pit latrines (on-site sanitation) in urban areas as adequate, so this brings the figure for adequate sanitation coverage within Nairobi to only 66.5 per cent (CBS 2002b, WSP 2004b).

Figure 3.6 shows the different types of sanitation facilities used by households in Nairobi.

As shown in table 3.10, sanitation in the informal settlements is very basic. It mostly consists of earth drains, communal water points, no solid waste disposal systems and pit latrines each shared by as many as 60 people (Practical Action 2005). The situation is perpetuated by the illegal status of the settlements. Because they are not officially recognized by the Government, the City Council of Nairobi has no mandate to supply piped water or sanitation services. This has a negative impact on the environmental health of these slum dwellers. There is a high incidence of diseases such as typhoid, diarrhoea, amoebic dysentery and others.

Sewerage systems

Approximately 48 per cent of Nairobi's population is served by the existing water-borne sewerage system (ROK 2002). This system suffers from a number of problems, including poor maintenance, illegal connections, use of toilets for the disposal of garbage, and deliberate blocking of sewage pipes for irrigation. For instance, at Maili Saba, farmers remove manhole covers and block the city's main sewer, diverting raw sewage on to their land to irrigate their crops (Scott *et al.* 2004). If properly implemented, there are opportunities for the use of wastewater in urban agriculture. Research in 2000 indicated that 3,700 farmers in Nairobi practise irrigation and that of these 36 per cent use wastewater (Ayaga *et al.* 2004). Urban agriculture is discussed in more detail under section 3.2.2.

Sewerage management problems are compounded by densities in some housing areas that are higher than those for which the sewerage system was originally planned, and the location of some informal housing in areas unsuitable for residential use. Existing treatment plants do not have the capacity to deal with the quantities of sewage produced. This results in the disposal of untreated sewage into water bodies in the city, posing a health hazard to residents. Indeed in all three rivers running through Nairobi, total coliform counts increase downstream and no dilution effects seems to take place, implying that there are human waste or other sewage discharge points along the rivers (UON/UNEP 2005). Studies have shown that 50 per cent of all preventable illnesses in Kenya are water, sanitation and hygiene related (Practical Action 2005). Box 3.7 discusses the sanitation situation in the informal settlements in Nairobi.

3.6.6 Improving sanitation services

In 2004, the Ministry of Health produced a draft policy on the national environmental sanitation and hygiene to tackle some of the problems identified above. The policy aims to enhance existing environmental health programmes for sustained behaviour change and, as a result, to expedite the coverage of improved sanitation facilities in a coordinated manner. It will also improve the existing legal and institutional framework for effective public, private sector, civil-society and community participation.

Improved technology for pit latrines is now common. Examples include the ventilated improved pit (VIP) latrine and Ecological Sanitation (Ecosan) toilets. The Ecosan toilets provide opportunities for the reuse of excreta, especially in soil conditioning for improved food production (WSP 2004b).

Privatisation of sanitation services

The City Council of Nairobi is increasingly looking at different options to improve on supply and demand management. Pay toilets are now a growth industry with sanitation facilities being privatized. Recently, the management of public toilets within the city centre was privatized (see box 3.8). Even in the informal settlements, for instance in Kibera and Mathare, "pay-and-go" toilets are becoming increasingly common.

Box 3.7: Sanitation in Nairobi's informal settlements

Only 10 per cent of the population is served by sewers, 20 per cent by septic tanks and 70 per cent with manually cleaned latrines. It is also estimated that about 94 per cent of the inhabitants of informal settlements do not have access to adequate sanitation. Only a minority of dwellings have toilets. Significant proportions of the total population have no access to showers and baths, and in most areas drainage is inadequate. Within Kibera traditional pit latrines are the only excreta disposal system available, and a high proportion of households have no toilet within or close to their home. Significant proportions of the total population have no access to showers and baths, and in most areas drainage is inadequate. There are often up to 200 persons per latrine. In Pumwani, there are 260 latrines with averages of 450 persons per latrine. Pits fill up quickly and emptying is a problem due to difficult access. Space for new pits is often not available.

Source: UN-HABITAT 2003b

Box 3.8: Public sector participation in the provision of public sanitation

There are a total of 138 public toilets in the city of Nairobi. Eighteen of these are located within the CBD. Most public toilets are in poor condition. A number of issues contributed to the decline of public toilet service delivery in the city. These include low budgetary priority; the lack of a clear policy on the development and management of public toilets in the city and the fact that responsibility for public toilets was shared between two departments of the City Council, resulting in inefficient service delivery.

Recognizing that public toilets within the city had to be improved, the City Council considered public sector participation in service delivery. This was also partly based on the council's experience and success in outsourcing the solid waste management function. Currently, six public toilets within the CBD are being managed by the Nairobi Central Business District Association. Immediate benefits include efficiency gains, improved quality of service, and the ability to raise funds for refurbishment. To improve the oversight function within the City Council of Nairobi, the Water and Sewerage Department has been put in charge of public toilets in the city and a Public Toilets Management Committee established in 2002.

Source: WSP 2004a

3.7 Information Communication Technology (ICT) and Telecommunications

Fixed-line telephony service is provided by Telkom Kenya Ltd. The regional fixed line distribution is more or less concentrated in Nairobi with 56 per cent of the country's total subscribers situated in the city, while the remaining 44 per cent are distributed across other regions of the country (CCK 2004). At the national level, fixed-line telephone coverage is 0.90 per cent (Mitullah and Waema 2005). Nairobi has 7.42 per cent, compared to Mombasa at 1.43 per cent and the other regions that are in the range of 0.5 per cent and below (Mitullah and Waema 2005).

Mobile phone services in Kenya started in 1992 and there are currently two service providers: Safaricom Ltd and Celtel Kenya. Mobile telephone coverage in Kenya is 12.42 per cent respectively. Kenya has 72 licensed internet service providers (ISPs), but, only about 14 are operating (Mitullah and Waema 2005). Most ISPs offer a range of services, including dial-up and leased line services charged mainly at a flat rate. Most facilities are located in Nairobi.

Postal services are provided by the Posta Corporation of Kenya. Its operations are guided by a strategic plan that spells out measures to be undertaken in response to the challenges posed by economic liberalisation and technological advances in the way people communicate today.

Access to mass media is very high in Nairobi, especially compared to the rest of the country. For instance, newspaper circulation of the Nation newspaper is about 70 000 in Nairobi compared to between 160 000-180 000 for the whole country as a whole (Onyango-Obbo 2006). Table 3.11 shows access to the different mass media in Nairobi.

Information and communication technology (ICT) and telecommunications offer many opportunities for development and can have a positive impact on quality of life, social capital and economic growth. ICT provides tools and conditions that can support good governance. It offers the possibility of enhanced approaches to issues such as the fight against HIV/AIDS, agriculture, trade and the management of natural resources. There are a number of examples to cite. The Kenya Agricultural Commodity Exchange (KACE), launched in 1997, is harnessing ICT to support agricultural marketing

Table: 3.11: Access to mass media

	Newspaper	Television	Radio	All three
Nairobi (men)	74.4	71.9	93.8	5.8
Nairobi (women)	49.7	72.1	89.4	40.7

Source: CBS et. al. 2004.

throughout the commodity production chain (KACE 2005). The components include market information points and centres, short messaging services, an interactive voice response service, regional commodity trading and information systems and a website (KACE 2005). The City Council of Nairobi uses a website to inform residents about the city council (http://www.nairobicity.co.ke). The Nairobi River Basin project is also developing a database on various water quantity and quality parameters for rivers and industries and profiles of analytical laboratories within the Nairobi River Basin. A website, to be developed, will also include spatial and other visual information.

The 2006 national ICT policy seeks to facilitate sustained economic growth and poverty reduction; promote social justice and equity; mainstream gender in national development; empower young people and disadvantaged groups; stimulate investment and innovation in ICT; and achieve universal access.

In March 2004, the Government of Kenya launched an ambitious "e-government" strategy for the period 2003–2007, in line with the national development strategy for wealth and employment creation. The initiative is a step in the right direction, given the rapid changes taking place worldwide with the tremendous growth in computing power and networking technology which is transforming the way Governments are operating and doing business (Mitullah and Waema 2005).

Another measure which should promote good governance in environment management is the Freedom of Information Policy, which is still in draft form. It will provide the framework for review of existing laws and regulations, and spell out mechanisms and procedures pertaining to access to information in Kenya (MOIC 2007). This will have implications for access to environment information, public participation in decision-making and access to environmental justice.

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CHAPTER 4: POLLUTION AND WASTE MANAGEMENT

Water, air and land in Nairobi receive large quantities of pollutants with significant deleterious effect on their quality and on the quality of life in general. While the problems of water pollution in the city and inadequate municipal solid-waste management are not visible to the naked eye, air pollution is not. The rapid growth of the number of vehicles and of commercial and industrial enterprises is generating enormous amounts of air pollutants. The terms "pollution" and "waste management" in this chapter refer to the pollution of water, air and land, and their management.

4.1 Water pollution

4.1.1 Water quality

Even when water is available, it is often unsuitable for human consumption, and boiling it is expensive. Paraffin fuel costs range between KSh 48 and KSh 50 per litre; a 2 kg tin full of charcoal costs KSh 25 and an average family size of six members requires double that daily (Practical Action 2005). Poor water quality and its high cost may contribute to malnutrition, child mortality and exposure to water-borne diseases and also impede efforts to reduce hunger and poverty.

The natural groundwater quality is generally good and reaches the drinking water standards for most constituents, except for fluoride, which often exceeds 1 mg/l (Foster and Tuinhof 2005). The fluoride poses a health risk of fluorosis, a dental condition. Between 1997 and 2002, a total of 290 boreholes were drilled within Nairobi. The evaluation of the quality of water from these boreholes indicates that fluoride often exceeds the WHO standard of 1–2.5 ppm (Mogaka *et al* and World Bank 2003). The fluoride content increases with depth and about 30 per cent of the bores have fluoride content above 2 ppm (table 4.1).

Nairobi's upper aquifer is particularly vulnerable to pollution from human activities such as landfills and dumpsites; seepage from latrines, septic tanks, sewers and drains; leakage from underground storage of petroleum and chemicals; seepage of industrial effluents; and infiltration from polluted streams (Foster and Tuinhof 2005).

Although Nairobi relies mainly on surface water supplies, the sources of these supplies lie outside the city. The surface streams, though numerous, are heavily contaminated by domestic and industrial effluents and solid wastes. Industrial effluents and direct discharges from urban centres, settlements and industry, as well as rainfall, introduce a variety of pollutants into surface waters, ranging from agro-chemicals, heavy metals, microbial pollutants and persistent organic pollutants (UON/UNEP 2005).

Naturally rivers are expected to cleanse themselves as they move downwards, but this is not the case with the Nairobi River and its tributaries, because there are many sources of organic pollution along the river (NRBP IUCN-UNEP, 2005). Indeed studies show that there are over 30 points of direct discharge along the Nairobi and Ngong rivers each. These require a consistent monitoring protocol to ensure that what is discharged meets recommended standards. Figure 4.1 shows the intensity of pollution in the Nairobi rivers and figure 4.2 shows pollution hotspots in the Nairobi river basin during the dry and wet seasons.

Table 4.1 Distribution of fluoride in ground bores in the Nairobi area

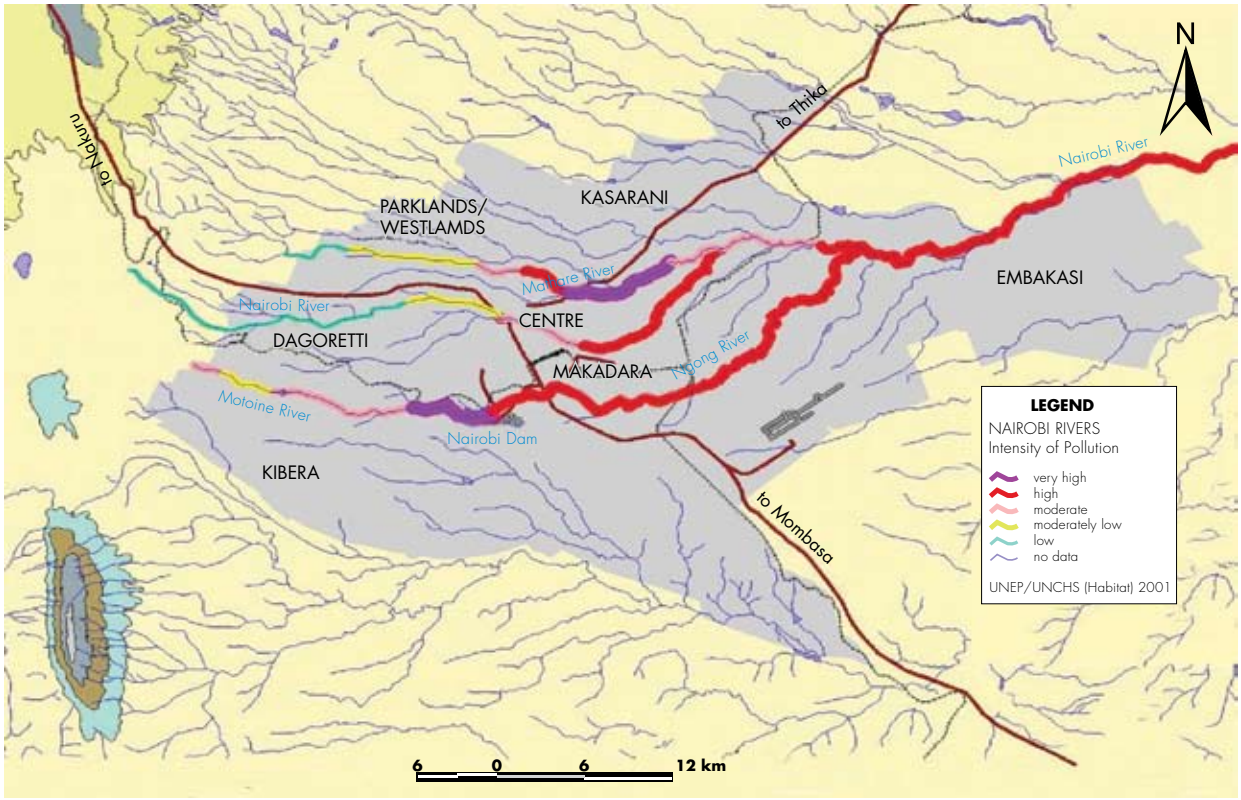
Depth	No. of samples	Percentage of wells with Ranges of Fluoride Content					
		0.1ppm	1-2ppm	2-3ppm	3-4ppm	4-5ppm	>5ppm
All depths	218	50	20	9	8	2	11
0 - 80	52	42	19	17	10	6	6
81 - 50	96	64	12	6	4	2	126
151 - 200	44	40	30	8	6	0	16
>200	26	27	35	4	12	0	22

Source: SWECO 1975

Solid waste floating in Ngong River

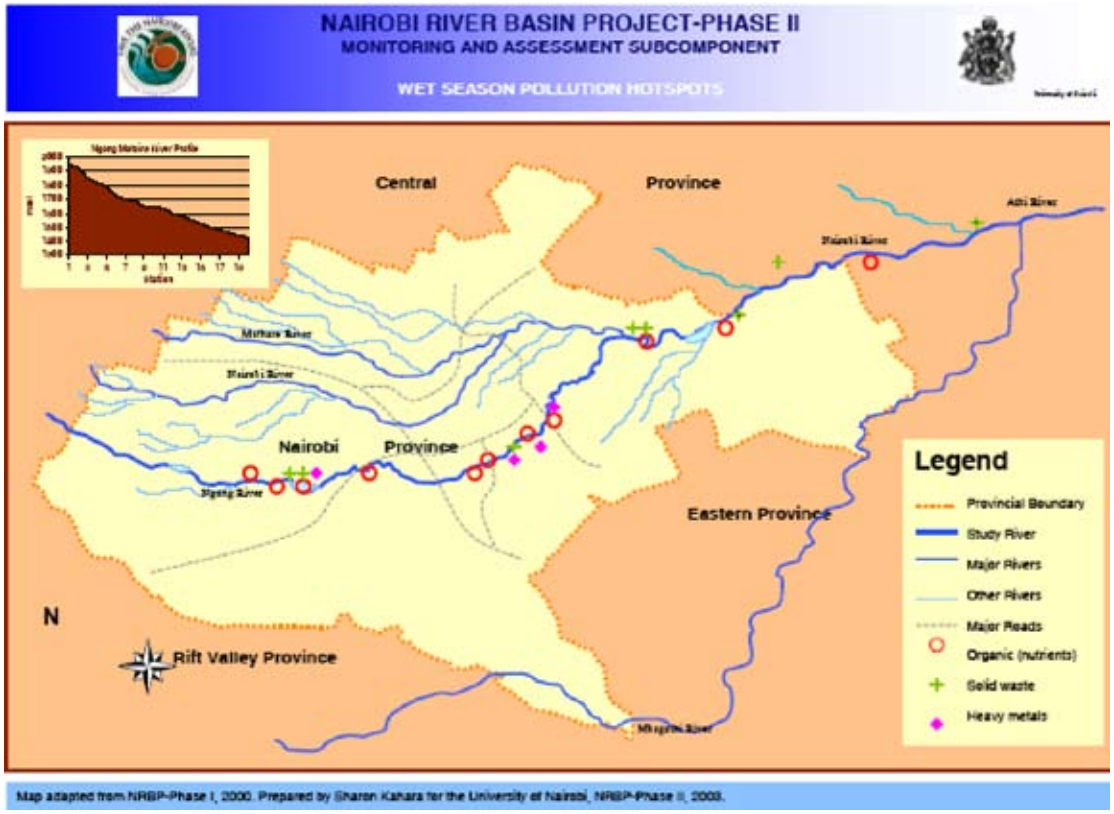
Nairobi River Basin Programme Phase III, 2005

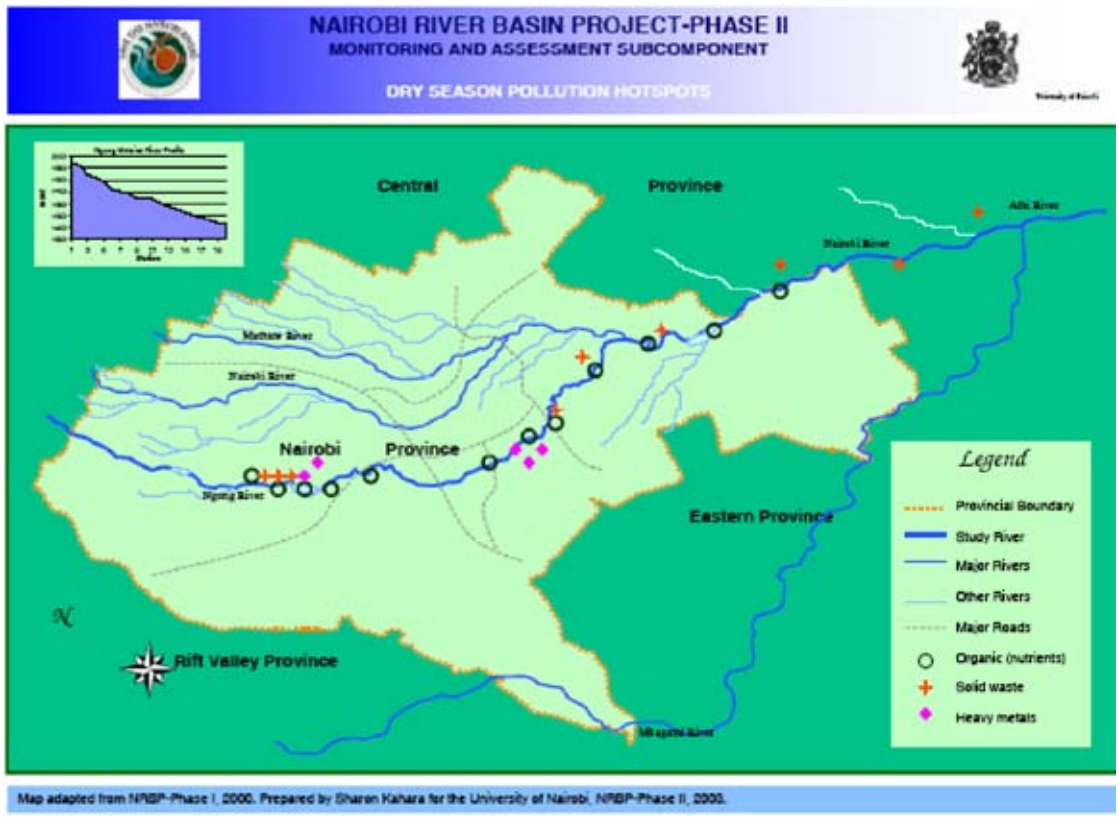
Figure 4.1: Intensity of Pollution in the Nairobi Rivers



Source: NRBP IUCN-UNEP 2005

Figure 4.2: Pollution hot spots in the Nairobi river basin





Source: NETWAS undated

4.1.2 Factors contributing to water pollution

Several factors are involved in compromising the quality of water in the city. These range from natural phenomena such as the high fluoride content in groundwater, to anthropogenic factors such as poor wastewater treatment and environmental degradation, both within the city and in the surrounding countryside.

The inadequacy of wastewater management capacity in the city represents one of the serious sources of water pollution for Nairobi River and its tributaries. A study by Gath Engineers consortium in 1991 shows that untreated effluents mainly emanate from industries, open drainage from car-wash activities, raw sewage from residential premises and hostels, discharge from burst sewers, oil from petrol stations and oil-manufacturing industries, among others. For instance, effluent from industries located in Makadara division exhibits high quantities of mercury, in a range of 2.8–13.4 mg/l (UON/UNEP 2005), well above the recommended WHO guidelines for mercury of 0.006 mg/l (WHO 2006). Mercury is highly toxic and bio- accumulates in the environment with negative impacts on human health (UON/UNEP 2005). It is likely that the magnitude of discharge in terms of effluent points and volume must have increased since then as there is little, if any, evidence of intervention.

Various factories discharge waste directly into Ngong River in Nairobi's industrial area rendering it the most polluted stream in Kenya (Biosafety News, 2002). The effluent generally consists of industrial and domestic sewage content, garbage, sediment tailings from quarries and urban agricultural waste. The waste-laden river also picks up oil and grease from the busy roads. The third source of pollution for the Nairobi River and its tributaries is solid waste. Some of the tributaries are polluted 2,000 times above the WHO standards, with biochemical oxygen demand (BOD) values ranging from 40 to 4400 mg/1 oxygen as a result of raw sewage and industrial pollution (NRBP IUCN-UNEP 2005).

Effluents from informal settlements are mainly from pit latrines and other on-site sewerage disposal methods, which are the source of considerable pollution to watercourses. Some unplanned settlements are further affected, however, by effluents from nearby industries, the waste generated from which pollutes watercourses passing through them, for instance, Ngong River along Mukuru Kaiyaba, Mukuru Kwa Njenga and Kwa Reuben (NISCC 1997, PPD and CPD 2004).

The generation of untreated waste from domestic, commercial, institutional and industrial premises that is discharged into unprotected surface watercourses and wetland areas also pollutes subsurface water, endangers environmental and human health and living organisms that use the polluted water courses. Similarly, leachates from dumpsites (e.g., Dandora and Satellite/Kawangware) pollute both riverine and subsurface watercourses. These impact negatively on rivers including Getathuru/Nairobi and Kirichwa Kubwa Rivers.

Within Nairobi province itself, deforestation, poor agricultural and waste management practices have destroyed the Nairobi river watershed with implications on the quality of the water (UON/UNEP 2005). The water retention capacity of the catchment has been reduced and there is evidence of increased soil erosion, as well as release of agricultural and industrial chemicals into the river (UON/UNEP 2005).

Environmental degradation outside the city boundaries also affects water supply and quality to Nairobi. For instance rising demands for hydroelectric power and charcoal is threatening the integrity of the Tana river basin. Already this has resulted in increased flooding,
pollution, reduced groundwater recharge and stream-base flow, and reduced ability of wetlands to perform crucial ecosystem services.
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4.1.3 Ecological, health and social-economic impacts

Visually, the Nairobi River and its tributaries are trunk sewers and the colour of their water range in colour from brown to blue-black. The Nairobi Dam, constructed across the Ngong River, originally intended to supply domestic water and later used for recreation, is testimony of the extent of pollution of these water bodies. The dam lies in the vicinity of the extensive Kibera slums (NRBP IUCN-UNEP 2005). Over more than the past ten years, the dam has become choked with water hyacinth because of pollutants – mainly nutrients – from these slums. The effluent coming from informal settlements is highly loaded with various types of contaminants, causing the water lose its natural colour.

In March 2005, large amounts of foam obstructed motorists and pedestrians on Mbagathi road downstream of Nairobi Dam. The results of the analysis indicated that the foam was heavily contaminated with pathogenic organisms such as

E. coli, Salmonella spp, *Shigella* spp and *Cholera vibrio* (NEMAnews, 2005). NEMA further established the cause of foaming to be the non-biodegradable detergent (branched akly benzene suphonate), which has been banned in many countries since the 1970s. In Kenya, alkyl benzene sulphonate (ABS) is used in the formulation of certain cheap detergents. Apart from the potential ecological and health impacts, such obstructions also causes loss of travel time and waste of fuel for commuters stuck in the resulting traffic jams.

Poor water quality and its high cost may contribute to malnutrition, child mortality and exposure to water-borne diseases and also have an impact on efforts to reduce hunger and poverty. Along the Nairobi River and its tributaries, agricultural activities commonly use the polluted waters and raw sewage for irrigation. Use of polluted water to irrigate crops may also cause health problems to the farm workers and to the consumers of resulting food crops, such as diarrhoeal disease and helminthic infections. Almost half of the vegetables consumed in the city of Nairobi are grown on the banks of these polluted rivers (Biosafety News 2002). The water of Nairobi River and its tributaries is also a source of irrigation water for downstream users in Machakos, Kitui and Coast province. No specific study has been made of the health impacts of the polluted Nairobi River and its tributaries, but it is well known that the use of their water for any purpose would pose health problems for its users. For example, during the rainy season, almost every city resident comes into contact with these polluted waters. Storm water floods the sewerage system, which flows on to the streets.

4.1.4 Towards improved water quality

In its 2006-2007 budget speech, the Government promised to reduce the cost of treatment and supply of natural water, and to work towards the supply of clean water to every home in Kenya. To that end, the Government has zero-rated the supply and treatment of natural water by all local authorities and public water suppliers (MOF 2006). In addition, small-scale water supply providers are increasingly coming up with innovative low-cost technologies, such as using solar energy to purify water for drinking (see box 4.1).

In addition, in 2006 the Government gazetted the Water Quality and Waste Management Regulations. These regulations seek to prevent the pollution of lakes, rivers and other water sources and to streamline disposal of wastewater into the environment. Firms are now required to submit records of the quality and quantity of the water they discharge into the environment. Effective implementation of the regulations will lead to a marked reduction of water-borne diseases and a reduction in the health budget.

Box 4.1: Using solar energy for safe drinking water

The Kenya Water for Health Organization (KWAHO), a national NGO, runs a solar-disinfection project (SODIS) that employs local people. The water-treatment programme promotes the use of plastic bottles and solar energy to disinfect water. SODIS sells bottles at KSh10 ($0.14). The bottles allow penetration of ultraviolet rays from the sun, and this inactivates the pathogens in the water. The bottle is exposed to the sun for a period of six hours, but if the sunshine is intermittent, then the bottle is exposed for a period of two days. Now in its fifth year, SODIS has reached more than 30,000 local households. Its success is down to its low cost, easy availability, and the fact that the taste of the water remains the same. Boiling water is expensive and changes the taste. SODIS peer promoters go door-to-door to promote the technology. Most of the promoters are women from the community. It is believed that involving the community in the organization and management of local water projects is essential to their success. The vested interest of a community protects the projects from vandalism, especially in poverty-stricken areas like Kibera.

Source: IRIN 2006

4.2 Air pollution

Air pollution is mainly the result of anthropogenic activities. The main sources of atmospheric pollution are vehicles, industries, emissions from the use of charcoal and firewood for energy, and other municipal sources such as the open burning of waste. Air pollution adversely affects human health, properties and the environment. In particular, air pollution is associated with respiratory and eye diseases such as asthma, lung cancer and conjunctivitis, especially in the young and elderly (UNEP/WHO 1992; Patel 1994). It is a major contributor to effects such as acid rain, which has been responsible for much damage to soil, fish resources and vegetation, often very far from the source of the pollutant. The main sources of atmospheric pollution are vehicles, industries, emissions from the use of charcoal and firewood for energy, and other municipal sources such as the open burning of waste.

4.2.1 Transport

Compared to other urban centres in Kenya, Nairobi has the greatest concentration of industrial and vehicle air pollutant sources (Mulaku and Kariuki 2001). This is partly due to the fact that most of the imported vehicles are used mainly in Nairobi. Indeed in 1989, Kenya had 362,000 registered vehicles and 65 per cent of these were in Nairobi (ESSD 2006). Today the number of private cars has risen to nearly 1 million (Ryu 2006).

The transportation sector is increasingly being recognized as the highest polluter, emitting atmospheric reactive gases and other toxic chemicals that depend on such factors as the daily kilometres travelled, the fuel composition, the age of the vehicle fleet, and also the composition of the fleet. In Kenya the transport sector accounts for 65 per cent of the fossil fuels consumed nationally and emits more than 65 per cent of the carbon dioxide gas (NEMA 2003). Old vehicles emit hydrocarbons and smoke to the atmosphere at up to five times the rate of emissions from new vehicles.

One of the most harmful of pollutants contained in vehicle emissions is the lead formerly added to gasoline. The health impacts of lead are well documented. An analysis of lead concentrations in Nairobi revealed soil lead levels up to 265 g/kg in the city centre, and 44 g/kg in the residential areas (UNEP 2004). The World Health Organization (WHO) guidelines for lead levels in soil are in the range of 0.1–0.12 g/kg (source). Up to 5 mg/kg of lead was also measured in kale (known locally as "sukuma wiki"), a common vegetable consumed in the country, exceeding the 0.3 mg/kg WHO limit nineteen-fold (UNEP 2004). Levels of lead in other food stuffs and water are all high. For instance, lead levels in maize have been found to be 20 times higher, water twice as high and milk 2.5 times higher than the WHO recommended levels (Mebratu 2004).

Table 4.2: Lead levels in soil and maize compared with WHO standards

	Nairobi central		Nairobi residential		WHO standard	
	Range (µg/kg)	Mean	Range	Mean	Range	Mean
	(µg/kg)					
Soil	96,160 - 663,470	265,918	36,760 - 63,940	44,350	100 - 120	
Maize	1,610 - 2,200	1,948	671 - 1,651	1,001		200

Source: Mebaratu 2004

Table 4.3: Lead levels in water in Nairobi

	Range (µg/kg)	Mean
WHO guidelines		10
River	3 - 35	19
Bore-hole	3 - 40	13
Tap	2 - 8	6
Rain	1 - 10	6

Source: Mebaratu (2004)

Table 4.4: Lead levels in milk in Nairobi

	Range (µg/kg)	Mean
WHO guidelines		20
Nairobi raw	30 - 80	46
Thika raw	25 - 83	44
Juja raw	10 - 70	34
Ithanga	10 - 50	30

Source: Mebaratu (2004)

Nairobi stands to benefit from policies that Kenya has adopted towards the gradual phase-out of leaded gasoline. In September 2003, a Kenyan task force was formed for the phase-out of leaded petrol. It is chaired by the National Environment Management Authority (NEMA) and comprises the Kenyan fuels industry, government bodies and civil society organizations, as well as international organizations. Other efforts are also in progress to try and reduce vehicle emissions. The Kenya National Cleaner Production Centre is working with the Ministry of Transport and Communication, Traffic Police and Motor Vehicle Inspection Unit to amend the relevant laws and incorporate environmental standards in the inspection of vehicles.

Recently, the Kenya Bureau of Standards (KBS) introduced rules requiring compulsory inspections of motor vehicles to ensure that they do not emit dangerous particles into the environment. According to the rules, it is an offence under the Traffic Act, Subsidiary Legislation Traffic Rules, part IV, section 27, for a vehicle to emit excessive dark smoke on the road, making visibility difficult for other road users.

4.2.2 Energy

All the fuel combustion processes in Nairobi emit a wide range of pollutant gases and particulate matter with implications for local and national air quality, health and the environment. In addition to emitting significant levels of methane (CH_4), carbon monoxide (CO) and other products of incomplete combustion, charcoal production – to meet the ever-growing charcoal usage – is a key source of particulate matter. Nairobi is increasingly constrained by an inefficient and malfunctioning energy supply that fails to provide services effectively especially to the urban poor. With the increasing costs of electricity, the demand for charcoal is growing. The use of traditional energy sources like wood and charcoal for cooking and heating has serious ecological effects. For example, the demand for charcoal in Nairobi is threatening the nearby Aberdares forest, which plays an important role in the city's water catchment system and at the same time is home to endangered animal species such as the forest elephant (UNEP/UN-Habitat 2006).

Indoor air pollution from unvented cooking stoves is a major cause of respiratory illnesses (Karekezi 2002), leading to reduced productivity and lower life expectancy, with an associated cost of about 6 per cent of the GNP of developing countries (World Bank 2000). Studies in Kenya have indicated that charcoal production and consumption in Kenya could be emitting more greenhouse gases (mainly CO^2, CH_4 and NOx) into the local atmosphere than industry and transport sectors combined (ROK 2003). Box 4.2 highlights some of the linkages between air pollution and human health.

Box 4.2: Air pollution and human health

In Nairobi, ambient air pollution from motor vehicle exhaust, simple energy use, industrial smoke stacks, dust and other particulates is a significant health risk. As women carry out most household tasks, they are particularly affected by indoor smoke and the time lost due to simple fuel use. Evidence of the health effects of indoor air pollution has grown in the last 10 years, and there is now fairly good evidence that exposure increases the risk of respiratory infections in children and chronic obstructive pulmonary disease (COPD) in adults. In addition, evidence is now emerging of links with a number of other conditions, including tuberculosis, perinatal mortality (stillbirths and deaths in the first week of life) and low birth weight, among others.

Source: WHO 2000

In the household energy sector, there have been efforts since the late 1980s to promote the use of improved cooking stoves, mainly the Kenya Ceramic Jiko (KCJ) for charcoal and Maendeleo for fuelwood in Kenya (UNEP 2006). KCJ dissemination is a major success story today, as over 60 per cent of urban charcoal users in Kenya use this stove (UNEP 2006). Improved charcoal kilns such as the Kakuzi, with an efficiency improvement of over 35 per cent, are also being promoted. The fact that charcoal and other biomass sources are likely to remain important sources of energy is recognized in the National Energy Policy 2004, which also calls for legislation to regulation charcoal and firewood production.

4.2.3 Industry

Nairobi is the most industrialized urban centre in Kenya and in East Africa in general. A total of 338 industries have registered with the Directorate of Occupational Health and Safety, excluding the EPZ industries on Mombasa road. Out of these, 123 are located in the industrial area, 53 in the CBD, 28 along Mombasa road and the rest dispersed in other parts of the city (JICA 2004).

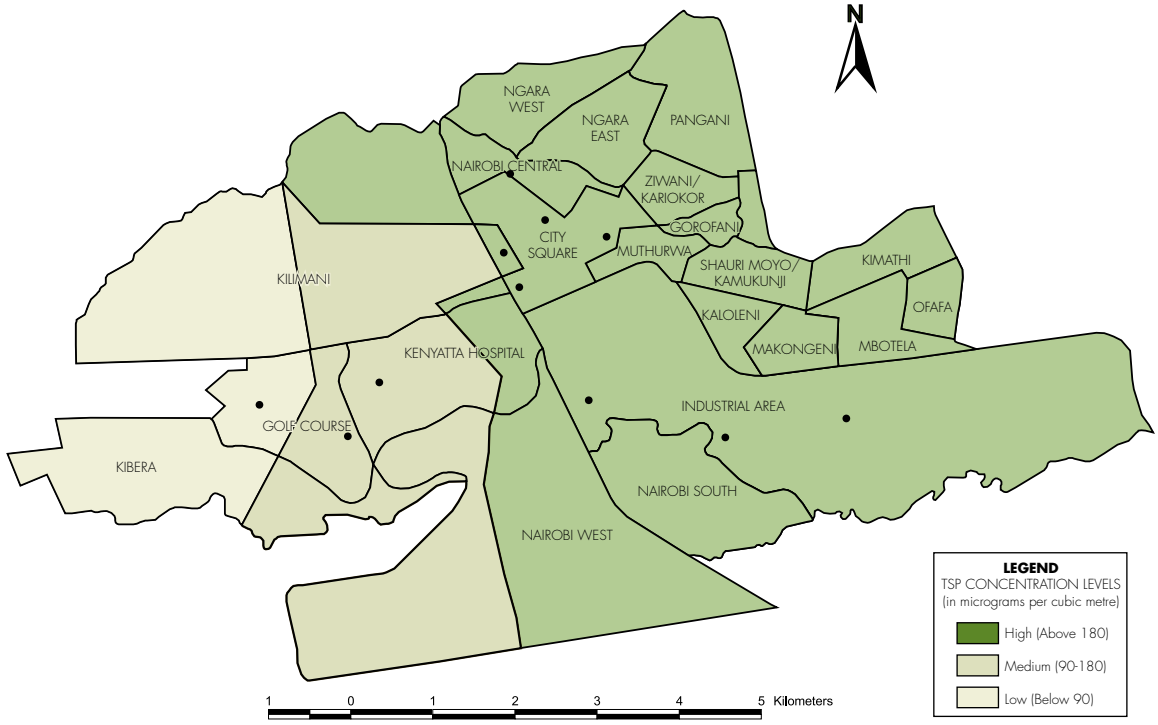
Emissions from industry contribute to smog and haze over the city. The industrial area is located to the east of the city, and the prevailing winds come from the east. Gaseous emissions from industries and vehicles are thus trapped against the western hills and sometimes form a cloud of smog over the city (MENR 1994). Apart from contributing to respiratory ailments in people, this affects visibility and can cause traffic accidents or create an unpleasant living environment for inhabitants. In 1992, measurements of the concentration of suspended particulate matter in Nairobi revealed the highest concentrations in the industrial area (252 $\mu g/m^3$), decreasing with distance from the industrial area. Other areas of the city had levels less than a third of this – 80 and 83$\mu g/m^3$ in Buru Buru area and Woodley areas, respectively (Rakodi 1997). Figure 4.3 shows the patterns of spread of particulate matter over Nairobi. Particulate matter is a major cause of respiratory diseases acting synergistically with other pollutants.

Promoting cleaner production

The Kenya National Cleaner Production Centre, through a partnership with the Kenya Association of Manufacturers (KAM), is promoting a cleaner production approach to industry work processes so as to cut down the costs of production and increase competitiveness. This has already been done for the members of Kenya Association of Manufacturers in Nairobi. The Kenya National Cleaner Production Centre is also working on a framework that will encourage the transfer of cleaner technologies.

The term "cleaner production" is defined as the continuous application of an integrated preventive environmental strategy to processes, products and services, to increase overall efficiency and reduce risks to humans and the environment and is applicable to the processes used in any industry, to products themselves and to various services provided in society (UNEP-DTIE 2002). Cleaner production means that, instead of managing outputs of emissions and waste, producers improve management of raw materials and other inputs, such as energy and water, from the moment a product or process is conceived (UNEP-DTIE 2002).

Figure 4.3: Average total suspended particulate matter over Nairobi



Source: Mulaku and Kariuki 2001.

4.2.4 Open burning of waste

One other source of air pollution is open burning of waste, which is increasingly becoming a preferred waste disposal option for Nairobi residents, especially in the informal settlements. Depending on the nature of the waste, burning can produce hazardous by-products such as persistent organic pollutants which are harmful to human health and the environment. Of particular concern are the polythene bags and plastics, including polyvinyl chloride (PVC) Items, that make up about 11 per cent of total waste generated daily in Nairobi and the chemical waste from various industrial and medical processes (ENVILEAD 2005). Incineration produces residues that require treatment or disposal, most often in a landfill. Incinerator ash – either as bottom ash or fly ash – is highly toxic and that from incinerators around Nairobi is normally deposited at the Dandora dumpsite (ENVILEAD 2005). Handling of this ash raises serious concerns because workers are often exposed to the ash, sometimes with little or no protective gear. In some instances incineration is rudimentary and with old equipment. The Kenyatta National Hospital incinerator has no air pollution control devices and the noxious fumes emitted are carried to the homes and hostels downwind (ENVILEAD2005). The hospital also burns some of its waste, mostly consisting of paper, plastics and clothing – usually considered to be of low risk – in an open pit in front of the incinerator.

The main issues in this area are the absence of a functioning system of waste management by the City Council of Nairobi and the failure by the Government to provide adequate legal guidelines on the disposal of solid waste. Other compounding factors include a lack of awareness on the part of the public, economic pressures and the general lack of administrative capacity in the City Council of Nairobi. The 1999 Environment Management and Coordination Act does, however, provide opportunities to address these issues.

4.2.5 Air quality monitoring

Nairobi does not have any regular air quality management system and any measurements of
air pollution have thus far been done on an ad hoc basis including studies conducted at the universities. Out of 20 mainly developing-country cities sampled for a UN study on air quality management capability, Nairobi was rated as the worst (UNEP/WHO 1996).

Opportunities exist, however, to implement sustainable solutions to the problems of air quality in Nairobi, mainly through the regulation of air emissions. Existing legislation, specifically the 1999 EMCA, provides opportunities to improve the management of the quality of Nairobi's air. The EMCA, which reaffirms the right to a clean and healthy environment, in section 78 specifically provides for the development of ambient and occupational air quality and emission standards for various sources. This process is currently under way. It also provides for other mechanisms to control air pollution. Box 4.3 lists other legislation that offers mechanisms to regulate air quality.

Box 4.3: Legislation for air pollution control in Kenya

The following are the major existing pieces of legislation that address air pollution:

- Penal Code, Cap 63
- Chiefs Authority Act, Cap 128
- The Public Health Act, Cap 252
- The Local Government Act, Cap 265
- The Mining Act, Cap 306
- The Traffic Act, Cap 365
- The Factories Act, Cap 514
- Grassfires Act, Cap 327

Lack of information on the scale and scope of the air quality problem has meant that the issue rates very low on the political agenda. Key interlinkages between, for example drought and poverty, or air pollution and human health, are not very clear to politicians and other key decision makers. There is thus need to develop a programme for the management of Nairobi's atmospheric resources. This should include a research agenda, incorporating the development of human and institutional capacity as well as the provision of much-needed monitoring equipment. Currently, such equipment only exists at the Institute for Nuclear Science at the University of Nairobi and the Department of Meteorology.

An air quality strategy for Nairobi, and Kenya as a whole, is under preparation. The aim of the strategy is to monitor ambient air quality. It sets out health-based standards for eight main air pollutants and objectives for their achievement. It provides a framework which allows relevant parties such as industries, businesses and local governments to identify the contributions that they can make to ensure the objectives are met. At a regional level, Kenya is a member of the Air Pollution Information Network for Africa (APINA). APINA was formed to address issues related to air pollution. To address the growing urban air pollution in Africa, APINA has organized workshops and conferences to create awareness and to develop a framework for action. The resulting recommendations include the requirement for harmonization or improvement of fuel quality in Africa and policies on old vehicles.

4.2.6 Climate change

The impacts of climate change, in the form of droughts and floods, are already being felt in Nairobi, especially in the informal settlements, where coping mechanisms and adaptation strategies are weak (Action Aid 2006). Rural-urban migration and poverty has led to houses being built in inappropriate places and poor disposal of waste into drainage channels and streams. This is compounded by weak enforcement of building regulations and local development plans by City Council of Nairobi to prevent building in flood hazard zones in the city (Action Aid 2006). For instance, in the Maili Saba slum, situated about 11.2 km from the city centre, flooding is a normal occurrence. Houses are built of weak, inadequate building materials, and because they are so close to the Nairobi river there is considerable disruption when floods occur (Action Aid 2006). The increased incidence of flooding appears to have links both to local activities and to global climate change. Indeed, research has shown that in slums like Mabatini in Mathare floods now occur in places they did not two decades ago (Action Aid 2006). Floods have been known to lead to human deaths and disrupt traffic flow within the city.

Other extreme climate events such as drought have also hit the city, increasing the vulnerability of the local population. For instance, the 1999–2000 droughts led to serious power and water rationing and an influx of pastoralists and their livestock in Nairobi. At that time, herds of livestock were a common sight in some areas of the city such as Embakasi (UNEP/DRSRS undated). The volume of water in urban water supply dams decreased drastically (as high as 70 per cent for Sasumua dam) in tandem with the decreased river flows at the height of the drought. Water supply to Nairobi then only measured 274,900 m^3 per day, way below the normal demand of almost 350,000 m^3 per day (UNEP/DRSRS undated). This resulted in water rationing and the mushrooming of water vendors, whose water was at times of questionable quality. The daily loss in revenue was estimated

at US$ 50,000 for Nairobi at the height of the drought (UNEP/DRSRS undated).

More recently in late 2006, heavy rains led to the deaths and displacement of people living along the banks of the Ngong and Nairobi rivers. It is estimated that by 29 November 2006, incidences of floods in Nairobi led to the deaths of 12 people, with scores of others displaced in the slum areas of Kibera, Mukuru kwa Yaaba and Mukuru kwa Njenga (OCHA 2006).

Animals grazing in the Langata cemetery in Nairobi due to lack of pasture caused by drought

Source: Situma C and Barreh J.K.

The City Council of Nairobi does not seem to have any specific mechanism or action plan for reducing disaster risk or managing disasters once they happen. For instance in the case of floods, once they happen, poor people are left to fend for themselves with whatever individual coping strategies they can muster (Action Aid 2006). There are opportunities that the City Council of Nairobi could explore, however, to improve disaster response and management in the city, for instance through partnerships with residents associations and other civil society organizations, and through the potential provided by national mechanisms.

There is, at national level, a National Disaster Operation Centre under the Ministry of State for Special Programmes in the Office of the President. A draft national disaster management policy was prepared in 2002, and the National Platform on Disaster Risk Reduction was launched in August 2004 to promote multi-level and multi-sectoral cooperation and collaboration in disaster reduction and the integration of disaster risk reduction in to policy formulation, national development planning and programme implementation. Kenya has also signed up to the Hyogo Framework of Action 2005–2015, which calls for disaster risk assessments to be incorporated into urban planning and the management of human settlements (ISDR 2005).

4.3 Solid Waste management

Waste management is a growing problem in Nairobi. Increasing urbanization, rural-urban migration, rising standards of living and rapid development associated with population growth have resulted in increased solid waste generation by industrial, domestic and other activities. The increase in solid waste generation has not been accompanied by an equivalent increase in the capacity of the relevant urban authorities to deal with this problem. The proper management of waste has thus become one of the most pressing and challenging environmental problems in the city.

4.3.1 Waste generation

According to an African Development Bank study (AfDB 2002), a total of 1,530 tonnes per day of solid wastes are generated in the City of Nairobi, with an apparent specific gravity of 0.28. Applying the 1999 census figures for Nairobi (2,143,254 people), this means that the amount of solid waste generated is about 0.714 kg per person per day.

Waste in Nairobi comes from a variety of household, service and industrial processes. The literature shows that 68 per cent of waste is from domestic sources, 14 per cent industrial, 8 per cent roads, 2 per cent hospitals, 1 per cent markets and 7 per cent from other sources (NEMA 2003). The different types of solid waste generated are shown in figure 4.4. Table 4.1 shows trends in waste generation in the city.

Table 4.5: Trends in wastes generation in Nairobi

Year	Amount generated/day
1973	452.66[1]
1975	501.92[1]
1985	850.86[1]
1998	1 426.00[2]
2002	1 530.00[3]
2004	2 347.00[4]
2015	2 679.89[3]

Adopted from MENR, 1994

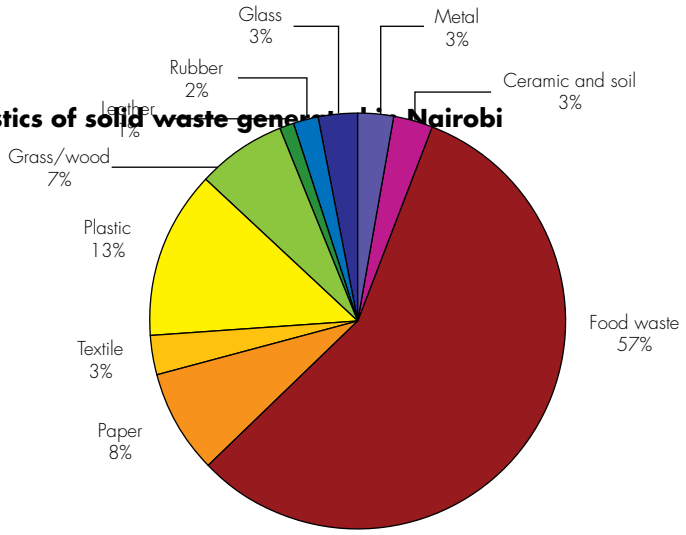


Figure 4.4: Characteristics of solid waste generated in Nairobi

Source: JICA 2003

4.3.2 Waste collection and disposal

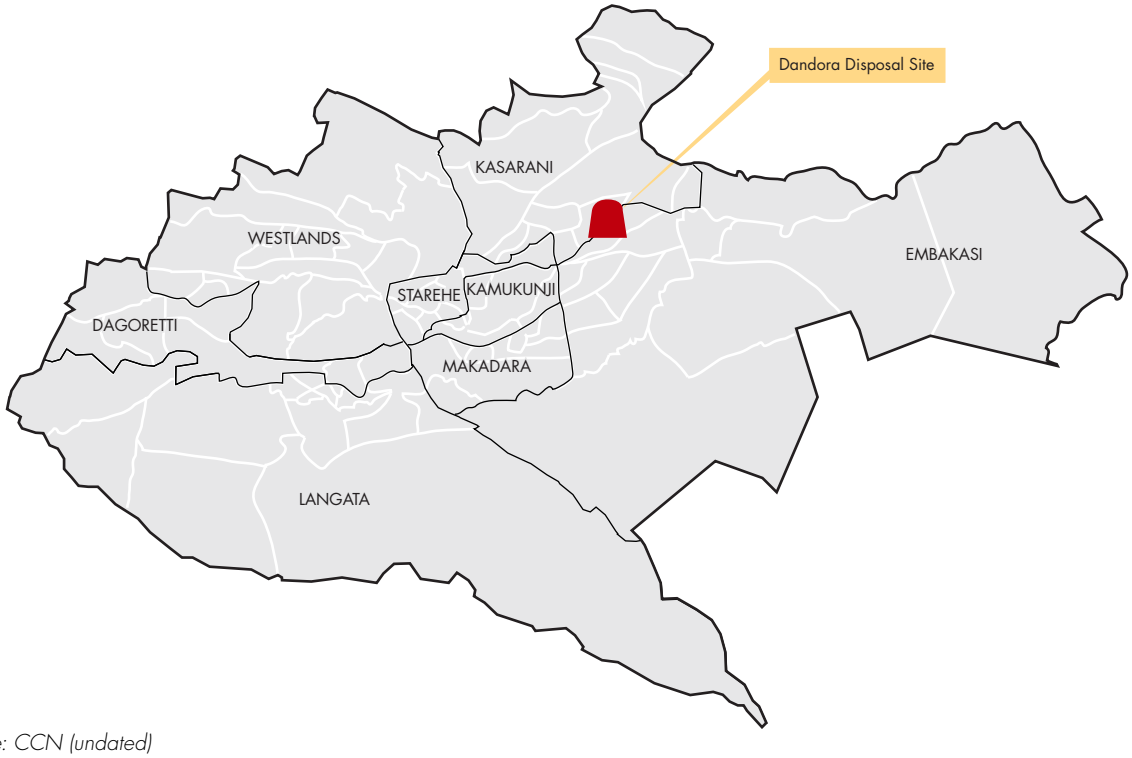
Only about 40 per cent of the waste generated in Nairobi is collected by the City Council of Nairobi, the private sector collects about 20 per cent and the balance is left uncollected, or is disposed of through other means, including by burning, dumping in pits and other unauthorised places, or is collected by the numerous nongovernmental organizations, community-based groups and other ad hoc or voluntary groups (Ikiara 2006). It is estimated that there are at least 60 private companies engaged in solid waste collection services in the city (JICA 1998 in UNEP/NEMA 2005). According to the City Council of Nairobi, at the beginning of 2007, this number had increased to about 85. Some of these companies also operate as waste recovery and composting groups and therefore improve on the cleanliness of the surrounding environment (Ikiara 2006). Mixed waste from industry is disposed of by the industries themselves at Dandora for land filling.

Nairobi has one official disposal site (City Council-owned and operated) situated in Dandora, Eastlands, about 7.5 km from the city centre, where about 30 per cent of the waste (excluding hospital waste) collected is taken (AfDB 2002). It is filled with approximately 1.3 million m^3 waste at present (AfDB 2002). Figure 4.5 shows the location of the Dandora dumpsite in Nairobi province. The disposal site has been in use since 1981 and has accumulated close to 1.4 million cubic metres of waste. As a result of poor management, the disposal site is perceived to be full and the City Council of Nairobi has no waste transfer facilities (UNEP/NEMA 2005). This poses particular threats, including potential pollution of water sources by landfill leachates and the migration of explosive gases. This situation requires regular monitoring.

There are other disposal sites that are categorized as illegal but these also take much of the waste generated within the city. Most of independent private waste collection companies end up taking their waste to these illegal sites, which do not charge user fees and are thus convenient for their operations. These sites present potential environmental and health risks. The City Council of Nairobi urgently needs to allocate and gazette a new disposal site for the city: the new site should be sanitarily managed and operated with other waste minimization practices like transfer stations and composting facilities.

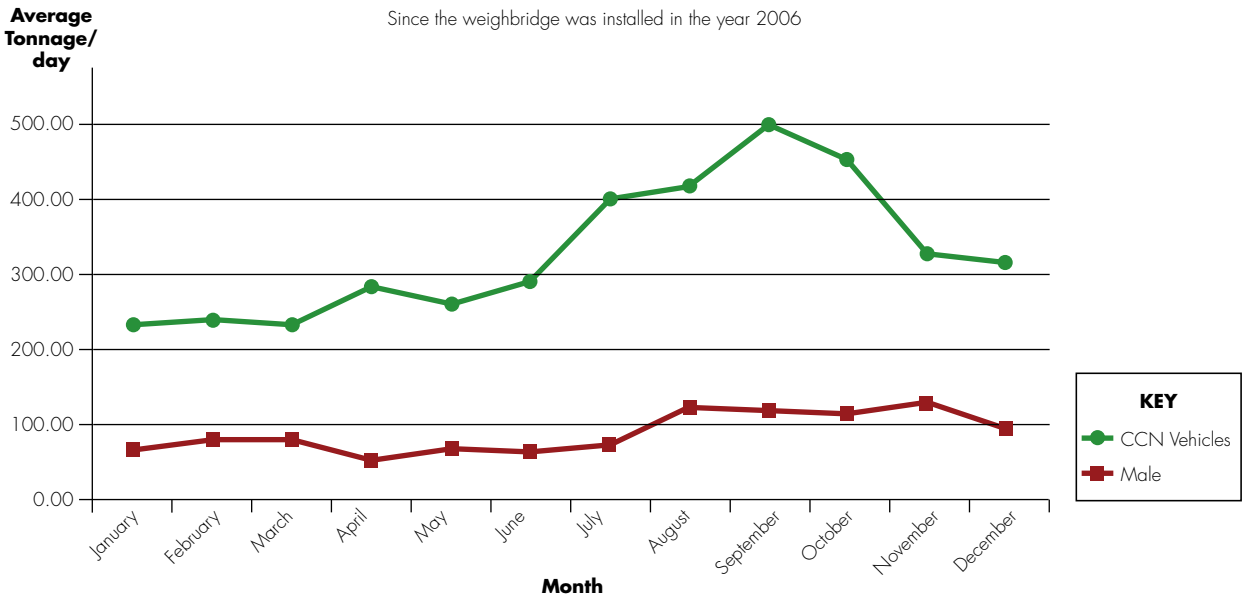
Currently the capacity of the City Council of Nairobi to fulfil its public and statutory responsibilities to the citizens of Nairobi, especially in this sector, is severely limited. In some areas, the council has virtually ceased to deliver its services. Where available, waste collection services are geographically skewed with higher and middle-income residential and commercial areas better serviced. The low-income areas, where up to 60 per cent of Nairobi's residents live, receive no waste collection service save for localized interventions by community-based organizations (UNEP/NEMA 2005). Figure 4.6 shows the waste collection trends in Nairobi in 2006.

Figure 4.5: Location of the Dandora dumpsite in Nairobi



Source: CCN (undated)

Figure 4.6: Waste collection trends in Nairobi in 2006



Source: Netwas undated

Because of the inefficiencies in waste collection and disposal, there is widespread indiscriminate dumping in awkward places. This has led to poor sanitary conditions,incidences of environment-related health problems and habitat modification. The situation is aggravated by the fact that waste is not sorted at source, so hazardous waste such as that from clinics is mixed together with manufacturing and biodegradable waste (Ikiara 2006).

A dump site located after Jamhuri Dam spill-way on the bridge to Kibera from Jamhuri Park

Source: Netwas undated

People scavenging through a rubbish dump at Embakasi Doonholm area; and an illegal dump off Naivasha Road next to ILRAD

Source: City Council of Nairobi 2005

Since over 50 per cent of the waste generated is organic in nature, there are opportunities for organic waste recovery. Using waste as a resource, for example through composting organic waste for reuse in urban agriculture, is one way of reducing the environmental problems linked to waste and also as a means of reducing urban poverty. There could be opportunities for the involvement of women and young people. Since the City Council of Nairobi has no capacity to collect all the waste generated, it should look into employing a policy of separation of waste, waste recycling, reuse and waste reduction at source.

4.3.3 Options for better waste management

Owing to its cross-sectoral nature, waste management is fragmented into several pieces of legislation, such as the EMCA Act, the Public Health Act, the Local Government Act and the Forest Act, among others. The Government should consider a comprehensive law on waste management, including a strategy and guidelines for implementation. At the twenty-third session of the Governing Council/Global Ministerial Environment Forum in 2005, President Mwai Kibaki reiterated the Government's commitment to resolving the plastic bag menace. The proposed strategy to deal with plastic bags (see box 4.4) is indeed a step in the right direction. Its success will depend, however, on the operationalization of functional incentive schemes, the promotion of recycling based on a coordinated return scheme and appropriate plastic waste recycling technologies, and a massive awareness-raising campaign. Institutional strengthening of relevant bodies and a national waste management policy will also be required.

In an effort to respond to some of the challenges presented by the sector, the City Council of Nairobi installed a weighbridge at Dandora disposal site in January 2006. In the past, the City Council only approximated the amounts of disposed waste, based on the number of vehicles and approximate tonnage. This was misleading and did not help much in planning. With the weighbridge, the council also implemented a waste collection contract based on nine operational zones in line with the constituency boundaries for Nairobi. These contracts have improved the efficiency of waste collection by the City Council of Nairobi in almost every part of Nairobi even though the impact has only been felt in the CBD, where collection levels are above 80 per cent.

The waste management function in the City Council of Nairobi is weak because of inadequacies in planning, governance, enforcement of existing legislation and the absence of economic and fiscal incentives to promote environmentally sound development. For instance, the City Council by-laws prohibiting illegal disposal of waste, specifying storage and collection responsibilities for waste generators and indicating the Council's right to collect solid waste charges are not adequately implemented (UNEP/NEMA 2005). In addition, the sector lacks a policy and strong reuse and recovery industry. Long-term waste management planning by NCC includes the construction of a new engineered 40 ha landfill at Ruai. The approximate total capital cost is KSh 1,969 million (US$ 33 million), with collection and transportation costs estimated at KSh 4,282 million (JICA 1998 in AfDB 2002). The City Council of Nairobi is currently looking for a strategic partner with financial and technical capability solid waste management in order to improve services in this sector.

It has been established that it is possible to generate revenue to cover operating costs for collection of refuse and treatment of raw sewage through energy generation and sale. Already efforts are under way in Nairobi to use waste-derived fuels by making briquettes from charcoal dust and through the direct burning of household waste. This is on a small scale, however. Municipal waste can be used as an energy source, thus getting rid of solid waste and associated pathogens and the gases associated with decomposition. If well designed, large-scale urban waste-to-energy projects can benefit the urban poor who are already involved in waste collection, sorting, recycling and disposal (Karekezi 2002).

Box 4.4: Kenya government strategy to deal with the plastic bag menace

About 4,000 tonnes of thin plastic bags are produced per month in Kenya mainly for use as packaging or carrier bags. Half of them range between 7 and 15 microns thick. In Nairobi, every year about 2 million plastic bags are handed out to shoppers. The industry is growing at between 8 and 10 per cent/year supplying both the local and regional market. The bags are an eyesore, block drainage channels, choke animals and pollute the soil. They are also linked to the upsurge in urban malaria.

The level of recycling and reuse of these bags is very low. Recycling has not been widely practiced for various reasons including lack of technology, high costs (energy and water), available space and the under-developed market for recycled products. But some firms have started recycling the bags and a supermarket chain has initiated a collection programme. The Government has proposed an integrated policy package based on the following seven instruments:

- Ban on plastic shopping bags that are less than 30 microns in thickness
- Consumer awareness and anti-littering campaign
- Promotion of voluntary schemes such as a national code of practice for retailers
- Plastic bag levy collected from either suppliers or directly from shoppers
- Support for development of environmentally-friendly alternative bags
- Support for an effective plastic bag recycling system
- Support for a disposal system for those bags that enter the waste stream despite measures taken

A Plastics Levy Management Committee, chaired by NEMA, has been proposed as the institutional set up to manage and implement the measures to deal with the problem.

Source: UNEP/NEMA 2005

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CHAPTER 5: ENVIRONMENTAL OUTLOOK TO 2015

5.1 What is a scenario?

Scenarios are stories about the future whose purpose is to enable better decisions in the present (Shell 2003). A scenario uses words, numbers and graphics to describe how future events could unfold, and suggests lessons on how to direct the flow of events towards sustainable pathways and away from unsustainable ones. Scenarios provide a means of examining the forces shaping the world, the uncertainties that lie ahead and the implications for tomorrow of today's actions (UNEP 2002). They are a strategic tool used to highlight uncertain aspects of the future or to discover aspects about which they should be most concerned and to explore ways in which these might unfold. Breaking through the barrier of uncertainty can provide a useful context for debate, lead to better policy and decision-making and, it is hoped, translate into better programmes and action on the ground (Shell 2003). In other words, if these scenarios are used, the leadership of the City Council of Nairobi should be able to prepare proactively for change ahead, instead of continually fire-fighting.

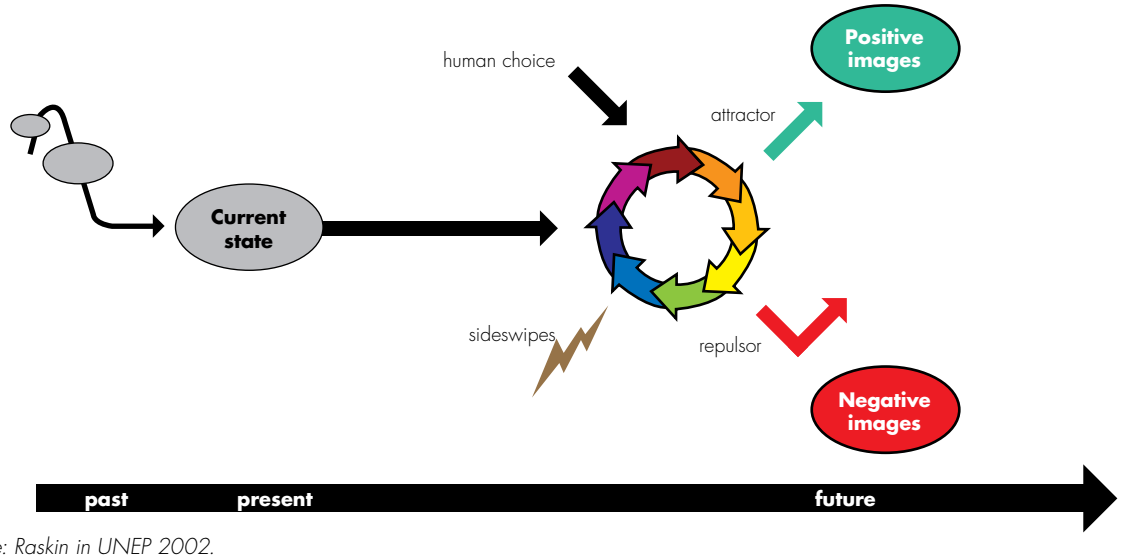
5.2 Scenario dynamics

To understand scenarios, one must be aware of their key components. Scenario studies have shown that the current state of the environment is the outcome of a historical process which is driven forward by a set of driving forces and trends that condition and change the system (Raskin et al. 2002). The preceding chapters of this document have highlighted the key driving forces and trends that have led to the current state of Nairobi's environment. This chapter will now use this information, coupled with insight and knowledge of the city, to try and visualize alternative futures for Nairobi. Since the future never proceeds in a smooth trend, the possibility of unexpected extreme occurrences or "sideswipes" that could affect development will be factored in (UNEP 2002). It is also possible that certain "forces of attraction" and "forces of repulsion" may shape the different futures. Figure 5.1 shows some of the scenario dynamics.

5.3 Three scenarios for Nairobi

Because there is no single answer to the way the future may unfold, this chapter presents three scenarios for Nairobi over the next 20 years. The scenarios have the same basic assumptions, but each describes a different way in which certain trends could play out. The issues selected for analysis in each scenario all have links to Millennium Development Goal *7* on environmental sustainability as this provides the road map to sustainable development to which Kenya is committed. Box 5.1 highlights the key components of Goal *7*.

Figure 5.1: Scenario dynamics



Source: Raskin in UNEP 2002.

Box 5.1: MDG 7 and its targets

MDG 7 is to ensure environmental sustainability. It has three targets:

Target 9: Integrate the principles of sustainable development into country policies and programmes; and reverse loss of environmental resources.

Target 10: Reduce by half, the proportion of people without sustainable access to safe drinking water.

Target 11: Achieve significant improvement in lives of at least 100 million slum dwellers, by 2020

The first scenario: **inertia: implies a resistance to change**. In other words, business proceeds as usual. Some environmental initiatives are put in place by the local government; however, the impact on the environment is much less than expected.

The second scenario: **worst case: increasing poverty and environmental degradation undermine the local government's efforts to ensure sustainable development**. Here the capacity of regulatory institutions and the City Council of Nairobi for environment management is reduced. Environmental initiatives are not effective. As environmental degradation increases, levels of poverty and disease epidemics rise.

The third scenario: **best case: responses by the local government and society are used for sustainable environmental management.** A strong City Council of Nairobi seeks to develop strong institutions and community leaders to develop home grown solutions to the city's environmental problems. It especially incorporates traditional, cultural and other indigenous values to augment national and other donor-driven development policies.

5.4 The driving forces

Driving forces are the mechanisms that allow change to occur (UNEP 2002). All scenarios begin with the same set of driving forces. Social, economic and environmental patterns then gradually diverge as they are conditioned by different events, institutional change and social choices (Raskin et al. 2002). The driving forces which may influence development in Nairobi include population, economics, social issues and the environment.

5.4.1 Population

Population will continue to be a driving force over the next 19 years. It remains high; although indications are that the growth rate is starting to level off and stabilize (table 5.1). The Government aims to meet the target set in the National Population Policy for Sustainable Development of stabilizing the fertility rate at 2.1 by 2010 (CBS *et al.* 2004). Rural-urban migration will continue to be a contributing factor in augmenting the city's population. This is likely to continue to pose great challenges for city authorities in terms of service provision, infrastructure development, environmental management and social cohesion. There will be implications for per capita access to natural resources such as land which are already in short supply in Nairobi.

Table 5.1: Population size and growth rate for Nairobi 1985-2015

Estimates and Projections							Annual Growth Rate			Share in country's urban population		
(thousands)							%			%		
1985	1990	1995	2000	2005	2010	2015	1985-1995	1995-2005	2005-2015	1985	2000	2015
1 100	1 403	1 810	2 310	2 841	3 346	3 773	5.0	4.5	2.8	28.0	23.2	22.5

Source: UN-HABITAT 2001

5.4.2 Economics

Economics will continue to play a big role in the future growth of Nairobi. As the commercial hub of the East African community, there are vast opportunities for growth and the local government is eager to take advantage of these. From a country perspective, real GDP grew by 5.8 per cent in 2005 against a revised growth of 4.9 per cent in 2004. Expansion in GDP was mainly underpinned by agriculture and forestry (6.7 per cent), wholesale and retail trade (6.5 per cent), and transport and communication (8.3 per cent) (CBS 2006). Growth is expected to be sustained across the sectors throughout 2006 and into the future. While this is good, the challenge for Nairobi is to balance strategies that promote economic growth while ensuring the sustainability of ecosystems and human well-being.

5.4.3 Social issues

Increasing inequality and persistent poverty characterize the city. About 44 per cent of people in Nairobi live below the poverty line, with the poorest 20 per cent accounting for one half of the city's poor population (CBS 2003, CBS 2005). Nairobi contributes 6 per cent to total national poverty. Although the Kenyan Government has made poverty reduction a major development goal, tangible impacts are yet to be felt. The links between poverty and environmental degradation are well documented and are likely to remain a pressure factor for years to come. Some social indicators such as access to sanitation (95.2 per cent) and primary school attendance (85 per cent) and under-five child mortality (95 per 1,000 live births) have improved. But there are still challenges – as with HIV/AIDS where the prevalence rate for Nairobi (9.9 per cent) is almost 1.5 times higher than the national rate (CBS 2003). The above indicators all have impacts on human well-being, affect the ability to earn a livelihood and are closely linked with the state of the environment.

5.4.4 Environment

The environment is a driving force for change through its interaction with other driving forces. Most basic human needs, such as food, shelter, energy and water, are linked to the environment. The increasing pressures on the environment for these resources translate into threats such as land degradation, water scarcity, deforestation and pollution, among others. These threats positively correlate with poverty. Such processes as depletion and degradation of the resource base intensify competition for resources, creating potential conflict and causing migration to less stressed areas. The ability of the environment to continue to support development depends on the employment of strategies that will reduce the risks posed by these threats and promote sustainable management of the asset base.

5.5 Environmental implications of the scenarios

5.5.1 Inertia scenario

Population continues to grow without major deviation from the policies pursued. Rapid population growth is projected until the year 2015 and will result in population densities of over 5,000 people per square kilometre. The rate of population increase will not, however, be uniform in all divisions of the city. The divisions dominated by the poor are expected to register higher populations than those occupied by the more affluent, as has been the trend. These include Embakasi, Kasarani and Makadara divisions. This will create more pressure on the available green spaces, infrastructure and the ecosystem at large. The growth in population will result in greater levels of pollution through higher solid waste generation rates, an improved economy, greater consumption rates, more vehicles, fewer open spaces for recreation and vegetation to moderate weather and climate, an increase in the number of poor settlements, more disease because of inadequate infrastructure in these areas, hence more public expenditure on health. For instance, it is estimated that, by 2015, the daily solid waste generation rate will hit 2,693,922 tons. With no overall improvement in solid waste collection, there will be increasing mountains of solid waste around the city.

Studies show that Nairobi has enough water at current consumption rates to supply the city for the next 10 years. So the City Council of Nairobi approaches this sector in a *laissez faire* manner. Foresight from international groups like UNEP, however, pushes the city council to devise innovative programmes to address the immediate problems in the sector. For instance, the Nairobi River Basin Programme is implemented to address pollution, catchment degradation, income generation and slum improvement. Because of external support and pressure from the donors, the programme is a success and, by 2015, there are signs of improvements in water availability and quality.

Urban agriculture assumes greater importance as far as food security and livelihood support are concerned. Currently,

urban agriculture in Nairobi is worth about US$ 3.2 million per year (Ayaga *et al.* 2004). The city authorities start to regulate the sector and by 2025 about 20 per cent of land in Nairobi is under urban agriculture, up from 13.9 per cent in 2006. The benefits include food security, use of underutilized urban resources, urban waste recycling and income-generation. Women play a central role in urban agriculture, with many engaging in it as a survival strategy. Use of waste and sewage to fertilize urban agriculture reduces the amount of waste the city has to manage and provides livelihoods for those employed in the compost industry. Given the success of using waste in this manner, other cost-effective options for using waste are explored. These include opportunities under the clean development mechanism.

The future of environmental resources such as forests is largely determined by the way they are seen by the elite. Forests were disappearing because of weak law enforcement, budgetary constraints in the institutions responsible for forest management, corruption, and outdated forest policies. Policy reviews were undertaken to increase the level of conservation and to increase forest cover and a new Forest Act (2005) was gazetted. Although this was supposed to strengthen forest conservation, illegal logging for high value species continues. For instance the Muhugu tree *(Brachylaena huillensis)* that is highly valued for woodcarving is extensively harvested from the Ngong forest (IUCN 2003). Already suffering from logistical problems, there are arguments in favour of degazetting forests that have high protection costs.

Although Kenya has enacted many environmental laws, regional and local treaties and agreements, the integrity of the environment continues to decline, especially at the local level. This is due to a lack of local implementation capacity, political will and real authority and power over finances and decision-making. Further reforms at the local government level are unlikely to happen within the next five years. Already the process to amend the Local Government Act has been shelved until after the constitutional review process is complete. In addition, although the Government claims to be committed to reform at this level, it is unlikely that real executive power will be decentralized to the lower levels.

Civil society groups grow weary of the apparent reluctance of the local authorities to take responsibility for the management of the city. So a broad coalition of civil society steps in to enforce certain standards of corporate behaviour. Local taxes are withheld until the city council delivers services. In some cases these taxes are used by the groups to provide urban services in their areas of jurisdiction. The Local Government seems rather bemused and tries to come up with a policy to regulate private sector participation in the city, but this is never formalized.

What would the inertia scenario mean for the City Council of Nairobi?

With sufficient political commitment from the City Council of Nairobi, a comprehensive set of policies could give the city the momentum required to redirect development towards sustainability. One way of giving the city a new lease of life would be to ensure that the environment is mainstreamed into all development programmes at all levels of governance. Although institutions are empowered to monitor and enforce the implementation of environmental laws, it would still be an uphill battle. Lack of capacity may make it difficult to deal with the competing demands of a dynamic globalizing world. So to achieve sustainable development under this scenario would require immense effort.

5.5.2 Worst case scenario

In this scenario, environmental degradation continues unabated largely because stakeholders are not convinced about the thinking behind the sustainable development paradigm. The Government tries to implement reforms within the environment sector without much success. For instance, reforms in the land and water sector have resulted in institutions being created and appropriate legislation put in place. But these have largely been ignored. Cases of change of land use continue with impunity. For instance, the Karura and Ngong Road forests continue to have large tracts given away to private investors without recourse to environmental impact assessment. Data by the end of 2006 show that over 50 per cent of Nairobi's forests have been lost though excisions for development, settlements, land speculation or for political reasons; deforestation; and illegal logging (KNCHR/KLA 2006, Kigenyi *et al.* 2002). This trend is expected to continue. Land reforms currently pursued are abandoned and expansionist land use tendencies threaten protected areas.

Although Nairobi continues to have a negative influence on the environment in its hinterland, city authorities ignore the warning signs. Rising demands for hydroelectric power and charcoal are threatening the integrity of the Tana river basin. This results in increased flooding, pollution, reduced groundwater recharge and stream base flow and the reduced ability of wetlands to perform crucial ecosystem services. The

demand for charcoal threatens the nearby Aberdare forest, which plays an important role in Nairobi's water catchment system and at the same time is home to endangered animal species such as the forest elephant (UN-Habitat 2005). By 2020, there is a looming development crisis. Poverty rates are higher, and vulnerability to natural disasters, disease and local food insecurity has increased.

These actions are not without negative impacts on Nairobi's environment. Air and water quality deteriorates with serious consequences on human health. Meteorologists predict another drought in 2012, following the usual ten-year cyclical nature of droughts in Kenya. As in 2002, this drought brings even more severe rationing of water and power. This will threaten the health and economy of the whole country. Air quality continues to deteriorate as the number of vehicles on the roads increases. Although the Traffic Act and the Environment Management and Coordination Act provide for regulations to control emissions, these are not implemented.

The outlook for Nairobi's water and sanitation situation is dire. Water demand in Kenya is projected to increase by 5.8 per cent by 2010 (FAO 2005 in UNEP/IISD 2005) and, by 2025, water stress will be a reality in the city. The poor continue to pay disproportionately more for water. Within Nairobi's catchment area, the increasing amounts of waste and its poor management contribute to increasing levels of water pollution and environmental degradation. This poses a major threat to water quality and quantity. Domestic freshwater resources are so polluted that Nairobi is forced to source water from over 50 km away. Already 30 per cent of the population lacks access to treated water and 50 per cent of water supplied is wasted. This amount of water, if saved, could adequately supply both Kisumu and Mombasa. Given the chronic water supply problems, more and more people sink boreholes, disregarding the 800 m separation regulation. By 2025, over-abstraction of ground aquifers is a real threat and there are signs that land subsidence is beginning.

Land degradation is rampant, owing to overcrowding and insecure land tenure. There is little investment to improve the situation. The Government abandons all attempts at reforms to improve the well-being of the people. Forced evictions occur with greater frequency, leading to increased violence and insecurity, loss of livelihoods, community structures and consequently greater poverty for those affected. This does not, however, get rid of the problem, the slums just relocate elsewhere. The situation worsens as the housing deficit becomes more pronounced. Rural migrants looking for opportunities in the city overstretch the urban infrastructure. The infrastructure in the low income, urban areas deteriorates rapidly as the city authorities become unable to cope with the rate of influx of people. In 2002, only 40 per cent of Nairobi was planned, these percentages decline as the planning fails to keep pace with the rate of development and expansion (UNEP 2002).

What would the worst case scenario mean for the City Council of Nairobi?

The worst-case scenario would put the city on the path to eventual political, economic and environmental collapse. Recovery from such a breakdown of society would take thousands of years. The plausibility of this scenario may be the wake-up call that the City Council of Nairobi requires to put it on course for a different scenario that can lead to a brighter future.

In order to avert this scenario, policy processes should be more inclusive and allow for equitable access, control and use of the resources. The City Council of Nairobi should be alert to the high probability for conflict over natural resources and employ conflict avoidance, resolution and management methodologies as part of environmental governance.

5.5.3 Best case scenario

The emergence of environmental issues over the past decades strongly influences the tone of development in Nairobi. The cities leadership is conscious of the cities ecological footprint in the wider Kenya and seeks to redress the situation. There is an increasing shift towards partnerships in implementing urban policy. Such partnerships have evolved from concerns over increasing poverty, lack of finances by the City Council of Nairobi; the deteriorating housing situation in the informal settlements; and recognition of the need to incorporate local communities in prioritizing poverty reduction interventions.

Ecosystem integrity is improved through restoration activities, both within the city and in partnership with communities outside the city. Although the impact is not immediate, positive impacts on biodiversity loss, wetlands degradation and water availability are expected within the next 20 years. Investment in large-scale water redistribution schemes is likely to take place in the next 30 years.

The Kenyan land reform process offers opportunities for sustainable land use. Land-use changes within the city are only sanctioned after a rigorous environmental impact assessment (EIA) process. Further increased public participation means that communities are vigilant in ensuring that mitigation measures are fully implemented.

Urban growth continues, but it is planned. As a result, the quality of services for urban dwellers is improved. Industrial emissions and discharges are controlled through regulations and by industries being located away from major settlements and sensitive ecosystems. Urban authorities are given adequate capital through streamlined revenue collection systems and are able to deliver improved services including refuse collection and street lighting. Improved environmental consciousness translates into more responsible consumption and ecofriendly practices such as reuse and recycling by the citizenry. Solid waste generation per person goes down to about 0.6 kg per person per day, a decrease of almost 16 per cent from the current rate. This is achieved by innovative "bread-and-water for waste schemes" in the slum areas basically taking care of about 60 per cent of the total waste generated in the city. More private sector involvement in the provision of services in urban areas opens up opportunities for wealth creation through trade in recyclable waste.

Population management policies that were initiated during President Moi's era start to bear fruit. The Government manages to stabilize the fertility rate in the city at 2.1 by 2010. This can be seen through a reduction of population-related pressures on land. Urban migration reduces through incentives to stay in rural areas with deliberate policies that encourage employment creation in the rural areas. By 2015, however, about 22 per cent of Kenya's urban population (UN-Habitat 2001) is living in Nairobi, drawn by increased employment opportunities and availability of services. The social infrastructure is overstretched for the next 30 years as investment in infrastructure development still lags behind the population increase. The housing shortfall currently stands at about 35 per cent, but this gradually reduces with more involvement of the private sector in the housing industry, despite the influx of people to the urban centres.

More planned and less congested urban centres emerge as land-use planning policies are implemented. The majority of urban dwellers have access to clean water and sanitation. Solid waste management problems are tackled with the involvement of the private sector. Crime rates are reduced, as better investment policies result in a vibrant private sector which is able to create youth employment. Integrated approaches to the management of urban areas, including water, are implemented so as to take into account the powerful interactions that characterize human settlements. For instance, water and sanitation programs cannot be properly planned or evaluated without taking into account the structure and dynamics of the settlements they serve. The Nairobi River Basin Project, which combines water basin management, slum improvement, employment generation and the control of alien invasive species, is one success story. By 2015, the quality of the river has improved to such an extent that there are plans to use the river for domestic freshwater needs. Studies by UNEP show that Kenya, with a population of about 40 million people, could collect enough rain to supply six or seven times that figure. The city authorities implement rain water harvesting systems as an alternative for those who are not on the Nairobi Water Company supply system and also for irrigation of urban agriculture. Thus, despite increasing urbanization and associated increases in water usage, water supply is augmented. Benefits include reduced vulnerability to water-borne diseases, especially in the slum areas.

The Government focuses more on the protection of forests where activities are more strictly regulated, thus improving their quality. The role of better land management for sustainable development is acknowledged and agreements between Nairobi and neighbouring districts are reached to increase investment in catchment management through forestry. Initiatives such as the Nairobi River Basin Programme reduce the pollution of waterways through tackling the city's wastes issues. Nairobi also invests in becoming a carbon sink by increasing the acreage of land under forest cover. This has the benefit of earning the city money. Forests also continue to be a major source of energy especially for the urban poor and the Government takes deliberate steps to promote agroforestry as part of the economic recovery programme.

What could the best case scenario mean for the City Council of Nairobi?

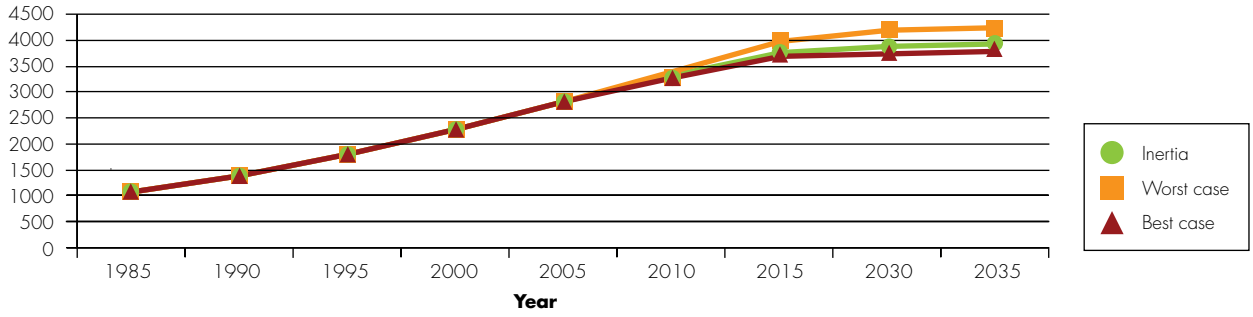
Elements of this scenario are already evident in Nairobi, as can be seen in the increase in public-private partnerships for policy development and implementation. If pursued, this could be the beginning of a new development agenda, encouraging the city to prioritize issues pertaining to city development above political interests. The City Council of Nairobi should embrace the MDG targets as a mechanism for achieving development. These can be mainstreamed in

urban policies and other sustainable development initiatives at the local level. Although a participatory approach to policy development and implementation may be cumbersome and time-consuming, these initiatives would encourage progress, while at the same time freeing City Council of Nairobi resources to ensure better enforcement.

5.6 Scenario highlights

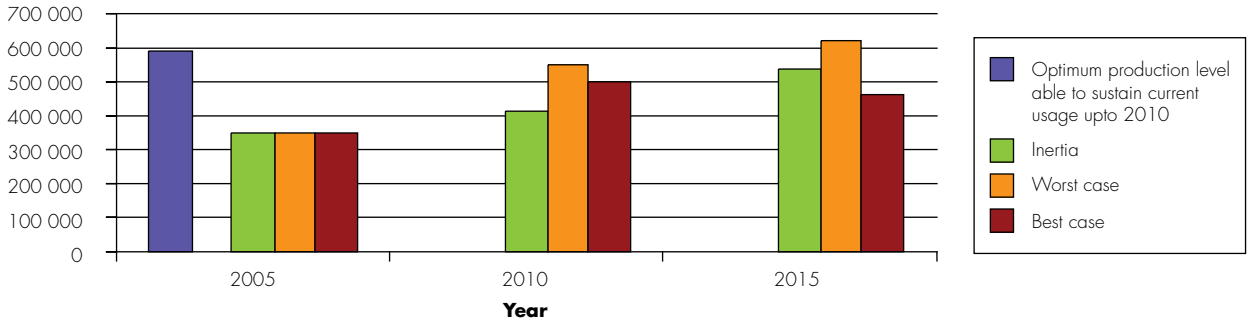
The following figures set out in quantitative terms trends in key environmental indicators under the different scenarios.

Figure 5.2: Population trends in Nairobi 1985-2025



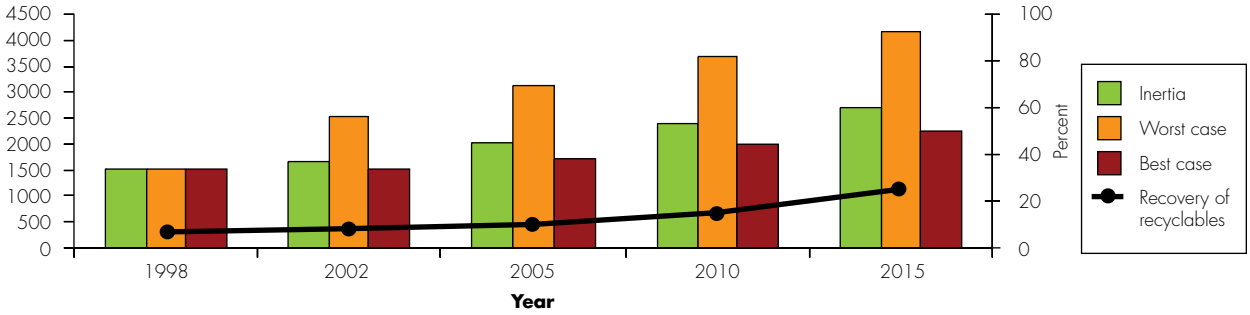
Source: Based on data from CBS 2002

Figure 5.3: Trends in daily water usage from the Nairobi Water Company supply 2005- 2015



Source: Based on data from MWI/WSP 2005

Figure 5.4: Trends in waste generation and recovery of recyclables between 2005- 2015



Source: Based on data from Ikiara 2006, AfDB 2002, UN-Habitat 2003

5.7 Policy implications

Nairobi faces the challenge of providing urban services in such areas as energy, waste management and water supply for almost twice as many people by 2025. Success in each of these areas will contribute towards the achievement of sustainable development and poverty reduction efforts. The relationship between poverty and the environment is well documented. Urban poverty will thus continue to dominate the development agenda if innovative interventions that can set the foundation for improved livelihood support, such as a regular and affordable energy and water supply, are not put in place. Accordingly, improving wealth distribution, economic opportunities, access to resources and improving the quality of life of residents are crucial to Nairobi's development strategy.

The urbanization rate and population-related land pressures are two policy issues that need to be tackled. Land is a highly volatile and political issue and its control continues to be a critical factor in the development of African politics and economies (Bruce *et al.* 1996). With limited land available for city expansion, it can be expected that this issue will assume growing importance in city politics. The continued growth of Nairobi will require a coherent and pragmatic approach to land-use planning.

Nairobi is not a closed system and has links with the rest of the country through such elements as food and labour. For instance, the trees that make charcoal used by many Nairobi residents mostly come from the countryside. Rural people treat charcoal as a cash crop and indeed the trade has a well-established production and marketing network. This has impacts, however, on biodiversity, water availability, soil erosion and rural livelihoods, among others. The city thus needs to consider its impact on the wider environment around it. The message is for the Government to implement policies that will enhance environmental and social conditions in the rural areas.

To improve the effectiveness of its policy processes, the city will need to make a number of key investments: support for implementation of the 2006–2010 strategic plan, including human and financial resources; implementing a programme of research that can provide answers to emerging issues or existing problems; and the establishment of an environment management information system. This will support planning, early warning, mitigation and the management of vulnerabilities within the city. It will also enhance the interlinkages between different environmental and social issues and avoid conflicts between policies. A strengthened City Council of Nairobi that can facilitate effective and efficient responses for Nairobi within this fast globalizing world is also essential.

As can be seen from the foregoing analysis, differences in strategies, initiatives and processes can propel the city either towards or away from a sustainable development pathway. The city leadership will require a clear understanding of the driving forces, indicators and policy actions under each of the scenarios in order effectively to put in place policies that would adequately mitigate or suppress any negative impacts while enhancing available opportunities. The extent to which the opportunities are harnessed will depend on the degree to which sustainable environment management practices are institutionalized.

The three contrasting scenarios are equally probable. The extent to which they can be realized depends, however, on the interplay of the various driving forces behind the scenarios. The power of scenario analysis is in its ability to prepare the city for any eventualities. The ability to incorporate these in plans, strategies and policy reform processes will help policy makers in making the decisions today that will determine the future attainment of an environmentally sustainable city.

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CHAPTER 6: KEY CHALLENGES AND POLICY OPTIONS

6.1 Introduction

One of the reasons this report was compiled was because inadequate information and data have been recognized as a major constraint on the strategic planning, implementation and management of environmental programmes in Nairobi. Success in achieving sustainable development ultimately depends upon implementation of sound policies and actions based on quality data and information on the environment at the community, ward and city level.

The analysis in the first two sections of this document shows that, although there are environmental challenges in Nairobi, it is still a city with great potential for growth and development. Accordingly, this first issue of the City of Nairobi Environment Outlook Report adopts a forward-looking approach in recommending actions for enhancing the city's sustainable development agenda. It is also important to note that implementation of these recommendations will not be the sole responsibility of the City Council of Nairobi, but will require the collaboration of all stakeholders in the city including the central Government, private sector civil society, communities and individuals.

6.2 Demographic characteristics

Addressing the population challenges

Population is a major driver of environmental change in Nairobi and current trends point to the continued growth of the city. This suggests a higher number of inhabitants with lifestyles that demand high energy, more land for the built environment and increasing natural resources consumption. This has implications for the natural ecosystems that are crucial for maintaining ecological and ultimately economic stability. The average density of population for Nairobi is 3,079 people/km^2 (CBS 2001), but this figure varies significantly across the different divisions. This has impacts on the effectiveness and ability of the City Council of Nairobi to deliver services such as health, education, transport, housing as well as recreational facilities.

The environmental consequences of population growth are amplified with increasing numbers. But the increasing population can also be looked at as an asset for development in the context of labour and markets.

To address the population challenges, the following proposals are made:

- The City Council of Nairobi, in consultation with the Government and other stakeholders, should formulate strategies for managing population growth in the city, including providing measures for increasing economic, educational, health, infrastructure and social amenities in urban centres in other regions of the country as well as satellite towns of Nairobi. The measures should include incentive-based programmes in other parts of the country (such as jobs and educational opportunities) aimed at slowing down immigration into Nairobi.
- The City Council of Nairobi, in consultation with the Government and other stakeholders, should formulate a city development strategy and implementation programme to expand provision of basic infrastructure, such as water and sanitation, decent housing, health and education facilities and ultimately eliminate altogether unplanned settlements in fragile environments such as flood plains, river valleys, waste disposal sites and quarries. The strategy and plan should provide measures for reducing vulnerability in the city; buffering heavily populated low income settlements sited near industrial areas and located along air pollution fall-out zones from industrial air pollution; and establishing flexible and affordable planning and building standards that support low cost technology housing to enhance urban poverty reduction.

Improving health and strengthening health services

To improve the general health status of people in the city, the following actions are recommended:

- Enforce the existing legal provisions relating to improved environmental health and health services provision in the city, particularly among the poor;
- Formulate a strategy for improving provision of water and sanitation services, especially among the urban poor in collaboration with all stakeholders;
- Provide economic incentives for the development of cheap, ecofriendly technologies such as clean energy,

especially for the urban poor. This will go a long way towards reducing indoor air pollution and related health impacts;

- Provide educational opportunities, especially to girls, as a means of improving the well-being of the people. Not only will they be better equipped to participate in solutions to everyday personal and community problems, but they will have greater control over their reproductive health, including family planning, and this will help reduce population growth and consequent pressures on ecosystems (WHO 2005).

Strengthening environmental governance

To improve management of environment in the city, the following are proposed:

- Promote community involvement and public education processes as the basis for successful planning and implementation of environmental management, poverty reduction and sustainable development;
- Strengthen existing governance structures with a view to enhancing environmental governance. The statutory provincial and district environment committees created under the Environment Management and Coordination Act should be provided with adequate resources and technical expertise to facilitate proper supervision of environmental programmes in Nairobi. In addition, the City Council of Nairobi should further enhance the capacity of its Environment Department.

6.3 Improving infrastructure, settlements and land use

Land resources in Nairobi include forests, freshwater systems, and biodiversity that hold vast potential for development if managed sustainably. This potential lies in such areas as agriculture, tourism, human settlements and provision of a vital carbon sink for the city. Components of infrastructure and services discussed in this section include energy supply and use; transport and urban mobility; water supply and sanitation; and health and education. Provision and maintenance of infrastructure has been a major problem, especially in low-income urban settlements.

A big threat to the development of Nairobi and, in particular, planned settlement is a lack of approved and up-to date physical development plans. Nairobi lacks an approved master human settlement plan or physical development plan. The only plan approved for Nairobi is the 1948 master plan, as the revised 1973 version was never approved (NEMA 2003). Most urbanization is therefore taking place in a planning vacuum. Urban planning and management have not effectively offered solutions to the increasing urban decay and environmental crisis. Some of the impacts of the lack of a clear planning strategy include haphazard patterns of development with a mix of activities that are may not be compatible with the area, an over-concentration of employment in the CBD and industrial area, resulting in traffic congestion and environmental pollution, and rapid growth of informal settlements.

Improving land use and land management

- A land-use policy should be formulated and implemented to promote environmentally sustainable development by integrating environmental concerns into land-use planning and physical development. The policy should address issues of urban physical development and expansion and improvement of the quality of the environment, including the provision of sustainable recreational open space facilities.
- Existing laws relating to land use planning and land development should be reviewed and the city's third master plan and development strategy formulated. The master plan and development strategy should be subjected to, and incorporate findings of, a strategic environment assessment study.
- An environmental policy for Nairobi should be formulated, to promote environmental quality, including providing measures (environmental impact assessment and strategic environmental assessment) for incorporating environmental concerns in the development and maintenance of human settlements, commercial and industrial uses, as well as for infrastructure such as transport, energy, water and sanitation services. This should be a participatory process involving all concerned stakeholders in its formulation and implementation.

Improving urban development

- A comprehensive spatial and temporal inventory of residential areas, industrial, commercial and service centres, infrastructure, recreational water bodies and riverine areas, urban agriculture, open land and natural and social environments should be undertaken on a regular basis.
- A comprehensive monitoring and evaluation programme should be developed and implemented for commercial

and residential expansion and development. This should ensure that the prescribed health, safety and environmental standards and guidelines for quality human settlements are followed.

- A policy should be formulated on the management of quarries, including measures for their rehabilitation, in accordance with the provisions of the Environmental Management and Coordination Act (EMCA) of 1999, the Local Government Act and the Mining Act.
- A policy on waste disposal and management should be formulated, including measures for setting aside waste disposal sites that meet requirements stated in EMCA, the Local Government Act and the Public Health Act.
- Strategies should be developed for enforcing the Physical Planning Act, EMCA, the Local Government Act and the Public Health Act, to meet environmentally tenable physical development standards and needs.
- A reliable spatial information system should be set up for the city of Nairobi that permits quick data input, storage and archiving, back-ups, analyses, updating and access. The database should be well maintained, networked and disseminated to end users. In addition, issues of data security, ownership and intellectual property rights must be taken into consideration.
- Urban agriculture should be regulate by assessing and monitoring urban crop cultivation and livestock regularly to determine its viability, taking into consideration the health quality of the harvested crops as well as meat and milk products.

Improving the quality of human settlement

- A human settlement policy and strategy should be formulated, focusing on re-planning, slum-upgrading and redevelopment of dilapidated formal and informal settlements and, in particular, the reduction of informal settlements. The strategy should provide flexibility with regard to planning and building standards for appropriate low-cost technology as a proactive measure for urban poverty reduction.
- A proactive housing policy should be formulated for Nairobi, to check the unplanned growth of environmentally degraded squatter settlements.
- The private sector, housing cooperative movement, non-governmental organizations, development partners and community organizations should be involved in the development of housing.
- A housing development fund should be established in which beneficiaries and the Government are involved in its management.
- Poverty reduction and employment creation strategies should be incorporated in urban sector development with a greater focus on informal settlements.
- A strategy and programme should be formulated to improve the delivery of water and sanitation services to the city. This should include:
  (a) Expanding the coverage of water and sewerage to all parts and populations of Nairobi;
  (b) Improving efficiency and effectiveness in the maintenance of the sewerage system;
  (c) Recommending opportunities for the use of waste water to benefit urban farmers;
  (d) Expanding the capacity of existing treatment plants to deal with the quantities of sewage produced;
  (e) Enforcing the 2006 water quality and waste management regulations.

6.4 Pollution and waste management

Pollution and waste management from industrial, domestic and other sources represent a growing problem in Nairobi. The main driving forces behind this trend are increasing urbanization, rural-urban migration, rising standards of living and rapid development associated with population growth. To reduce and control pollution, the following recommendations are proposed:

Improving solid waste management

- An integrated solid wastes management strategy should be formulated and implemented, providing measures for managing or controlling the generation, collection, minimization, transportation, recycling, treatment and final disposal of wastes. In particular, it should provide for the following:
  (a) Establishment of a regulatory system to promote an effective and efficient system of public and private enterprises for refuse collection and disposal;
  (b) Creation and implementation of economic incentives that are aimed at creating wealth and improving social and economic status by supporting recycling and composting as well as encouraging the development of technologies for utilizing solid wastes, for example in brick-making and cement-making;

(c) Promotion of environmentally sound technologies for use in the reduction and reuse of solid wastes;
(d) Support for studies on solid waste collection and treatment and the introduction or transfer and assimilation of technologies that are environmentally sound for use in the recycling, treatment and utilization of solid wastes;
(e) Creation of awareness among city residents of the harmful effects of solid wastes and encouragement of public participation in waste recyling, especially the participation of women, young people, trade unions and other civil society organizations;
(f) Raising awareness of Nairobi residents, to encourage them to practice separation of wastes at source (households, institutional and commercial enterprises);
(g) Establishment of waste separation stations and a supervisory network with an administrative framework;
(h) Improvement of access roads in the slum areas to facilitate collection of solid wastes; and
(i) Development and finalization of standards, regulations and guidelines for solid waste management in accordance with EMCA.

Controlling air pollution

n view of the limited knowledge about the status of air pollution and its impact on the residents and environment of Nairobi, the following actions are recommended:

- Development of ambient air quality standards; and
- Formulation and implementation of an air quality monitoring programme for the city and the country as a whole.

Improving water quality

- Standards and methodologies should be developed for protecting stream and river banks during periods of increased storm water quantity, including increased total runoff. The measures should also provide for protection of channel stability during dry seasons, when the base flow is reduced or during periods of flooding and higher peak discharge rates.
- In view of the threats to human health and environmental quality posed by polluted and or contaminated water, it is recommended that the City Council of Nairobi formulate a strategy for enforcing legal provisions for the protection of underground and surface water from pollution as a result of:

(a) Human activities such as landfills and dumpsites; seepage from latrines, septic tanks, sewers and drains; leakage from underground storage of petroleum and chemicals; seepage of industrial effluents; and infiltration from polluted streams;
(b) Discharge of industrial effluents and discharges from commercial centres and settlements, as well as rain water flow carrying with it a variety of pollutants into surface waters, ranging from agrochemicals and heavy metals to microbial and persistent organic pollutants.

6.5 Implementing the recommendations

With a view to facilitating implementation of the foregoing key policy recommendations, it is proposed that the City Council of Nairobi collaborate with the Ministry of Local Government and other relevant government agencies in the preparation of a strategic master plan to guide such implementation. This proposed master plan should also incorporate the functional Nairobi metropolitan area, which has forward and backward linkages with the city.

Priorities need to be identified for environmental management within the city of Nairobi.

In particular, for the effective implementation of the above proposed actions, the following measures are required:

(a) Approval of the proposals by the City Council in consultation with the Government and all other stakeholders;
(b) Establishment of a technical steering committee under the chairmanship of the Town Clerk; and
(c) Prioritized work plan, dedicated staff and supporting budget.

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ACRONYMS

ABS	alkyl benzene sulphonate
AEO	Africa Environment Outlook
AfDB	African Development Bank
AMCEN	African Ministerial Conference on the Environment
APINA	Air Pollution Information Network for Africa
ARI	acute respiratory infection
BOD	biochemical oxygen demand
CBD	central business district
CBS	Central Bureau of Statistics
CCN	City Council of Nairobi
COHRE	Centre on Housing Rights and Evictions
COPD	chronic obstructive pulmonary disease
CPD	City Planning Department
DEAT	Department of Environmental Affairs and Tourism (South Africa)
DPSIR	driver-pressure-state-impact-response
DRSRS	Department of Resource Survey and Remote Sensing
DTIE	Division of Technology, Industry and Economics (UNEP)
EGH	Elder of the Order of the Golden Heart of Kenya
EIA	Environmental Impact Assessment
EMCA	Environment Management Coordination Act
EPZ	export processing zone
ERC	Electricity Regulatory Commission
GCI	Galvanised Corrugated Iron
GDP	Gross Domestic Product
GEO	Global Environment Outlook
GFN	Global Footprint Network
GOK	Government of Kenya
HIV/AIDS	Human Immuno Virus/Acquired Immune Deficiency Syndrome
ICT	information and communications technology
IISD	International Institute for Sustainable Development
ILRAD	International Laboratory for Research on Animal Diseases
IMT	intermediate means of transport
IRIN	Integrated Regional Information Networks
ISDR	International Strategy for Disaster Reduction
ISP	internet service provider
IUCN	World Conservation Union
JICA	Japan International Corporation Agency
KACE	Kenya Agricultural Commodity Exchange
KAM	Kenya Association of Manufacturers
KBS	Kenya Bureau of Standards
KCJ	Kenya Ceramic Jiko
KENSUP	Kenya Slum Upgrading Programme
KEPI	Kenya Expanded Programme on Immunization
KLA	Kenya Land Alliance

KNCHR	Kenya National Commission on Human Rights
KUR	Kenya-Uganda Railway
KWAHO	Kenya Water for Health Organization
KWS	Kenya Wildlife Services
LPG	liquid petroleum gas
MDG	Millennium Development Goal
MENR	Ministry of Environment and Natural Resources
MNDP	Ministry for National Planning and Development
MOEST	Ministry of Education, Science and Technology
MOF	Ministry of Finance
MOH	Ministry of Health
MOIC	Ministry of Information and Communications
MWI	Ministry of Water and Irrigation
NEAP	National Environment Action Programme
NEPAD	New Economic Programme for Africa's Development
NEMA	National Environment Management Authority
NETWAS	Network for Water and Sanitation
NGO	non-governmental organization
NHDP	National Housing Development Programme
NISCC	Nairobi Informal Settlements Coordination Committee
NRBP	Nairobi River Basin Programme
NWSC	Nairobi Water and Sewerage Company
OCHA	Office for the Coordination of Humanitarian Affairs
ORC	Opinion Research Company
PPD	Physical Planning Department
PVC	polyvinyl chloride
RCMRD	Regional Centre for Mapping of Resources for Development
ROK	Republic of Kenya
SCP	Sustainable Cities Programme
SENKE	Sustainable Development Environment Network for Kenya
SID	Society for International Development
SODIS	solar disinfectant project
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nairobi Environment Programme
UNCHS	United Nations Centre for Human Settlements
UNFPA	United Nations Population Fund
UN-Habitat	United Nations Human Settlements Programme
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UON	University of Nairobi
VIP	ventilated improved pit
WHO	World Health Organization
WRI	World Resources Institute
WRMA	Water Resources Management Authority
WSRB	Water Services Regulatory Board
WSP	Water and Sanitation Programme-Africa
WTO	World Trade Organization