IMPACTS OF URBANIZATION ON THE SUSTAINABLE CONSERVATION OF NAIROBI NATIONAL PARK

BY

AGGREY OCHIENG KWADHA

BSc. NATURAL RESOURCES (HONOURS)

A THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE AWARD OF DEGREE IN MASTERS OF ARTS IN PLANNING TO THE DEPARTMENT OF URBAN AND REGIONAL PPLANNING

UNIVERSITY OF NAIROBI

JULY, 2009

DECLARATION

I, the undersigned student declare that this thesis is my original work and has never been submitted in any university or any other research institution toward thesis report for the award of a degree.

Signature ..... Date 27/7/09

Kwadha Aggrey Ochieng

B63/71435/07

Supervisors

This thesis has been submitted for examination with our approval as the University Supervisors

Dr. George Ngugi Njuguna ..... Date 10-08-09

Dr. Fridah W. Mugo ..... Date 11-08-09

Department of Urban and Regional Planning

University of Nairobi

DEDICATION

I dedicate this work to my Mum, Phoebe and the entire family of the late Richard Kwadha. I owe you this and much more.

ACKNOWLEDGEMENT

I would like to sincerely express my appreciation and gratitude to everyone who assisted me during the preparation of this work. Special thanks go to Mr. and Mrs. Abonyo who encouraged me to pursue the course, Prof. Olima who recommended me to the Board of Postgraduate Studies for the award of University of Nairobi scholarship, and Dr. Mugo and Dr. Ngugi whose supervisory roles throughout the study enabled me to produce this report. I would also like to thank the entire staff of the department of Urban and Regional planning for their constructive criticism that helped in shaping this work. My gratitude also goes to Mr. Kenana of KWS for his help in facilitating access to data from his organization in addition to other inputs. Lastly, I would like to appreciate my colleagues, the M.A (planning) class of 2007/08 for their various contributions during discussions and my research assistants, Mr. Parashina.

ABSTRACT

Nairobi National Park established in 1946 with an area of 117km^2 to protect wildlife from human activities and threats has grown to be a tourist destination earning an average of Kshs.45 million per year for the country. It also plays other roles such as educational, scientific research, posterity and employment to many people. Sustainability of the park is however threatened by the rapid urbanization, increasing peri-urban land use changes and population growth. These threats are more pronounced within the wildlife migratory corridor. Despite the prevailing realization of land use changes, urban population increase together with associated activities and human – wildlife conflicts within the corridor, no empirical examination has been carried out to determine the extent and trends of these challenges. Similarly, there has been no documented attempt to study any relationships between these challenges and the population dynamics of the park's migratory wildlife.

This study was carried out to: identify land use changes and their spatial trends within the wildlife corridor; investigate the current human – wildlife interactions; and examine the correlation between human population in Isinya and the population of migratory wildlife in the national park. Temporally varied Landsat TM images of 1995 and 2002 were processed and analyzed using ERDAS Imagine 9.3 to map spatial trends of land use changes within Isinya division, Kajiado which constitutes a part of the wildlife migratory corridor. Pearson's product- moment correlation was used to correlate human population in Isinya and the population of wildebeests and zebras in the national park. A household and institutional survey was also carried out to examine the current human - wildlife interactions in the area.

The study findings show that land use changes in Isinya have occurred in stages, starting with land tenure policy shift from communal to private ownership, then subdivisions and sales culminating in the current developments. This has been exacerbated by rapid population growth with density having increased eight fold between 1979 and 1999 from 5 to 42 people per square kilomieter, and lack of land use plan for the area. The current new dominant land uses are residential, irrigated large-scale floriculture and quarrying.

Human population in Isinya negatively correlates with the population of migratory wildlife in Nairobi National Park, having r = -0.097 and r= -0.400 with Zebra and Wildebeest populations' respectively. Wildebeest population has been more seriously affected than the zebra's population. These have affected wildlife by both fragmenting their migratory corridor and posing environmental risks of pollution and soil erosion. Trends show a constant decline in population of migratory wildlife in the park having concurrently started with a shift in the human population composition in Isinya, in the 1990s.

The trend indicates continued future land uptake by other land uses than for traditional pastoralism and wildlife migration that will enclose all wildlife in the park. An enclosed small-sized park is likely to result in an ecological crisis, rendering the conservation of Nairobi National Park unsustainable. The study recommends: a) ceasing of land subdivision, b) encouraging conservation lease program, c) development of Nairobi Metropolitan Open Space System (NMOSS), and d) compulsory corridor land acquisition by the government on behalf of KWS. The first two are for a short term while the latter for long term planning. This study is informative to land use planners, conservation organizations and relevant policy makers on revelation of the trend of land use changes that have taken place within the wildlife migratory corridors in Isinya in the last 30 years and which are likely to continue due to urban sprawl. It can also guide planning other areas with similar challenges like Maasai Mara, Tsavo and Meru national reserves and parks. The study has also recommended the determination of the required corridor width for the migratory wildlife of Nairobi National Park.

TABLE OF CONTENTS

LIST OF FIGURES

Figure **Page**

LIST OF MAPS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

ACC - African Conservation Center

ASALs - Arid and Semi Arid Lands

CBOs - Community Based Organizations

DRSRS - Department of Resource Survey and Remote Sensing

EAWLS - East African Wildlife Society

EMCA - Environmental Management and Coordination Act

FoNNaP - Friends of Nairobi National Park

GEF - Global Environmental Facility

GOK - Government of Kenya

ICLEI - International Council for Local Environment Initiatives

ILRI - International livestock research institute

KWS - Kenya Wildlife Service

MVA - Minimum Viable Area

NEMA – National Environmental Management Authority

NMOSS - Nairobi Metropolitan Open Space System

UNCED - United Nations Conference on Environment and Development

UN - United Nations

1. INTRODUCTION

1.1 Background to the study

Conservation areas are usually established with the aim of protecting wildlife from human activities and threats in addition to providing scenic and historical sites. The latter leads to the development of tourism. A part from conservation of wildlife, Nairobi National Park established in 1946 with an area of 117 km^2 has grown to be a tourist destination earning an average of kshs.45 million per year for the country, (Ogendi, 2003; Debra *et al*, 2005; KWS, 2006). It also plays other roles such as educational, scientific research, posterity and employment to many people. It is a convenient and easily accessible recreational site for most people living in the city. Sustainability, the ability to conserve wildlife for both the present and the future generations to enjoy these benefits from Nairobi national park is however, threatened by the rapid urbanization, increasing peri-urban land use changes and population growth of the city (Rita, 1981; Omondi, 1984; Oimbo, 2002; and Trzyna, 2005). These threats are more pronounced within the wildlife migratory corridor.

Unlike other cities where natural areas have been retained due to their unsuitability for substantial building – including steep slopes, wetlands and floodplains (Adams *et al*, 2006), the Nairobi National Park was purposefully left out as a conservation area. Urbanization, the process of people migrating from rural areas to urban areas and engaging in non-agricultural activities is a major threat to sustaining the park for this conservation purpose. Urbanization also involves expansion of urban centers through natural population increase and extension of their boundaries. In Kenya a centre is considered urban if it has a resident population of 2000 and above (GOK, 1978) and one of the salient characteristic of urbanization is the uneven distribution of the urban population in the country with Nairobi being the most urbanized city in the country with over three million inhabitants.

According to UN-HABITAT (2003), significant population increases in developing countries have been and will continue to be absorbed by urban areas (45% in 1970-1980;

58% in 1980-90; 71.8% in 1990-2000; 83.4% in 2000-2010; and 93.4% in 2010-2020). Cities are viewed world over by environmental scientists and planners as consumers of resources and producers of waste (Satterthwaite, 1999; Habitat, 2003). Major conservation interventions in response to urbanization challenges have thus been increasingly dealing with management of energy, and water resources as well as efforts to decimate air pollution and solid waste menace (Adams *et al*, 2006; Cullen, 2003; Newman, 2006). The efficient management of these challenges has been used to measure environmental and economic sustainability of cities (Chen, *et al,* 2008; Choguill, 2008). However, urban population growth and land use changes also affect conservation/protected areas in more different ways than just in these often commonly experienced concerns.

1.2 Problem Statement

The following paragraphs give a brief account of experienced and impending impacts of urbanization on protected areas in different parts of the world and finally narrows down to the study area.

The Californias (Mexico-USA)

The Californias are in the U.S. state of California and the northern part of the Mexican state of Baja California both divided between Mediterranean-type ecosystems along the coast, and desert ecosystems in the interior. These Mediterranean-type ecosystems, which comprise the California Floristic Province, are one of the 34 global biodiversity "hotspots" identified by Conservation International (2006). They constitute a region very rich in biodiversity, including numerous endemic plant and animal species

The rate and scale of population growth in the U.S. state of California is like that found in many developing countries. Urbanization is moving inland along both sides of the border. One of the problems caused by urbanization along the border between California and Baja California, and the planned border fence, is interference with wildlife migration due to fragmentation of wildlife migration corridors (Reynolds, 2005).

Tijuana River National Estuarine Research Reserve

This is a 10-sq-km conservation area at the ocean between San Diego and Tijuana. Coastal salt marshes, dunes, riparian corridors, and coastal tablelands dominate the reserve. Overall, this estuary is relatively intact. However, the Tijuana River, which feeds it, flows through the Mexican cities of Tecate and Tijuana before entering the U.S. about eight kilometres east of the ocean. Almost three-quarters of its watershed lie within Mexico. Major challenges in sustainable management of this reserve relate to sewage and urban runoff from Tijuana and Tecate. This urban pollution also affects ocean water quality. In addition, sedimentation from the stripping of vegetation from Tijuana hillsides adjacent to the reserve has filled in parts of the marsh. Invasive species are a serious problem, in the wetlands.

Sierra Nevada parks: Sequoia-Kings Canyon and Yosemite

These two parks administered as one protect groves of giant sequoia *(Sequoiadendron giganteum);* a tree that grows to immense proportions and is the world's largest living thing. The parks also preserve deep granite canyons and peaks rising to 4,400 m and receive some 1.5 million visitors a year. Unfortunately; Sequoia-Kings Canyon has the worst air pollution of any unit of the U.S. National Park System. This is chiefly because it is downwind of the San Francisco area, some 275 km to the northwest, as well as the farms, cities, and roads of the San Joaquin Valley, a vast agricultural area to the east. The mountains keep pollution from escaping from the valley and turn it into a swirl that concentrates near the parks, rising to 2,500 meters and higher. The main culprit is ozone, a serious hazard to human health. Many visitors complain of difficulty in breathing, and park officials have had to curtail some guided tours because of poor air quality. The ozone also cuts down visibility — to less than 15 km on the worst summer days. Two forms of urbanization affect Yosemite National Park directly. These include growing gateway communities and overdevelopment within the park itself. Within Yosemite Valley, overdevelopment, as well as traffic, pollution, and noise from cars and buses, have been criticized for decades (Reynolds, 2005).

Australia

Many Australian protected areas in and near cities are severely impacted by invasive species, especially feral cats and dogs and garden plants that go wild. Examples include: Dandenong Ranges National Park, in the northeastern suburbs of Melbourne, which has trouble with feral cats that prey on wildlife, including ground-dwelling birds and Blue Mountains National Park, 100 km west of Sydney, which has a serious problem with exotic plants spreading from private gardens (Conner, 2005).

Africa

In South Africa's Cape region, the main threats to sustainable biodiversity conservation from urbanization are within the city limits of Cape Town, which also happens to include some of the richest biodiversity in the region. According to Katzshner *et al*, (2005) the threats to protected areas in Cape Town are urban infill and encroachment from informal settlements. Crime is also a serious problem. At the edges of the city, and further a field, second-home, retirement, and tourism development is increasing.

Also for the Table Mountain National Park the major threat to the park is crime by residents of neighboring shantytowns. The crimes committed are mainly limited to pick pocketing, breaking into visitors' cars, or stealing park property, but there have also been violent assaults on hikers (IOL, 2006). There is also crime of a different sort along the coast. This includes poaching of Beige Abalone (Haliotis midae), a shellfish locally called perlemoen. Fire in this ecosystem, though is a natural phenomenon needed periodically to maintain biodiversity; it is always a problem along any wild land-urban interface. In the Cape region, it is an increasing threat because of arson and climate change (the climate is becoming warmer and drier).

In Tanzania, Tarangire - Manyara ecosystem that provides habitat for both resident and migratory wildlife of aquatic and terrestrial nature experience threats from land use changes and human activities in the watershed due to rapid population growth. According to USDA forest service (2000) this has impact on the ecosystem health and directly

affects the ecological and economic viability of the system. It also has further impact on agricultural production, grazing regimes and human livelihoods (Mwamfupe, 1998).

Nairobi national park

The idea of parks is usually associated with vast remote rural areas where land uses in most cases are few and commonly uncompetitive. Nairobi National Park's location in close proximity to a city is unique; a feature associated with numerous benefits as well as challenges. Cloke *et al* (1985) identified no level of compatibility of urban land uses with wildlife conservation. There are threats of rapid expansion of the city with associated activities encroaching on the park's boundaries, the wildlife migration corridors, and increasing demand for park facilities due to population growth. Such activities include housing and industrial expansion. Among others these pose a challenge to sustainable conservation of the park.

Land use changes within the migratory corridor can have numerous consequences. They can modify the natural environment, which supports the migratory wildlife and also block their seasonal migration into and out of the park. This can result in the park's carrying capacity being exceeded or the blocked in-migration and deaths from ensuing conflicts and changed environment significantly reducing wildlife population. The increased human population and land use changes also translate into increased human-wildlife conflicts. The results are more wildlife deaths and injuries, including some affecting human beings, more economic losses being incurred by land developers within the corridor, and park's biodiversity decline hence unsustainable conservation.

Despite the prevailing realization of land use changes and urban population increase together with associated activities within the corridor, no empirical examination has been carried out to determine the extent and trends of these challenges. Similarly, there has been no documented attempt to study any relationships between these challenges and the population dynamics of the park's migratory wildlife.

The purpose of this study was to investigate the major land use and population changes and their impacts on the wildlife corridor and population of major migratory animals. The guiding question was: what are the effects of urban population increase and land use changes on the wildlife dispersal area and population of major migratory species of Nairobi National Park?

1.3 Objectives

Nairobi National Parks proximity to a rapidly expanding city faces sustainability challenges due to very competitive urban land uses as well as pressure of demand for facilities within the park. The study's main objective therefore was to examine the population and land use changes and their impacts on the park's migratory corridor and population of major migratory species.

The specific objectives included the following: -

i. To identify land use changes within the wildlife migration corridor and their spatial trend
ii. To investigate the nature of human-wildlife interactions in the area in relation to urban population changes.
iii. To determine changes in the population of major migratory animals in Nairobi National Park in relation to the above land uses and urban population changes
iv. To suggest planning interventions that can help enhance the parks sustainable conservation within the urbanization framework.

1.4 Hypothesis

In order to achieve the above objectives the following hypotheses were used as a guide.

i. There is no relationship between land use changes within the wildlife corridor and the population of major migratory species.
ii. There is no relationship between human population growth and the population of major migratory species.

1.5 Assumptions

To test the above hypotheses the following assumptions underlie the study:

- There have been land use changes in the wildlife corridor due to urban growth and expansion.
- The above changes and associated human - wildlife interactions have a negative impact on the wildlife population

1.6 Significance

Economically, the Nairobi national park is a major source of foreign exchange earning through wildlife tourism and is contributing significantly to the national economic development. According to KWS (2005), the tourism industry accounts for 21% of the country's foreign exchange earnings and 12% of gross domestic product (GDP), (KWS, 2007). Nairobi national park generates an average of Kshs. 45 millions annually, directly employs 120 permanent staff and an average of 20 temporary staff per week, (Korir, 2006). Indirect employment opportunities created in tour operation and hospitality industries are even greater.

The park is an ecological laboratory for many science students and institutions, an advantage many benefit from given its proximity to the largest number of such institutions in the city. It also serves as a major public amenity offering accessible and convenient leisure site (with five picnic sites) closer to the city.

Ecologically, it is a very important atmospheric ventilator for the city and also constitutes part of the Athi and Tana watershed. The park is an Important Birds Area (IBA) with over 400 species, conserves two major ecosystems: highland dry forest and the savannah, and is a dry season refuge for most herbivores. With increased urbanization, demand for these services is set to also increase. All these important roles are however, threatened by the urbanization process itself, rapidly being experienced hence the interest in looking at possible planning interventions towards sustainable conservation of the park.

To the existing knowledge, this study will add emerging issues related to the extent and trends the land use changes have taken in the study area and even project this into the future assuming no intervention is undertaken. It will also establish any relationships between the growth of urban population, land use changes and the population of migratory wildlife in the national park. This information is vital for planning land uses where terrestrial migratory wildlife is involved. This will have a wider application in the country given the currently high urbanization and population growth trends and the fact that about 80 percent of Kenya's wildlife is still living outside national parks, (Ogendi, 2002). The outcome of the study will be beneficial to a wide range of stake holders and interested parties in wildlife conservation including land environmental managers, KWS, policy experts, urban physical and environmental planners as well as local authorities involved in guiding and controlling urban development.

1.7 Scope of the study

The study area was spatially limited to Nairobi national park and continuous from the unfenced 22 km stretch southern boundary to include the wildlife migratory corridor area (Isinya division-Kajiado district). Information was gathered only on land uses and their spatial changes since 1969 and on current human-wildlife interactions within this migratory area. Within the park, population dynamics of migratory species (wildebeests and zebras) were examined and correlated with that of human population changes within the wildlife migratory corridor over the same period. Information on human-wildlife interactions in the area and related issues of management was also collected. This was collected from the land developers (entrepreneurs) within the migratory corridor, the park management and other agencies concerned with land use management and conservation in the area.

1.8 Operational definitions

Conservation - the rational use of resources to achieve the highest quality and integrates both use and protection, and not preservation (no use).

Habitat - the general environment in which wildlife lives and from which they get both shelter and food.

Fragmentation – change in the spatial configuration of habitat. It may disrupt the movement of individual organisms, and the resulting genetic and demographic isolation of population may be a stage on the way to regional extinction.

Human-wildlife-interactions - benefits and problems encountered by people from animals and by animals from people. The problems include any disagreements or contentions relating to property destruction, injuries or loss of life, attributable directly or indirectly to wild animals.

Land use - the conversion of a natural environment or virgin land within the wildlife corridor by permanently or persistently siting human activities.

Migration corridor - a continuous "protected" natural area or pathway used by native wildlife regularly for movement into and out of the national park between their seasonal ranges. They maintain biodiversity, allow populations to interbreed, and provide access to larger habitats.

Urbanization - this is a multiple facet process**.** It involves migration of people from rural to urban areas, expansion of urban centres through natural population increase and extension of their boundaries.

Sustainability - the conservation of Nairobi National Park's wildlife for the benefit of the present without undermining the ability of the future generations to enjoy the same. The park is considered sustainable if its component parts like wildlife population and even their migration corridors and dispersal areas are relatively stable and not deteriorating.

Wildlife - usually used to refer to both animals and plants that are not tamed. In this study, the term will be limited to animals only.

2. 0 LITERATURE REVIEW

Threats to sustainability of conservation areas are not a new concern. Urbanization has long been one of the major forces shaping the world, and it will continue to be so. According to Trzyna (2005), Urbanization that affects protected areas takes several forms that are not mutually exclusive. Some of these forms include Urban sprawl; Ribbon development; Urban intensification and infill; Coalescing "megapolitan" regions; Tourism developments; Second-home and retirement developments; Growing settlements within protected areas; and Informal settlements.

This chapter first gives a the historical development of national parks in various parts of the world before narrowing it down to Kenya, and at the association that exists between national parks and wildlife corridors, especially as far as management of the latter is concerned. Secondly, it reviews literature of previous research findings and case reports about impacts of human population growth and land use changes on wildlife and their conservation areas. Even though an attempt has been made to separate these aspects of urbanization here, they are so closely interlinked that a clearly distinct separation of their impacts remains very difficult.

2.1 Historical development of national parks

The idea of national parks is old having started developing over 100 years ago. The initial development is associated with early human activities especially industrialization. It was observed that human activities were exerting pressure on certain species of animals and plants, which were beginning to disappear. Similar pressures were being experienced on eminent geological features which were being disrupted by human forces. The idea started in the USA where the first national park, Yellowstone national park, was established in 1872, but become legally recognized in 1886. According to Bush (2000), its establishment followed worries that were expressed by John Muir (founder of Sierra club) that "All of the United States of America will be covered by industry, urbanization, or agriculture"

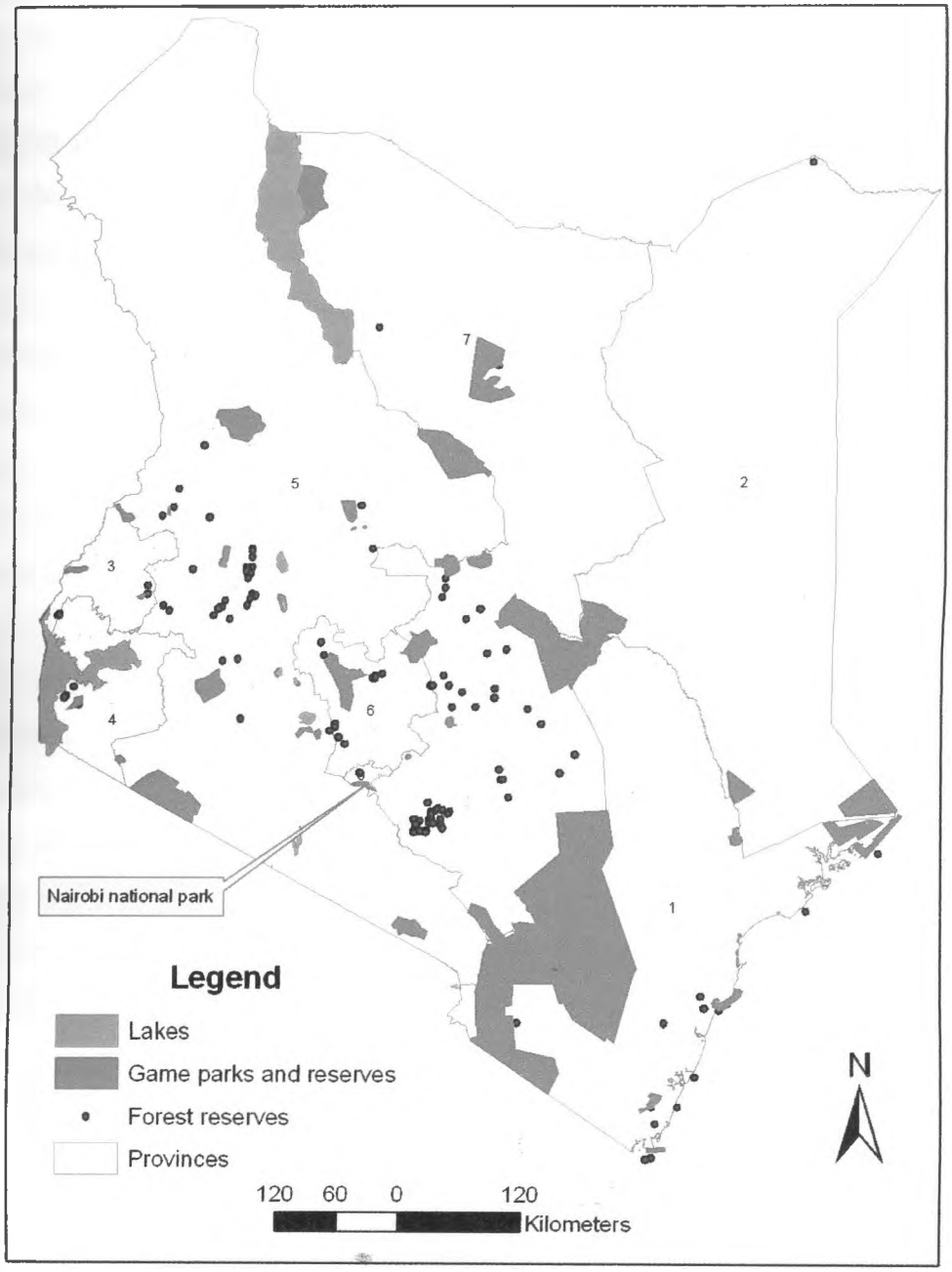
Through the club, Muir crusaded and succeeded in convincing the then president, T. Roosevelt, to help set aside and protect a wilderness area where man is secondary to nature. In Canada, the first proto type of a national park was created in 1885 and it was the establishment of Yellowstone national park that encouraged similar establishments elsewhere in the world.

In Europe national parks movement started in Great Britain in the late 1920s following the developments in USA and Canada. In 1949, an Act of the national parks and access to the country side was passed to conserve resources of the wild and the beautiful countryside (Cloke and Park, 1985). In Britain there was careful control of new developments to the best satisfaction of all interests involved in the area. Parks were mostly on privately owned land but planned with local national objectives, allowing co-existence with other land uses like mining and farming (Rita, 1981). In Germany, efforts to set state parks for protection of nature started in 1898 but the first park, Naturschatz park lune-burge, was however private and established in 1921. As a form of land classification, national parks were officially recognized in Germany by the state of Bavaria in 1969 when it set aside its first national park in Bayerischer wald. National parks in Germany were established on land that had undergone intensive human activities over a thousand of years. This differs remarkably with the Kenyan situation where they were set aside just about the time the Europeans had settled in the country and the lands had not been subjected to very intensive human activities. In Asia, the Japanese established their first park in 1931 by designating twelve areas for conservation. In India, the idea only began in 1952 with the establishment of Indian Board of Wildlife to conserve and control wildlife through national sanctuaries and zoological gardens (Telsuman, 1969 as quoted by Omondi, 1984).

The first protected area on the African continent was the Sabi game reserve founded by the then president Kruger of South Africa in1892, which later was named Kruger national park. In 1900 the East African game regulations were developed, and this led to the creation of the Kenyan game department in 1907. Thus in Kenya conservation was

introduced by colonial administration. In 1937 an ordinance was passed strengthening laws in Kenya relating to the protection of game animals and birds (Nyeki (1992) as quoted by Otuoma (2004)). Consequently the government appointed a game policy committee in 1938 to study and recommend where and how to establish a system of national parks. Thus ordinance no. 9 of 1945-the National Parks Ordinance- was developed and a board of trustees appointed to administer areas to be designated as national parks and reserves. This led to the creation of Nairobi National Park in 1946. The ordinance later became the Royal National Parks of Kenya ordinance, which later became the National Parks of Kenya Act. It is under this act that most of the protected areas in the country were established. The term" Royal national parks of Kenya" was bestowed by King George VI and dropped at independence in 1963. More and more national parks were created after independence (*see map 3 below)* and were managed by the Kenya national parks guided by Wildlife Conservation and Management Act passed in 1976 (Ogendi, 2002) prior to the establishment of Kenya Wildlife Service-KWS in 1989.

CONSERVATION AREAS IN KENYA



Map 1: Conservation areas in Kenya. Source: Compiled by the author

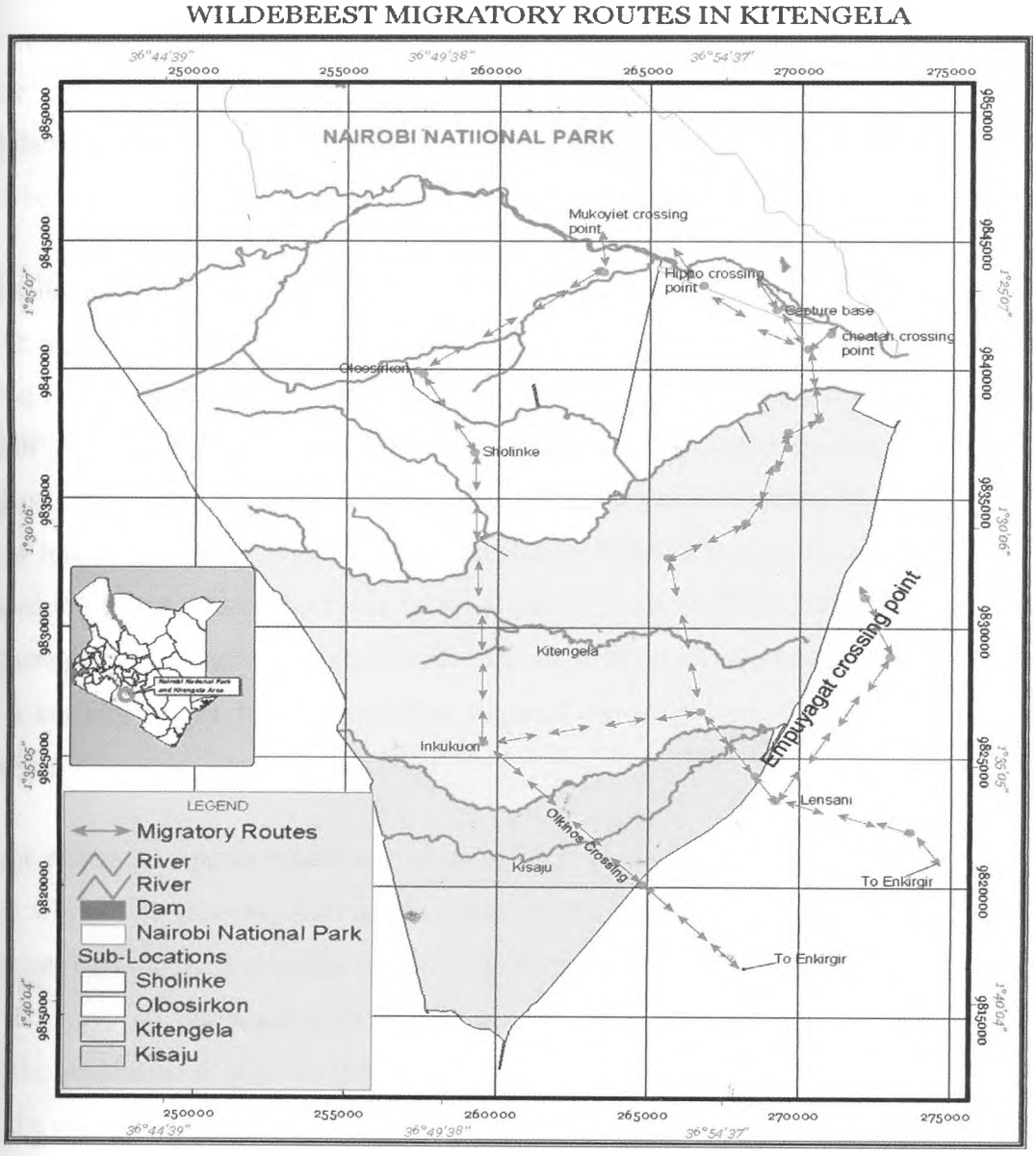
2.2 Wildlife corridors

The idea that a national park or a nature reserve can have a rigidly defined boundary assumes that there will be no changes in the future area occupied by the wildlife community. Wildlife corridors enable them to respond to variations or changes in their environment through migration. A wildlife corridor is a continuous natural "protected" pathway along which native wildlife species can move in relative security between high quality natural habitats. It can also be considered as a habitat "patch" that connects two or more areas of undeveloped habitat that are isolated from one another. The land through which wildlife passes when transiting between these habitats may, at times, consist of platted plots in private ownership and public roads. Corridors work best when sparsely developed. The aim of their establishment is to maintain a nearly contiguous greenbelt of native vegetation as possible. Wildlife corridors increase the amount of habitat available for species and effectively reverse habitat fragmentation.

Wildlife corridors are necessary because they maintain biodiversity, allow populations to interbreed, and provide access to larger habitats. According to Wildlife Management Institute (2005), wildlife Corridors connecting core reserves are crucial since they increase the effective amount of habitat that is available for species and effectively reverse habitat fragmentation. This is especially important for migratory animals and those with large home ranges. Larger habitats support greater biodiversity, larger populations, and a wider range of food sources and shelter. They also allow populations to interbreed, improving long-term genetic viability. However, Wildlife Corridors cannot substitute for large areas of protected habitat like those in core reserve systems or in this case the national park.

Essentially, two major types of wildlife corridors exist. Corridors that are present on the landscape level are generally thought to be serving a connective function, benefiting species that require large expanses of undeveloped habitats because they have large home ranges, disperse over great distances, or need to travel great distances to find mates. Wildlife corridors to Nairobi national park is a good example of this type as shown in map 4 below. According to Prins *et al* (2000), before the establishment herds of wildlife

moved across the plains from as far as Mt. Kilimanjaro at the border of Kenya and Tanzania to Mt. Kenya. A second type of wildlife corridors exists on a smaller scale, usually a local level, generally connecting two isolated habitats that are not necessarily separated by large distances. In agricultural areas, for instance, these corridors are often refereed to as fencerows or hedgerows. These strip habitats provide food and cover for wildlife. Another example of this local scale wildlife corridor is the buffer strip of vegetation along a stream or a river.



Map 2: Nairobi national park and its migratory corridors
Source: KWS, 2003.

The right size of a wildlife corridor is a major challenge facing land use planners. Migration corridors and crucial wildlife habitats also do not fall neatly within human-created boundaries. Usually there is a mix of land-ownership patterns and management decisions across these patterns or even international borders. These invariably impact on wildlife populations. According to Wildlife Management Institute (2005), the appropriate size of a wildlife corridor is yet to be determined. However, the size is expected to vary according to the species of animals involved. In Alaska, studies have shown that wolves need corridors ranging between 12 and 22 kilometres in width while bobcats need at least 2.5 kilometres wide. At the largest scale, wildlife corridors must be wide enough to allow easy movement for even the largest mammals, including Wildebeests, Elephants, Buffaloes, and Zebras among others. Widths of several miles will be typical.

Wildlife Corridors can also serve at smaller scales to provide habitat connectivity for other species, including amphibians, fish, and birds. These are particularly beneficial along riparian corridors, where they provide both aquatic and terrestrial connectivity. In urban areas, they can provide significant recreational opportunities and important linkages in a highly fragmented landscape. Whenever possible, urban and rural parks and open spaces should be linked to form functional Wildlife Corridors, which can then be joined to outlying core reserve or national parks. Since Wildlife Corridors are typically vulnerable, they must be managed with extreme caution. For instance, pesticide use next to a corridor might have destructive impacts on pollinators, in turn reducing plant diversity.

If the reserves or parks which are areas of high biodiversity were considered as nodes, they will not be constant throughout the time and will be expected to migrate. If some species from the node migrate, they will be able to establish populations in the corridors. In this way, one particular node can be smaller than the Minimum Viable Area (MVA) for the population of a given species so long as the sum area among the nodes connected by the corridors encompasses the (MVA). MVA defines an area with a set of resources,

such as nest sites, food and water required to sustain a population large enough to retain at least 90 per cent of the genetic diversity of the species for 200 years, (Bush, 2000).

Connectivity of nodes via the corridors produces a single continuous habitat rather than a landscape of isolates. Corridors are more than just highways between nodes as they may become temporary homes of wildlife population. They must therefore be suitable for long term survival of species (Bush, 2000). Whenever possible, urban and rural parks and open spaces should be linked to form functional wildlife corridors, which can then be joined to outlying core reserves. This relationship between nodes and corridors can be compared to the connectivity between interdependent towns and or cities through transport corridors that is beneficial for the continuation of such relationships. The good maintenance of such transport corridors is thus as essential as that of the wildlife corridors.

2.3 Impacts of human population on wildlife conservation

In the Californias (Mexico-USA), urbanization has been moving inland along both sides of the border with a protected Mediterranean-type ecosystem along the coast, and desert ecosystems in the interior. Population rose from 1.5 million in 1900 to an estimated 37 million in 2006 (Reynolds, 2005). One of the problems caused by urbanization along the border between California and Baja California, and the planned border fence, is interference with wildlife migration due to fragmentation and wildlife migration corridors. Connectivity between protected areas became a major concern. This fragmentation was attributed to urban sprawl, building over unprotected rural land between a city and a protected area, sometimes surrounding it. However, in this case the reason behind protection was not biodiversity conservation, but rather for water supply or flood control purposes, to preserve landscape, or to provide outdoor recreation. Urban population changes were therefore only examined in relation to its impacts on these reasons behind protection. The impact of habitat fragmentation was just observed and no empirical determination was carried out and relationship established between the population growth changes and wildlife habitat fragmentation due to the sprawl. Habitat fragmentation squeezes animals into ever diminishing areas. As these areas are further

reduced, the effects are more likely to affect the survival of an entire species. The impact will be rapidly experienced if the species is habiting a small area. Even though this may not be the case with migratory species found within Nairobi national park as their population exists elsewhere outside the park, their continued survival in the park will be severely affected.

Rapid population growth in North Carolina averaging 35000 people annually has had impacts on watersheds and ecosystems. The increase has led to reduced habitat quality and quantity and negatively affected listed and sensitive species (North Carolina Wildlife Resources Commission, 2008). According to Kerr (2007), In Ecuador, Galapagos Islands have experienced population increases largely due to high in – migration. Between 1982 and 1998, the overall annual population growth rate increased from 6.0 percent to 6.4 percent. People moved to take advantage of the then growing tourism industry. This influx resulted in increased pressure on marine life and introduced new species that have threatened the islands' fragile ecosystems. Pressure on the marine wildlife was due to wastes being dumped into the sea. It is also vital to recognize the role tourism plays in the economy of a state thorough foreign earnings, and direct and indirect creation of employment opportunities. This report gives an example of how to study human population changes, by looking at size and rate of growth and relating the same to conservation areas. However, like the above study from the Californias, it did not examine the trend of the pressure resulting from the human population changes.

According to Chen *et al* (2008) enormous changes in land use patterns have occurred in China, having been caused by rapid growth of large cities with accompanying accelerated growth of industrialization, high speed economic development, massive urban housing and infrastructure investment. These have contributed to substantive conversion of green fields and prime agricultural lands into industrial and residential uses in many cities in China. These major urbanization impacts have been due to urban population growth which increased by 3.9% per annum between 1986 and 2000 rising by 222 million during the nineteen nineties. In seeking sustainability in the face of such growths, they argued

for encouragement of compact cities in China. It was argued that compact cities would help save land and encourage preservation of green fields and arable lands. That this way encroachment into the countryside (urban sprawl) would be prevented and hence assist in maintaining biodiversity. In their analysis of the relationship between urban compactness and environmental externalities, they found that increased human population density was positively related -though statistically weak- to urban externalities. The observed externalities were less green space, more air pollution, and noise. The advantages of the increased density include improved accessibility to services, reduced per capita domestic energy consumption and promotion of infrastructure efficiency and use of public transport. However, one should also realize that the advantages mentioned here are not guaranteed but are a function of various social, economic, and institutional variables. In other areas, such high urban population densities have been associated with heavy traffic congestions (infrastructure inefficiency) and rise in the use of private transport.

Another impact of human population growth on conservation is the reduction of land under forest cover. In Malawi, population growth of 3.2% per year in many regions has forced farmers to expand their operations by clearing new areas of forest (important conservation areas). According to World Rainforest Movement (2002), Malawi might therefore seem to be a good candidate to prove what many believe to be a main cause of deforestation: population growth. Nevertheless, another published research presents a broader picture as noted by the same movement. It makes it clear that population growth alone cannot fully explain deforestation in the area. They argued that such population increases, which put additional pressure on forests, was the result of government decisions to liberalize maize markets and other agricultural policies and not due to population growth alone.

In Ngorongoro conservation area (NCA), Tanzania, a rapid growth of pastoral population was documented from 8500 people in 1966 to over 18000 people in 1978. According to Madulu (2004), this poses a big challenge of ensuring long-term biodiversity, productivity and, stability of the NCA. In another related case, expansion of settlement

consequence was their migration into ASALs due to pressure on land and the need for alternative land for settlement and crop cultivation. The focus of this study was however, on the implications of government land and population policy changes on social, economic status of arid and semi arid lands (ASALs) and of the wildlife-livestock-human interactions on the area habitat. Despite identification of reduction in both livestock and wildlife resource base, the study did not show the extent to which these were affected by the human population changes. However, this study also applied the use of population size as in most studies reviewed here and also used population density in its analysis.

Increased human population also leads to increased human- wildlife conflicts. According to Dahiye (2001), human settlements increase of more than 75% due to population growth over two decades in Ijara district had the impact of increased conflicts between wildlife and people. Settlements and farms took up vital wildlife grazing lands causing human-wildlife conflicts over these land resources. Animosities between and within local ethnic groups were also attributed to the increased human and wildlife populations in the area. In examination of Tsavo wildfires, Muasya (1998) found that they were caused by increased human activities of charcoal burning which were taking place outside the park. He found that fire used by herdsmen to kill ticks on grasses and by farmers to clear land for cultivation got out of control to burn the wildlife forage and some crawling and slow moving animals to death and caused injuries to others. Such fires also forced migration of wild animals from the affected areas of the park. Other impacts of such fires were frequent interference with park management activities with a lot of resources redirected to fire fighting. A difference emerges between these two situations and the current study area. In the case of the wildlife corridor, though the native communities were pastoralists with practices similar to the above, their interaction with the urbanites and both urban social - cultural and economic forces might have had them change significantly. Oimbo (2002) found that the area population composition has changed with the natives only constituting 47%. The threats of wildfires remain, but likely from different causes such as arson, motor accidents, and industrial fires.

These studies and reports also give examples of impacts of human population changes on wildlife and conservation areas. Even though increased incidences of the fires in Tsavo were attributed to increased human activities due to increased human population growth, no empirical examination of changes in both human population growth and wildlife population dynamics were carried out. The study areas adjoining the Meru and Tsavo parks and in Ijara were also rural in character and so were the examined human activities. Similar reports and studies from other countries like Mexico, USA and Zambia only give generalized impacts covering large areas or even the whole nation without any specificity. These therefore only give examples of impacts of human population increase on a protected area but not within an urbanization and area specific context, a gap this study will fill with the case of Nairobi National Park.

2.4 Land use changes, human activities and conservation areas

Human land uses are major causes of wildlife habitat loss throughout the world. Human settlements and associated activities in general have impacts on the natural environment in a number of ways, which are varied in nature and in their intensity. Urbanization is associated with increased intensity of human settlements and hence increased intensity of impacts. Settlements including urban development impact on the environment through direct or indirect consumption of land, water, wildlife, vegetation and the associated disposal of both domestic and industrial wastes. All these modify the natural processes in the environment in one way or another. According to Satterthwaite (1999) and Habitat (1996), urbanization is often blamed for environmental degradation.

In reviewing urban wildlife management in America, Adams *et al* (2006) observed that developers most of the times fail to take into account the surrounding wildlife community, which lead to management challenges. This they attributed to the population shift from rural to urban areas (urbanization). They also noted, however, that as Americans have become urbanized, so has their curiosity about wildlife increased in attracting wildlife in order to improve their quality of life. One of the most profound effects of urban development (land use change) on the population dynamics of wildlife is

habitat fragmentation that creates islands of habitats or ''patches'' in affected areas. These patches affect animal behaviour, reproductive patterns, survivability, immigration and emigration or dispersal capabilities, and foraging activities. In Nairobi the urban population already enjoys this kind of desired opportunity. However, there seems to be less recognition of the value of the existing wildlife (Rita, 1982; Omondi, 1984; Oimbo, 2002) and instead urban population and land use change pressure is threatening the sustainability of the same in the national park. It is under such context that associated impacts should be examined towards enhancing the park's posterity. Following the developments in environmental management legislations in Kenya such as Environmental Management and Coordination Act (EMCA) of 1999 (GoK, 2000) urban developers are expected to take into account the wildlife communities in their surrounding areas through carrying out EIA prior to commencement of development.

Conservation efforts are challenged by agricultural land use changes. Pfeffer *et al* (2001) used satellite images and social surveys to examine land use changes in Cerru Azul Meambar National Park in Honduras. In this study the attempt was to draw a relationship between population change and agricultural intensification to understand the impacts of conservation policies. They found that intensification of agricultural production increased with increased human population density. This led to greater opposition to forest conservation efforts in the area. They concluded that in areas with intensified agricultural land uses, due to increased human population density, environmental conservation efforts are unlikely to succeed. Environmental conservation and even restoration is in direct conflict with agricultural intensification. Even though this study was carried out in a rural set-up, the methodology that was employed is vital in similar studies. The conservation focus here was on the forest. The implications of land use changes are therefore likely to be even greater, given the urban set-up and the involvement of wildlife in the case of Nairobi National Park. However, forests are more susceptible to conversion into agricultural land uses than are rangelands where most wildlife is found in Kenya. Urban population is characterized by high densities. As the population density of an area

increases the amount of fallow land (which constitute part of migratory corridor in the case of Nairobi National Park) will decrease and fallow periods will also be shorter.

In Cape Verde, the island of Sal that is only 30 km long by 12 km wide has several terrestrial protected areas and one marine natural reserve. One area, the salt marsh of Pedra Lume, is on the tentative list of world heritage sites. Tourist resort complexes are being built here whose impacts are still unclear. Studies have however shown that land use changes due to overgrazing and introduced species have already caused severe loss of natural habitats and stressed a number of endemic plant and animal species (Trzyna, 2007). These are challenges to sustainability of both the economic and conservation uses to which such areas can be put.

In Kenya many studies have been carried out especially on human-wildlife conflicts, which have been identified as threats to the future of wildlife conservation in many areas. Similar threats have also been identified in the urbanizing areas of the country. Study on industrial land use activities' impacts on Lake Nakuru National Park found industrial pollution to be a threat especially to the bird life (foundation for the parks establishment in 1968) and fish in the park. Analysis linked numerous deaths of both birds and fish to pollution by chemicals like Lindane, Chlordan and DDT (Mhlanga and Mares, 1976). Another study identified urbanization concerns with respect to the interrelation between human settlements and the Lake Nakuru national park (Tuts, 1998). This however, did not draw any relationships between the two or identified the effects of human settlements on the national park's sustainability. Apart from these other urban land uses also carry similar threats. Urban runoff from major rains carry oil, grease, and other toxic chemicals from motor vehicles; viruses and bacteria from leaking septic tanks; sediments from new constructions; and plastic bags. In areas where urban agriculture is practiced sediments and agricultural chemicals flowing into rivers and lakes will only act to exacerbate the pollution impacts.

Mwangi (2000) in a study of partnerships in urban environmental management also noted the environmental effects of rapid expansion of Nakuru town. He specifically identified environmental concerns arising from the relationship between Lake Nakuru National Park and residential cum industrial expansion. The effects or the likely effects of these were, however, not the focus of the study and were never investigated. The park also slightly differs from the case of the Nairobi national park as the former is fully fenced while the latter is not. The interactive intensity with urbanization between the two conservation areas is hence significantly different. The study only focused on the potentials and limitation of partnerships between municipal authorities and local and external groups in addressing environmental problems. This was done in the light of localizing Agenda 21 programme that was developed by International Council for Local Environment Initiatives (ICLEI) in 1999, a framework originated by United Nations Conference on Environment and Development (UNCED).

In a study of community conservation value systems in Nairobi river basin, Karisa (2002) identified as effects of urbanization in the preceding four decades, a disruption of its natural processes with destructive consequences on the riparian ecosystem. These were attributed to numerous urbanization impacts including irresponsible production practices due to forces of urban poverty. The latter are as manifested by unplanned human settlements, poor riparian farming practices and paralysed infrastructure. His further argument was that these conditions had made it impossible for any significant positive contribution of the river to the city's socio-economic growth, including aesthetic functions as well as lowered value of water front land. Ecosystem integrating both aquatic and the terrestrial components adjoining the river, within an urban set up can also be viewed as a vital conservation area. These are threats to environmental sustainability within an urban set up and give an example of how urbanization and sustainable natural resources can be looked at. Just like the riparian ecosystem is capable of significantly affecting the livelihoods of communities in a wider area considering a river's catchment area, the park is a vital urban natural resource with known and even greater potential

effects on livelihoods of large communities. Its sustainable utilization is thus an important endeavour.

On the north – western flanks of Tsavo National Park, there has been growth of subsistence agriculture in the agriculturally marginal areas, clearing for charcoal burning and squatter settlements encroaching on the park as well as poaching incidences for certain animals (Omondi, 1984 and Ogendi, 1999). Mushrooming of settlements and encroachment of agricultural activities in the Maasai Mara game reserve has also been identified. These have been some of the major causes of human-wildlife conflicts in the affected areas. Omondi (1984) identified the then land use changes taking place in the areas adjoining the N.N.P including Athi-River, Kitengela, Ongata Rongai and Ngong. In his analysis he saw the potential of changes in land use patterns including pastoralism and human settlements, displacing wildlife in the dispersal areas and confining them in the small sized park thus exceeding its carrying capacity. He also identified change in land tenure system from public or communal holdings to private ownership as cause of human-wildlife conflicts.

Oimbo (2002) also noted increasing threats to the habitat required by wild life in Kenya despite being one of the most aesthetically and economically valuable natural resources. She observed in Kitengela – that farmers had been forced on to marginal land unsuitable for agriculture due to human population increase, as was the case in Tsavo area. This isolate parks and reserves from wildlife traditional dispersal areas adjoining the conservation designated areas. It was found that human-wildlife conflicts in the area had increased with increased settlements and attendant agricultural activities. She also found out that land sub-division and sale in uneconomical plot sizes resulting from high incidences of poverty and changing lifestyles among the local (Maasai) people were also hindering long-term conservation efforts in the area. Non - participatory approaches in the area in attempting to manage such conflicts were identified as unable to achieve the objective. Communal Areas Management Program for Indigenous Resources (CAMPFIRE) was proposed as the best alternative. However, this study was basically

based in a rural set up and the findings may not be applicable to an urban scenario. It is thus vital to identify impacts of human settlements and associated activities in an urban set up and propose contextual approaches towards sustainability of conservation areas within the urban environment. Urbanization will increase land subdivisions unless controls are put in place. If urbanization in the area does not generate commensurate job opportunities, poverty will be urbanized with negative repercussions like poaching even inside the park, and robbing visitors, threatening survival of the targeted species and discouraging visitors respectively.

In a separate study undertaken to find the level of popularity of Nairobi National Park with neighbouring communities and visitors' activities in the park it was found that the residents in Kitengela Conservation Area had a negative attitude towards it as a threat to their property (depicting the earlier mentioned human-wildlife conflict). Many visitors on the other hand felt that the park provided a prime opportunity by facilitating visits within a short period of 2-3 hours. However, only car owners or those able to hire visited the park (Rita, 1982). This may change with the recent introduction of shuttle services to the park with guided tours on weekends and public holidays by KWS. The study also observed various problems which were then experienced by the park as land use conflicts in peripheral areas, poor infrastructure and lack of certain visitors' facilities, apart from absence of institutional bodies to intervene in such problems as related to land. Some of these findings like land use conflicts and hence human-wildlife conflicts with threats to sustainability were confirmed by later studies by Oimbo (2002) while studying conflicts management options. However, these studies only looked at the levels of facilities provision and accessibility in the park and management of human-wildlife conflicts. It is therefore vital to focus on the impacts urbanization pose on the park's sustainability with regard to associated land use changes. The relationship between urban population changes, land use changes and the populations of wildlife in urban protected areas remain unexplored.

2.5 Urbanization for conservation

In the foregoing literature reviewing, high population increase and associated human activities have been identified as the major causes of land use changes with consequent habitat fragmentation, destruction and even loss. Despite the widespread negative consideration of urbanization and growth of cities especially as concerns environmental degradation and threats to conservation, some authors paint a positive picture in their relation to environmental sustainability. According to Satterthwaite (2004), those who live in or move to cities generally have smaller families than those living elsewhere and the countries with the largest increase in their level of urbanization are also generally those with the largest falls in population growth. Does this mean that urbanization can reduce the human population impacts on the environment and threats to conservation areas?

According to Satterthwaite (1999) and Chen *et al* (2008), there exists potential to combine safe and healthy living conditions and culturally rich and enjoyable lifestyles (aspirations of the population) with remarkably low levels of energy consumption, resource use and wastes. High human population densities in urban areas mean lower costs per household and per enterprise for the provision of piped water, treated water supplies, waste management, amongst provision of other services. Urban centres provide the concentration of production and consumption, which means a greater range and possibility for efficient resource utilization. Urbanized population has a reduced demand for land relative to the population size. Yet in the case of Nairobi National Park just as it is with some other conservation areas, competition between conservation and urban development appears to be on the land resources. In temperate countries, potential exists for reduced winter heating energy requirements and expenditure due to economies of scale. There also exists greater potential for limiting the use of private motor vehicles substantially, reducing air pollution, if public transport is encouraged.

The product of urbanization, the urban environment, therefore presents dynamics of resources, processes and effects. The resources include both artificial (housing,

industries, fences, electricity, roads etc) and natural (land, water, minerals, sunlight etc.). Processes include migration, settlement, population growth, manufacturing and transportation. The effects are the outcomes, either positive (value-added products and services, education, access to goods and services etc.) or negative (pollution, waste generation, congestion, overcrowding etc). Broadly, the urban environment can thus be defined as an intersection of natural environment, the built environment and the socio-cultural and economic environment. These interact such that taking only one dimension like the built environment at the exclusion of the other two poses a danger of missing the habitat for the wildlife.

This study hopes to bring to the theoretical front the challenges imposed by urbanization on the management of ecologically sensitive open spaces, where wildlife are involved, among other urban land uses. This will also give direction on how relevant information needed in decision making for effective planning and management of such areas can be practically obtained. While one of the government's flagship projects in vision 2030 is to secure wildlife corridors and migratory routes (KWS, 2005; GOK, 2008), one of the challenges facing the government in conservation is inadequacy of data to aid decision-making (GOK, 2002). By introducing the perspective of urbanization impacts on sustainable management of conservation areas, this study hopes to contribute to filling part of this lacuna, especially in the planning sector. The study will also bring ecological concepts into the complex situation of urban community planning as most people will be living in urban areas-in this region (UN, 2004) - where we may be furthest from sustainability (Cullen, 2003). It will also therefore broaden the predictive capacity to guide planners and urban managers in their decision-making, and ability to trace effects of comprehensive change on small parts of the system.

2.6 Theoretical framework

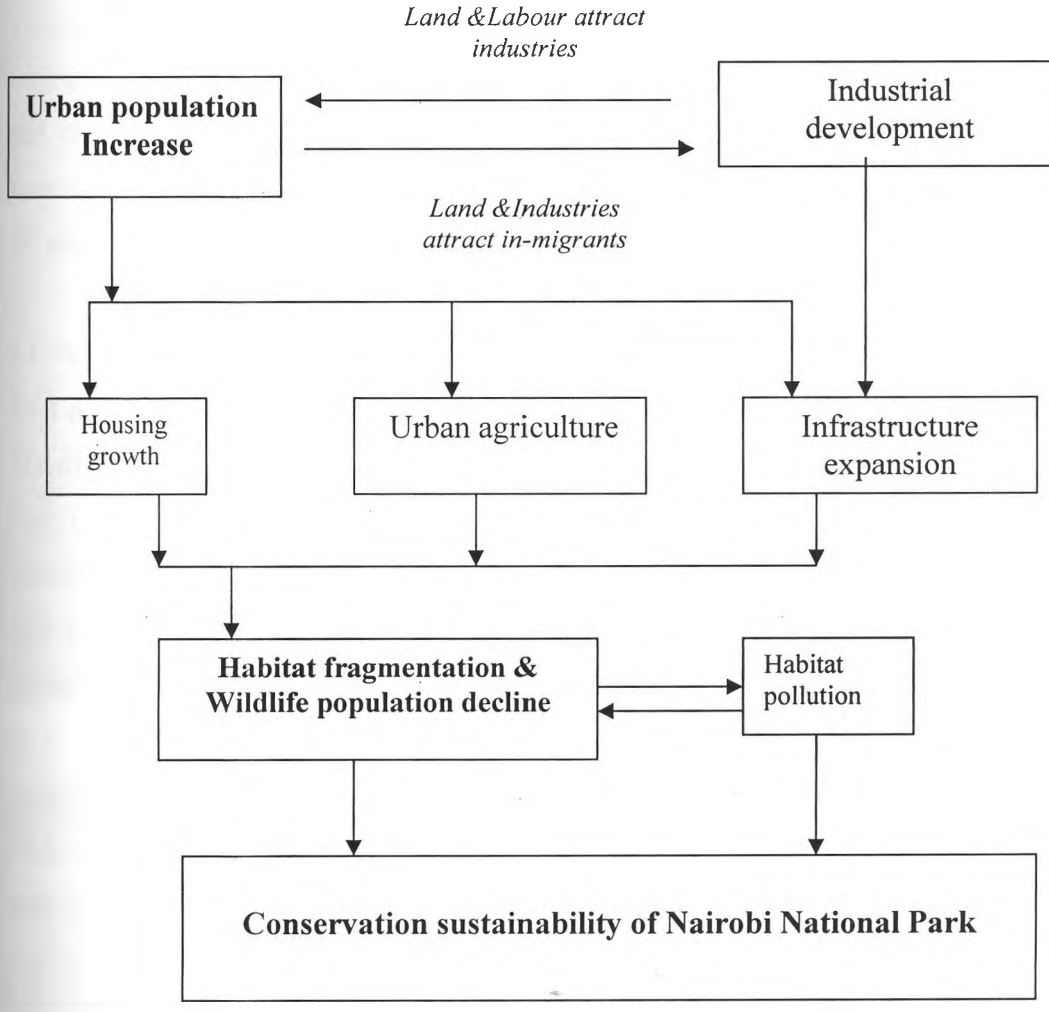
Conservation sustainability of Nairobi National Park is threatened by rapid urban population growth and land use changes taking place within the wildlife migration corridor. Much has been written about why the world is urbanizing. The reasons for

urban population growth are complex. Rural-to-urban migration account for most urbanization, but migration from cities to rural areas that then become urbanized also occurs. Industries in urban areas with real and perceived job opportunities partially contribute to the former. Wars can bring people into cities, but they can also have the opposite effect, depending on where people feel safer. Natural disasters and city congestion can cause people to move out of cities, but those people may then contribute to urban growth elsewhere. Expansion of urban boundaries also contributes to their population growth.

The expanding urban population in endeavouring to meet the increased housing demand, while moving away from the city centre, is rapidly settling within the migratory corridor. In the process, they also carry out other activities such as agriculture in this place which increase human – wildlife conflicts. Attempts to reduce such conflicts by fencing farms and at sometimes killing wildlife only complicate conservation efforts in the affected areas.

Expansion of industrial and infrastructural facilities is also taking place as urban growth continues outwards. These developments lead to fragmentation of the migratory corridor and destruction of wildlife habitats within it. Apart from these, there is also increasing generation of both domestic, agricultural and industrial waste among other sources of pollution (of air, surface water sources and soil) associated with these developments. All these factors operating in varied degrees of intensity negatively affect the seasonal migration and even breeding of certain animals. These reduce the population of migratory species in the park, hence its conservation sustainability.

2.7 Conceptual framework



→ Arrow points to the affected parameter

Figure 1: Conceptualization of the effects of urbanization on the sustainability of Nairobi National Park. *Source: Author*

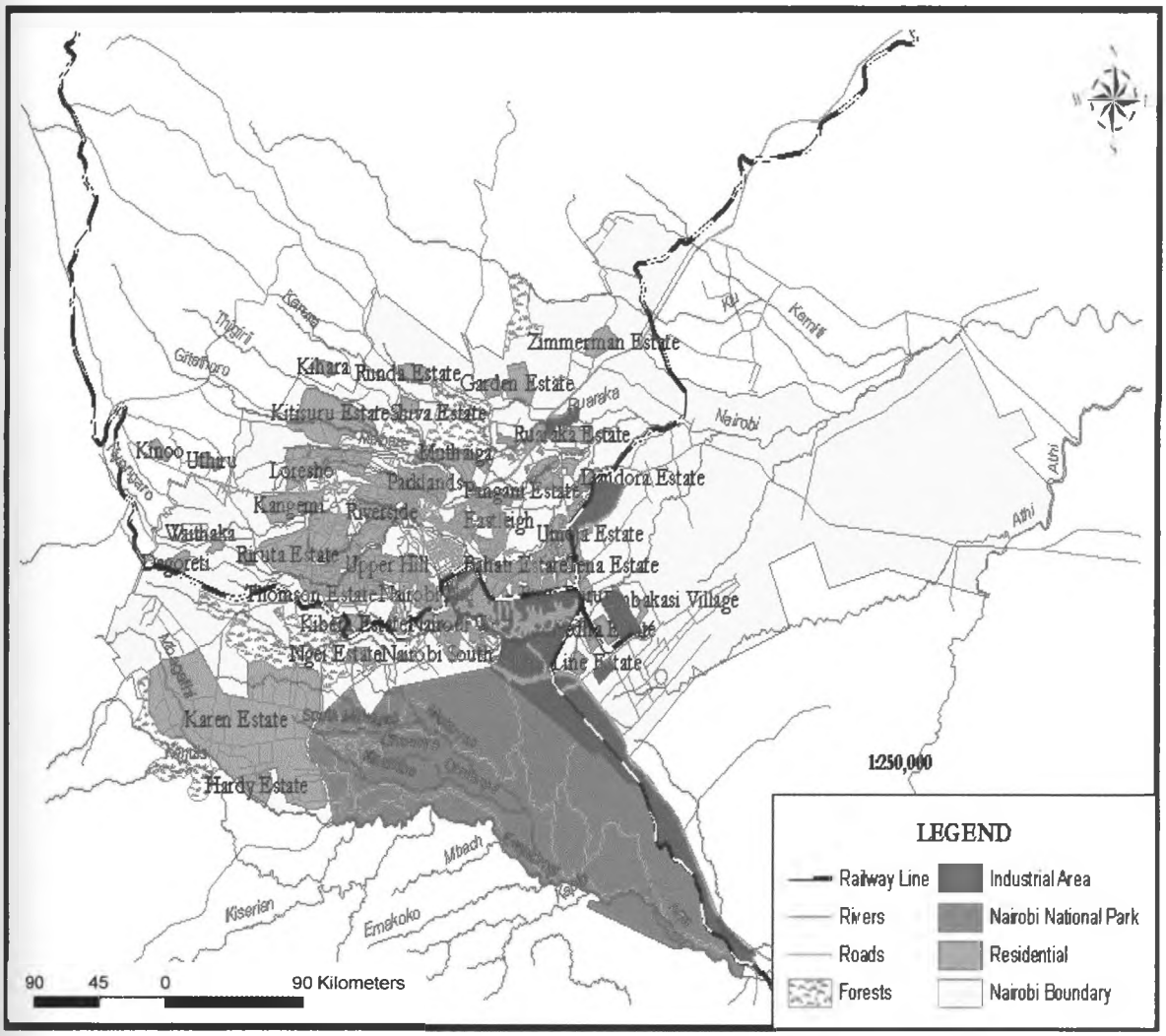
3. METHODOLOGY

This chapter first presents the background information of the study area, Isinya division of Kajiado district and the Nairobi national park. The information relates to the physical and climatological characteristics of the area as they influence human activities and seasonal movements of wildlife within and through the area. Its second part focuses on the procedure that was adopted in carrying out the study.

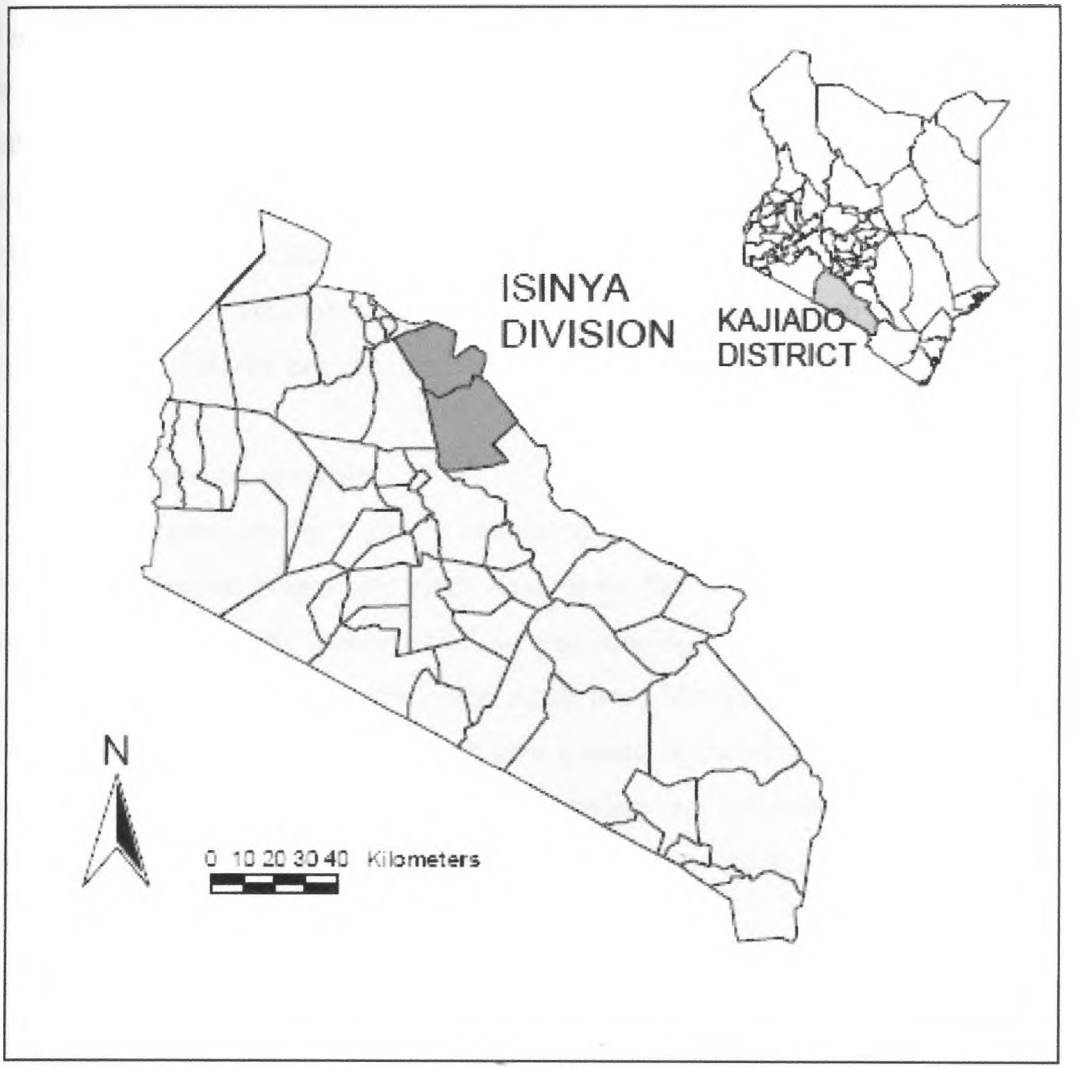
3.1 Study area

3.1.1 Administrative and geographical location

The study area straddles two provinces of Rift valley and Nairobi area. Nairobi National Park, covering 117 square kilometres, is within the city of Nairobi which also makes the Nairobi area province. It lies between 2° 18″ S, 2 ° 20″ S and 36 ° 23″ E, 36 ° 28″E (KWS, 2006). The northern, eastern and western sides of the park are fenced. The southern side opens into the wildlife migratory corridor. The corridor is 36 ° 44'E, 36 ° 54'E and 1 ° 40' S, 1 ° 25'S and is part of the greater Athi - Kapiti plains in Kajiado district of Rift valley province. It is made up of three sub locations- Kitengela, Isinya and Olturoto- within Isinya (1066.3 square kilometres) division of Kajiado district (GoK, 2002) as shown in the figure below.



Map 3: Nairobi National Park and the city centre. *Source: Author*



Map 4: ***Isinya division in Kajiado district.*** *Source: Author.*

3.1.2 Geology and soils

The park's geology was described by Saggerson (1991) as overlain by a series of lava flows. To the western part of the area is the Nairobi trachyte, characterized by grey mottled lava which has a glistering appearance due to numerous tiny feldspar crystals. The central plains comprise of the Nairobi phonolite. It contains less feldspar crystals and smaller Nepheline. Small flakes of Biotite are sometimes present. The Mbagathi Phonolytic trachyte occurs across the park. These contain feldspars, Phenocrysts and

Nephelines. Athi tuft are found in the bushy vale and rocky valley of the park. They are soft and friable in texture.

Soils of the area was described by Scott (1963) as follows; the summit, the upper and middle slopes consist of red clay soils; the lower slopes are characterized by shallow soils over laterite and the depressions are composed of clay soils. In the central plains the soil consists of dark brown calcareous clays, reddish-brown sandy clay loams and alluvial soils. The flat plains' soils are composed of shallow yellow brown to yellow and friable clays overlaying a laterite horizon, shallow soils and alluvial soils.

3.1.3 Topography and drainage

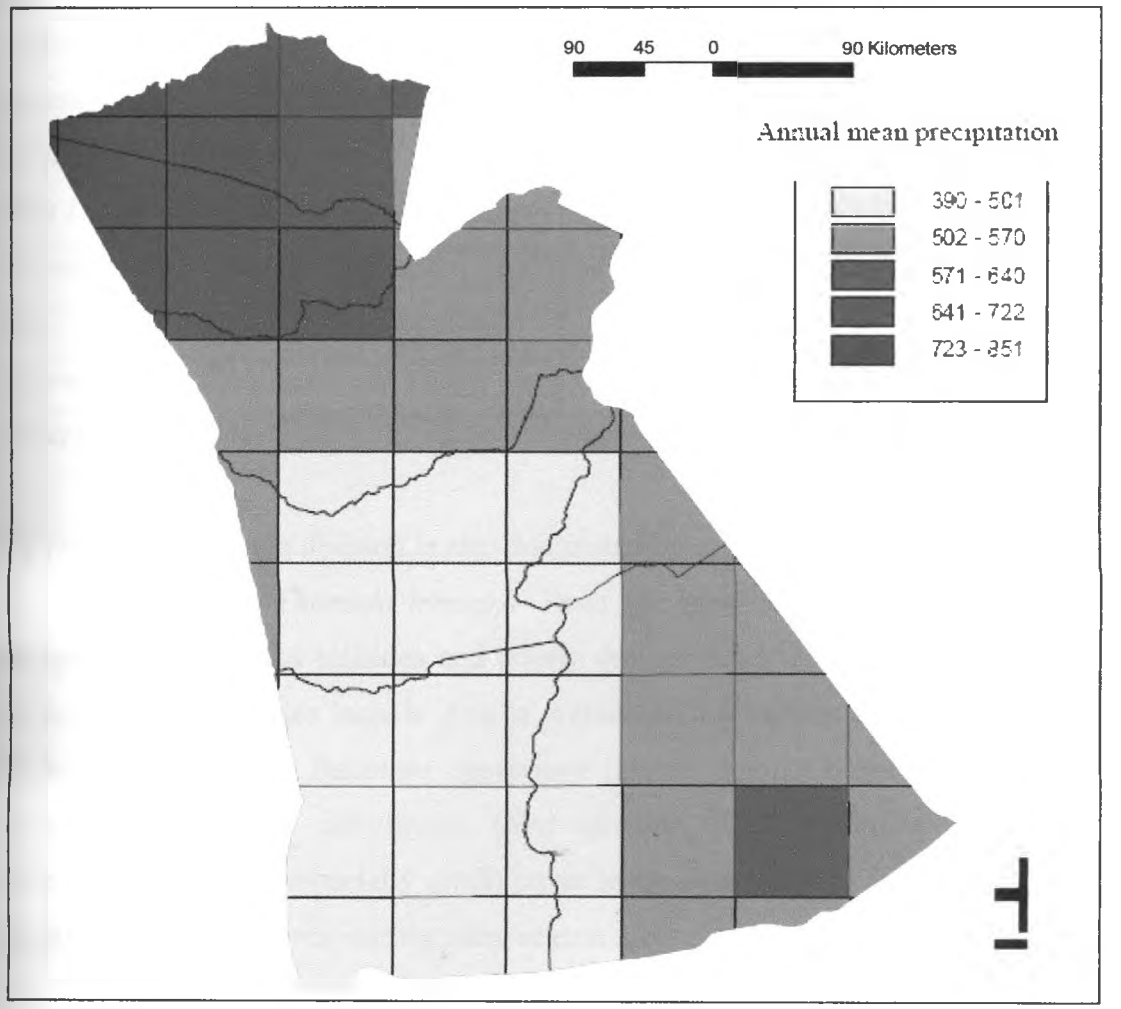
The area is characterized by a gently undulating topography. The land declines gently towards the Embakasi plains into river Athi, from the western and central parts. The topography is dissected by a number of streams running from the northern and western boundaries of the park to Mbagathi River. Apart from Mbagathi, stoney Athi is the other major stream receiving water from the higher ground in the west and flowing into river Athi. Scott (1963) noted that most of these streams are seasonal. The area is poorly drained partly due to the low angle slopes and the nature of the soils.

3.1.4 Climate

Climate influences human activities and vegetation types and distribution that in turn affect the distribution and migration of wildlife. According to Omoke (1998) as quoted by Oimbo (2002), the climate of any region is a function of parameters such as altitude, latitude, prevailing wind conditions, proximity to a large water body and topography. Areas of Kajiado district generally experience tropical dry climate with little variations at local or micro-levels.

Rainfall in the area is strongly influenced by altitude and ranges between 500mm and 1250mm per annum. The highest rainfall is experienced in northern parts near Nairobi and Ngong hills while the lowest is experienced in the southern part corresponding to the highest and the lowest elevations respectively. Rainfall distribution in the area, as in most

other parts of Kenya, is bimodal with alternating dry and wet seasons. Short rains occur between November and December while long rains occur between March and May. In between the short and long rainfall seasons are intermediate periods of dry spells between January and March and between June and October.



Map 5: Annual mean precipitations across Isinya Division, 1961-1999
Source: ILRI (2004)

Temperature in the areas also varies with altitude in addition to the rainfall seasons. Annual mean temperatures are 25.3°C and 13.5 °C at maximum and minimum respectively. The coldest moths are July and august while November to April are the

hottest months (GoK, 2002). Migratory wildlife move from the park into the greater Athi Kapiti plains and beyond through the corridor in wet season and return to the park in dry season (Prins *et al*, 2000).

3.1.5 Vegetation and wildlife

Vegetation type and distribution is a vital determinant of wildlife distribution and seasonal migration. The national park's vegetation is summarized by Ngene (2002) as shown in the table below.

Table 1: Vegetation distribution in Nairobi national park

Vegetation type	Forest	Bush woodland	Woodland	Bushed grassland	Open grassland
Coverage	2.53%	0.38 %	0.15%	1.34%	95.60%

Source: Ngene, 2002.

The vegetation in Isinya division is also dominated by savanna grassland. The dominant grass species include *Themeda triandra-* Read oat grass- in the plains and *Harpchne schimperi* on the eroded hillsides and poorly drained black cotton soils in the valleys. Dominant Woody species include *Acacia drepanolobium* (Galled acacia), *A. tortilis, A. xanthophloea, A. kirkii*, *Balanites aegyptiaca* (Desert date), *Croton megalocarpus, C. dichogamus, Diospyros abbysinica, Olea africana, Grewis similes,* and *Dombeya burgensis*. Vegetation (especially grass) cover in the area varies seasonally with rainfall and grazing intensity hence during rainy season most pats have enough forage but in the dry season only higher areas remain with enough forage. This differential is responsible for seasonal migration of animals between the higher areas, part of which constitute the park, and lower areas.

The common wildlife species in the area are zebras, impala, giraffes, and wildebeests as herbivores while the primary carnivorous species include lions, spotted hyena and black jackal. Wildebeest and zebra are the numerically dominant herbivores in Nairobi national

park (Khisa, 2001). The table below shows the population estimates from aerial counts of Wildebeest and Zebra in Isinya division from 1990-2000.

Table 2: Population estimates (from aerial counts) of Wildebeest and Zebra in Isinya division from 1990-2000.

SPECIES	POPULATION ESTIMATE	YEAR	MONTH	SEASON
WILDEBEEST	12968	1990	April	Wet
	170	1992	October	Dry
	7023	1994	April	Wet
	4035	1998	March	Wet
		2000	November	Dry
ZEBRA	7301	1990	April	Wet
	5805	1992	October	Dry
	8244	1994	April	Wet
	4272	1998	March	Wet
	1944	2000	November	Dry

Source: ILRI, 2004.

Other herbivores that migrate with wildebeest and zebra but in very small numbers are eland, impala, hartebeest, Thomson's gazelle, giraffes among others.

3.1.6 Economic activities

Pastoralism is traditionally the dominant economic activity in the rural areas of Isinya owing to the semi- arid nature as well as the culture of the people. However, with decreasing land sizes and increasing population, the locals are diversifying in their economic activities in order to cater for their basic needs. Subsistence farming is also found in some areas with the main crops grown being maize and beans. Women usually sell the milk to the nearest market centres and also charcoal which is affecting the vegetation cover in the area. Other economic activities include mining building stones and floriculture (GoK, 2002).

3.2 Research methods

Both survey and trend studies were used to effectively investigate land use changes, human activities and their interactions with wildlife. This blend was to bring together the synergistic advantages of these two research designs while also achieving design triangulation. Survey research was to bring in representativeness through random sampling of the wide population of land developers within the wildlife migration corridor, (Mugenda and Mugenda, 2003; Kombo and Tromp, 2006). Descriptive survey was expected to yield holistic and in-depth information about the various phenomena. Trend study was used to map land use changes over time and investigate any relationships between changes in urban human population and that of migratory wildlife in the park. It enabled the examination of what happened in the past, what is happening now, and what is likely to happen in the future. Trends regarding a phenomenon can also be correlated with other characteristics of the study population, (Kumar, 2005; Wallnau and Gravetter, 2002).

3.2.1 Study population

Within the park participants included the wardens, community wildlife, research and monitoring divisions' staff as well as rangers while study objects were the zebras and wildebeests. These two species are the numerically dominant herbivores and the major migratory animals in Nairobi National Park. In Isinya division, households were the participants and the study objects included existing land uses/developments in the area. Also within this area were the municipal/council officials with their jurisdiction boundaries included in and or affecting the park. Other participants were drawn from other conservation bodies. These participants together with the developments in these areas constituted the population of the study from which samples were drawn.

3.2.2 Sampling

There were a total of 7469 households (N) in Isinya division according to the last human population census carried out in 1999. A sample of 85 households (n) was settled on for the survey guided by the central limit theorem which state that the higher the number of

samples, the less the level of skewness within the normal curve and any sample more than 30 is assumed to be representative enough of the population (Mugenda and Mugenda, 2003; Kombo and Tromp, 2006). The survey was conducted through random sampling of 53, 11, and 16 households in Kitengela, Olturoto and Isinya locations respectively. The households were interviewed in each location based on their proportional numbers. Even though the initial sample consisted of 85 households, 5 respondents did not answer all their questions. It is the remaining 80 that were selected for analysis.

On land use change analysis, the study was originally intended to use Landsat TM images of 1979, 1989, 1999 and 2008. However, these were not readily available in useable formats and the expected temporal intervals hence images of 1976, 1986, 1995, 2000 and 2002 obtained from the Regional Centre of Resource Mapping for Development were used.

From the institutions, selective sampling procedure was applied for the participants from the park's management (planning, research and monitoring units and community wildlife departments), officials from the government departments as well as other agencies involved in the conservation (such as EAWS, ACC, CBOs and FoNNaP), classified as other stakeholders. Only officers with immediate involvement in the park's conservation issues and land use planning and management were sampled. Before proceeding to the field, a research clearance permit was obtained from the Ministry of Science and Technology.

3.2.3 Data needs

The data gathered from the above sources consisted of the following:

i) Urbanization

- Land use changes and trends in the park's wildlife migration corridor
- Demographic trends of Isinya division and human activities in the area

ii) **Sustainability of the park**

- Population dynamics of major migratory animals
- Human activities and nature of human-wildlife interactions in the corridor

3.2.4 Data collection

The above data needs were met through multiple approaches. These included broadly both primary and secondary data collection. Primary data was obtained through interviews, administration of questionnaires designed for different respondent's categories (appendices 1 to 3), field observation and photography. Secondary data were mainly from population censuses, both for Isinya residents and major migratory animals (wildebeest and zebra), and from temporally varied Landsat satellites images. These were sourced from libraries, publications and reports from KWS and other conservation agencies, government reports, maps and satellite images amongst other sources.

3.2.5 Data analysis and presentation

Data analysis was carried out in three different levels. First, thematic analysis of different Landsat TM images showing land use changes over time was carried out. Landsat TM images of 1976, 1986, 1995, and 2002 (appendix V) were processed using Arc view GIS 3.2. This involved correcting images for errors due to satellite sensors, atmospheric scattering, and geometric distortions. Ground truthing was also done by visiting the study area and identifying the current land cover classes (training sets) in the latest image. Spatial trend was analyzed using ERDAS Imagine 9.3 to show spatial changes from natural to built-up area in Isinya, which was presented on maps.

Secondly, changes in human population growth in Isinya was compared with changes in population of the park's migratory wildlife (wildebeests and zebras) and their correlation established to determine any relationship between the two sets of variables. The two variables have similar units and therefore did not require any standardization. The Pearson product- moment correlation coefficient was used for this purpose. These two stages established the patterns, trends and relationships of the variables involved. Critical

values of the Pearson correlation was employed to test the hypothesis that there is no relationship between urban population growth and that of migratory wildlife in the Nairobi national park. To be significant the sample correlation coefficient r must be greater or equal to the tabulated value at 4*df* (=n-2; n=4, the number of censuses used) at 95% (α =0.05) level of confidence (see appendix VI).

The last stage of analysis involved coding and quantitative descriptions to give summary statistics of human-wildlife interactions within the wildlife corridor. In this case, the statistical package for social scientists (SPSS) was employed. It is from these that generalizations were made. According to Leedy (1983) qualitative data analysis is usually carried out simultaneously with data gathering and sometimes it's difficult to draw a clear line between data collection and data analysis. Qualitative data is such that as one does the analysis, he/she is also putting the report together (Mugenda and Mugenda, 2003; Leedy, 1983). Tables, charts, photos, maps, graphs and descriptions were used for illustration and presentation of the analysis and findings.

Table 3: The analytical framework

Objectives	Data needed	Data sources	Method of analysis	Expected output
Identification of wildlife corridor and examination of land use changes	Maps, satellite images	KWS,DRSRS, Survey of Kenya, Field observations	Thematic, ERDAS Imagine 9.3 and trend analysis	Land use changes and trends in the migratory corridor
Examining human - wildlife interactions in the wildlife corridor	Human activities in the corridor, Their experience (benefits /conflicts) with the wildlife Existing management interventions	Interviews/questionnaires to the households and entrepreneurs in the area, KWS, other conservation and land management institutions	Qualitative analysis, SPSS	Identification of activities incompatible with wildlife conservation
Examination of population changes of major migratory species and that of the Nairobi metropolitan area	Trends in population of Nairobi metropolitan area and in population of migratory species	NBS Census reports Wildlife census reports	Trends and correlation analysis	Urban population trend in the area Trends in migratory wildlife population and projections

Source: Author

4. RESULTS AND DISCUSSION

4.1 Human-wildlife population dynamics

Human population density in Isinya division increased eight fold between 1979 and 1999 from an average of 5 to 42 people per square kilomieter. Of the households interviewed, 70.0% of the respondents were males and 30.0% were females. Many of the households had less than ten menbers. Majority of residents in Isinya division (37.5%) work in the local town of Kitengela with Nairobi city coming second town of work accounting for 32.5% as shown in Figure 2 below. This shows the greatest influence on land use in the area is shaped by people working in the immediate urban (Nairobi and Kitengela) areas. Kitengela town's population,for instance, has inccreased by more than 200 per cent in the intercensus years of 1989 and 1999 from 6548 to 17347 people.

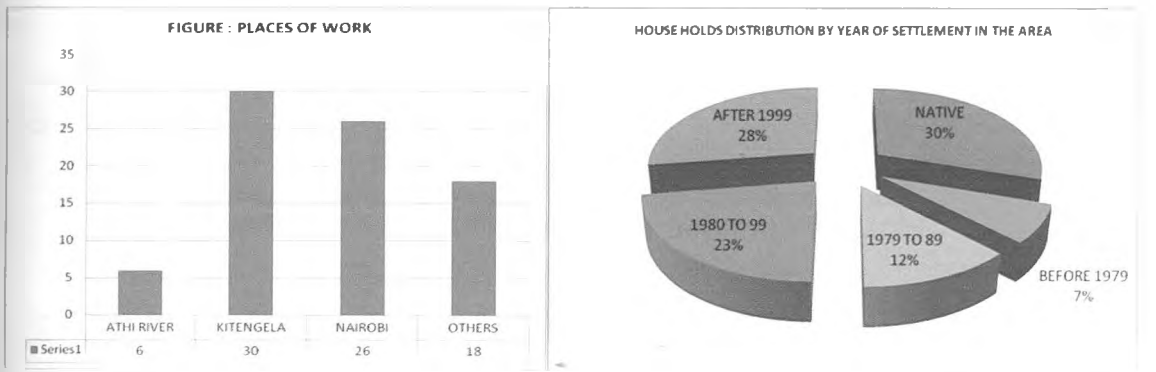


Figure 2: Places of work and household distribution by period of settlement

Source: Field survey, 2008.

From the household survey, majority of immigrants (28.0%) settled in the area after 1999 and population composition trend shows a constant increase in their number in the area. The area is currently having more immigrants (70.0% of the population) than the indigenous population with the turning point being the 1990s as shown in Figure 3 below.

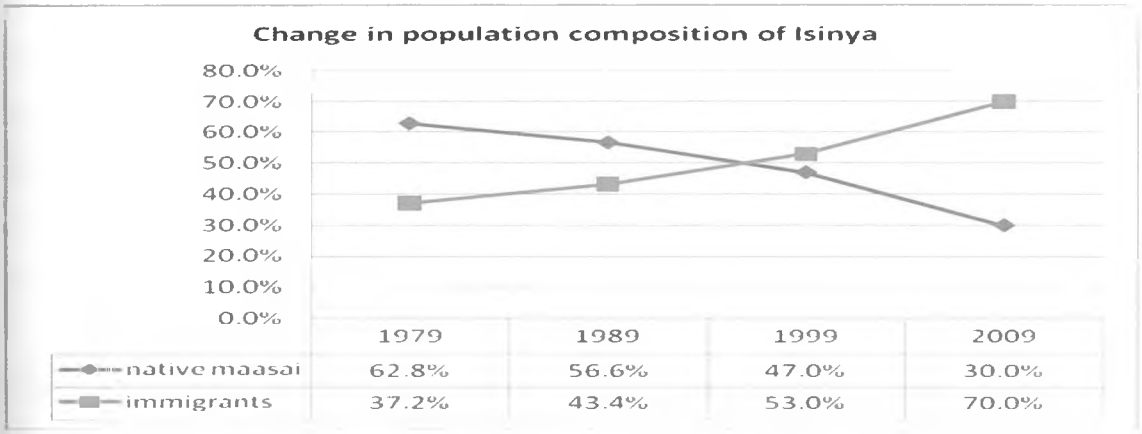


Figure 3: Population composition of Isinya

Source: Analyzed from Census reports of the respective years

A comparison of trends of human population in Isinya and population of two migratory species of Nairobi National Park shows a constant decline in the latter as human population steadily increases as shown in Figure 4. Population of Wildebeest started declining in the nineteen eighties while that of Zebra in the nineteen nineties. This period corresponds to the time when majority of immigrants moved into Isinya as discussed above.

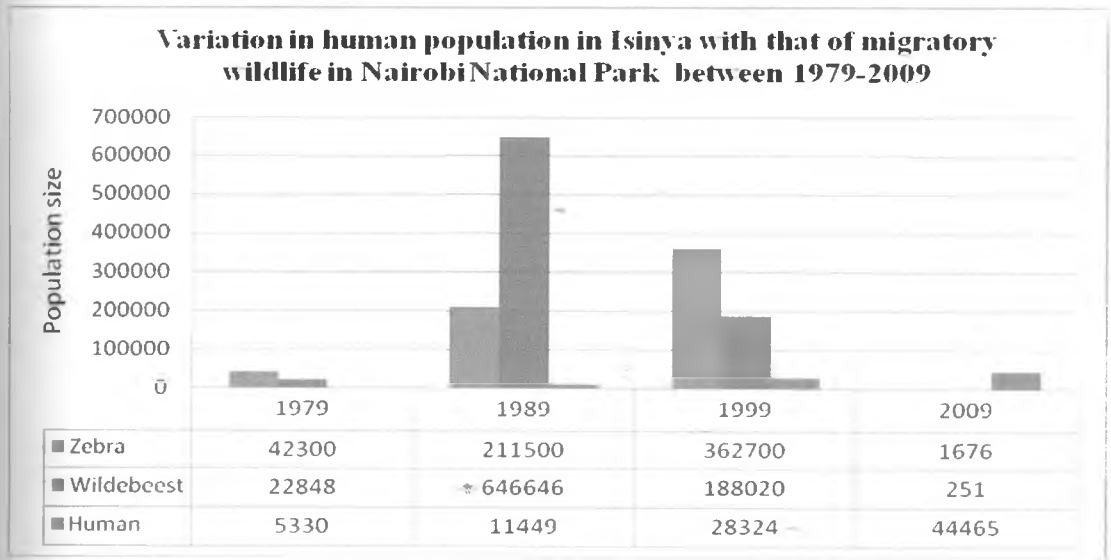


Figure 4: Human and wildlife population trends in Isinya and Nairobi National Park

Source: Analyzed by author from Census data of 1979, 1989, 1999 and 2009. Human population of 2009 is based on projection from 1999.

These trends show that there is a relationship between human population growth in the area, especially of immigrants, and the declining migratory wildlife population inside the national park. This can be attributed to the land use activities of immigrants in Isinya that may have severely limited free movement of migratory wildlife between the park and its dispersal areas.

From the correlation analysis, human population in Isinya has a correlation coefficient (r) of -0.097 and -0.400 with the populations of Zebra and Wildebeest in the national park respectively as in Figures 5 and 6. Statistically, this means that human population in the wildlife corridors of Isinya negatively relates with the population of Nairobi National Park's migratory wildlife. However, the relationships are statistically weak for Zebra and moderate for Wildebeest (Sloan, 2009 and Sekeran, 1992) and cannot be considered as reliable predictor of the relationship between the different populations.

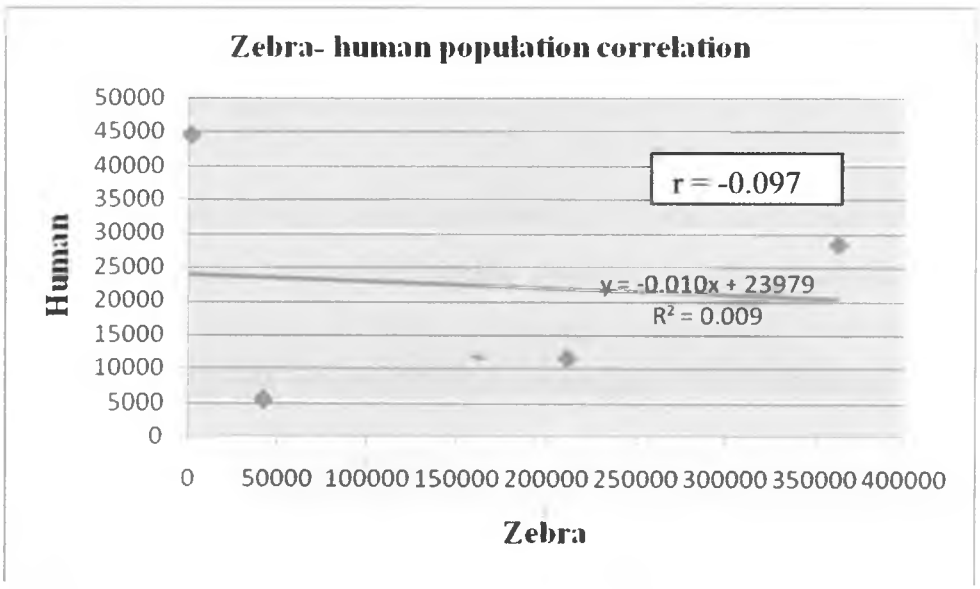


Figure 5: Scatter diagram for human population in Isinya and Zebra population in the national park. *Source: Author.*

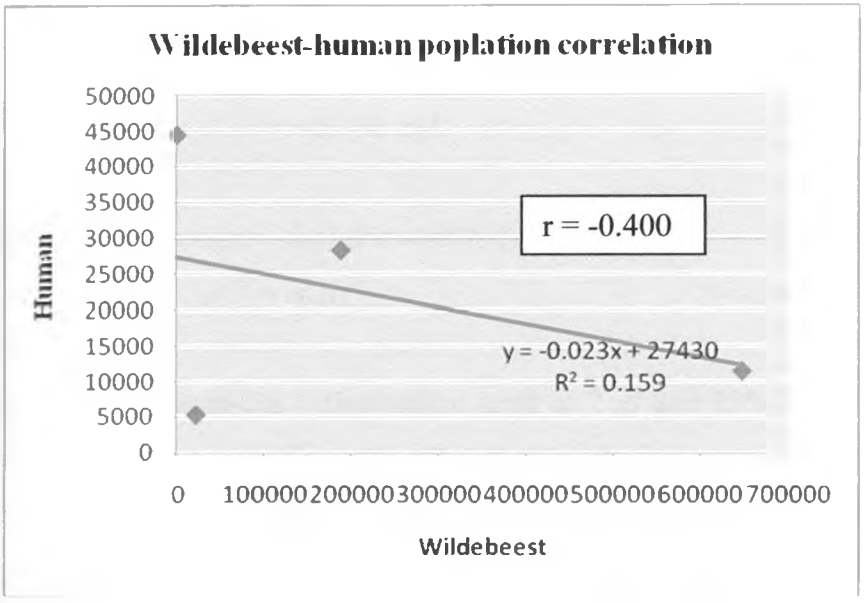


Figure 6: Scatter diagram for human population in Isinya and Wildebeest population in the national park. *Source: Author.*

***Note**: **r** values were automatically generated by excel statistical tool from inputs of the various populations for 1979, 1989, 1999, and 2009 and rounded off to three decimal places corresponding to automatically generated R^2 values in the scatter graph.*

From the above analysis, though human population growth in Isinya has a negative effect on the population of migratory wildlife in the national park, the proportion of variance accounted for by its influence (0.9% for Zebra and 15.9% for Wildebeest-*obtained by converting the proportion of variance R^2 into percentage*) on the population of wildlife is very low.

In testing the null hypothesis (Ho) that there is no correlationship between human population in Isinya and the population of wildebeest and zebras in the Nairobi National Park., observed *t* values were compared with the critical *t* values at 2*df* and 95% level of confidence. Observed *t* value was calculated from the following formula.

Observed $t = r\sqrt{1-r^2} \times \sqrt{n-2}$ (Furr, 2008)

Hence, for zebra, observed $t = -0.097/\sqrt{1-(-0.097)^2} \times \sqrt{4-2}$

$= -0.138$ and

For wildebeest, observed $t = -0.400/\sqrt{1-(-0.400)^2} \times \sqrt{4-2}$

$= -0.617$

The critical *t* value from the *t* distribution table at 2 *df* and 95% level of confidence is 4.303. This critical value of *t* is greater than the observed absolute *t* values for both cases above. Hence, the null hypothesis above fails to be rejected (see appendix VI). This statistically means that the samples' correlations are not significantly different from zero. That is, human population alone has no effect on the population of migratory wildlife inside the national park. Other variables are likely involved in influencing the population of migratory wildlife in the national park than the human population. Apart from human settlements taking up land used by migratory wildlife, their other land use activities may be strongly responsible in influencing the wildlife population decline in the park. From field observation, fencing of land under different uses is the possible major responsible factor. Fencing ensures that the fenced areas are completely inaccessible to wildlife and sustains the corridor fragmentation by other different land uses.

4.2 Human- Wildlife Interactions

Human population growth and associated land use changes affect the distribution of wildlife over space in the affected areas. Many respondents (69%) in Isinya have the perception that there has been a reduction in the number of wild animals they spot around them. Decrease in the number of variety (species) spotted is however, perceived by a relatively lower fraction of the respondents (Figure 7). It is evident that new human settlements and other land uses have contributed to this in the area. This fails to support the hypothesis that there is no relationship between land use changes in the area and the population of wildlife.

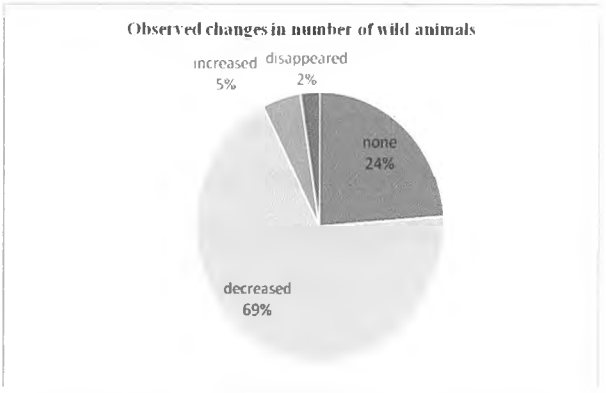


Figure 7:Changes in wildlife population. *Source: Field survey,2008.*

The high level of immigration of agricultural households into Isinya is similar to that in Meru conservation area (Otuoma, 2004). The result is that areas formerly serving as wild life corridors and grazing lands have been subjected to fragmentation as immigrants take up land for settlement and crop production among other uses.

Human-wildlife intearactions in Isinya is dominated by conflicts as perceived by the the local people. Only a third of the respondents were positive as having benefited from wildlife in the area (Figure 8) either directly or indirectly, from tourism proceeds (18.8 %) or

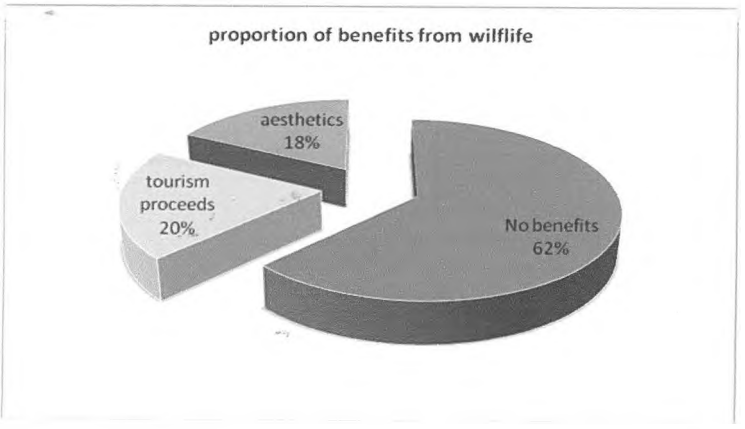


Figure 8: Benefits from wildlife. *Source: Field survey,2008.*

aesthectics (17.5%). According to one of them "the only benefit we have got is that our children can see the wildlife freely without paying as others do in the park".

The main problems experiened from wildlife (Figure 9) are livestock attacks and deaths, noise at night, and destruction of agricultural farms (crops, fences and irrigation infrastructure) in decreasing order of significance. Others include spreading of livestock diseases and competition for pasture.

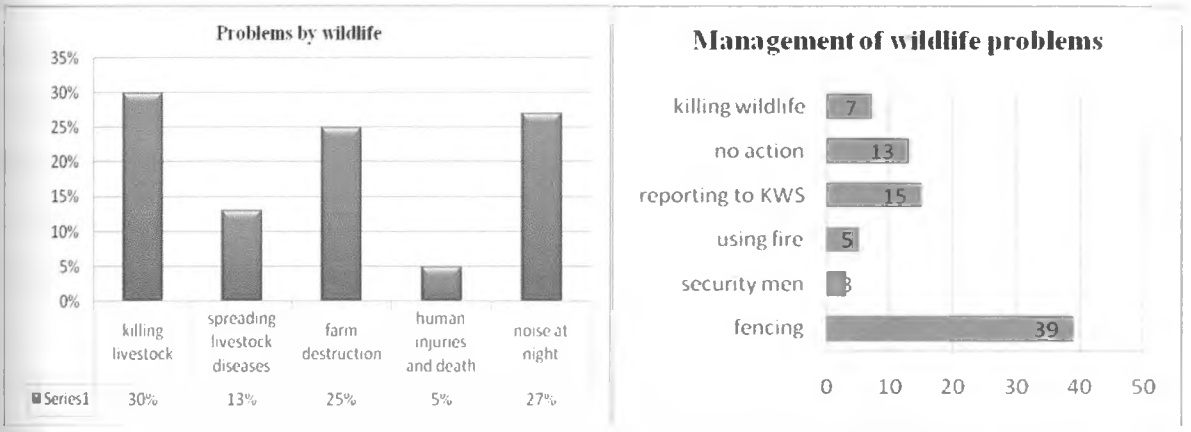


Figure 9: Wildlife problems and their management. *Source: Field survey, 2008.*

According to one of the respondents, Rev. Ole Sekuda "spots where *Ngatata* (Maasai for Wildebeest) give birth are where our animals contract most deadly diseases" . This was confirmed by ILRI'S report on one of the diseases, Malignant Catarrhal Fever, spread by wildebeests' calves following calving periods. Even though competition for pasture resources did not emerge as a major threat in the open ended interviews, it can be inferred from the predation of livestock by carnivores who usually go after their preys, the herbivores.

These findings are similar to those of earlier examinations in other parts of the greater Kitengela Consrvation Area (Oimbo, 2002 and Omondi, 1984) and in Meru Conservation Area (Otuoma, 2004) as far as wildlife problems experienced are concerned. However, in these ealier studies competition over pasture featured more prominently than is the case in Isinya currently. Reduced conflict levels over pasture relative to earlier cases can

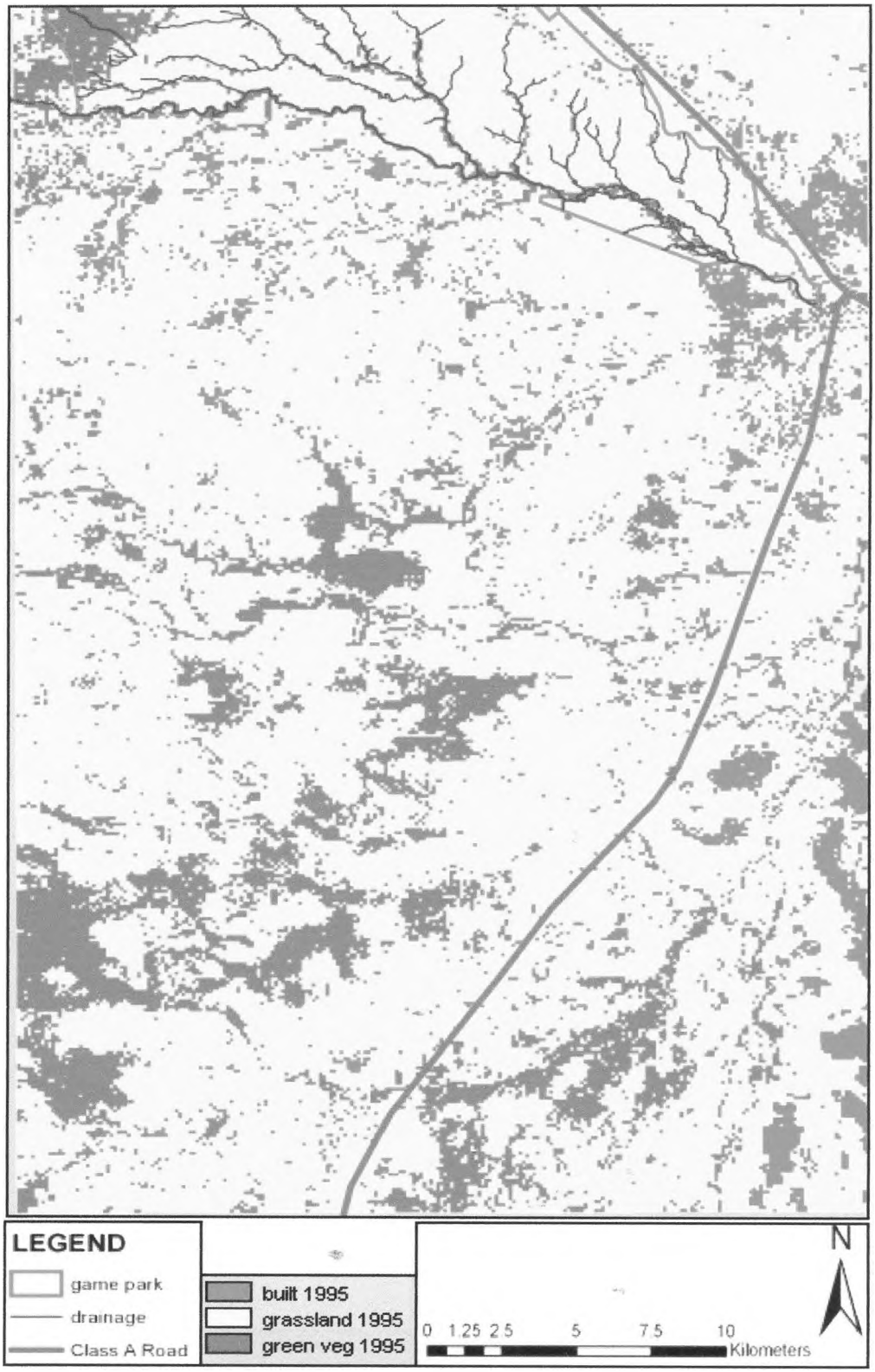
be attributed to the reduced level of pastoralism as a major activity by the dominant immigrants and the increased fencing of the shrinking grazing areas. In addition, the noise by wild animals at night is a new emergence. This can be attributed to fenced fragments of the corridor resulting in restricted movement of wildlife even at night. This represents a new front of conflict with unique management requirements.

In managing the above wildlife problems, fencing is the most widely used approach with nearly half of those interviewed applying it. Other approaches include employing security guards, using fire at night, seeking help from KWS, and killing the problem animals while others take no action at all (see Figure 9 above). With the smaller parcels of land after subdivisions, fencing remains the most economically viable management option. In the process, this development heavily deters free movement of wildlife even in the initially unfenced large parcels of land within the corridor.

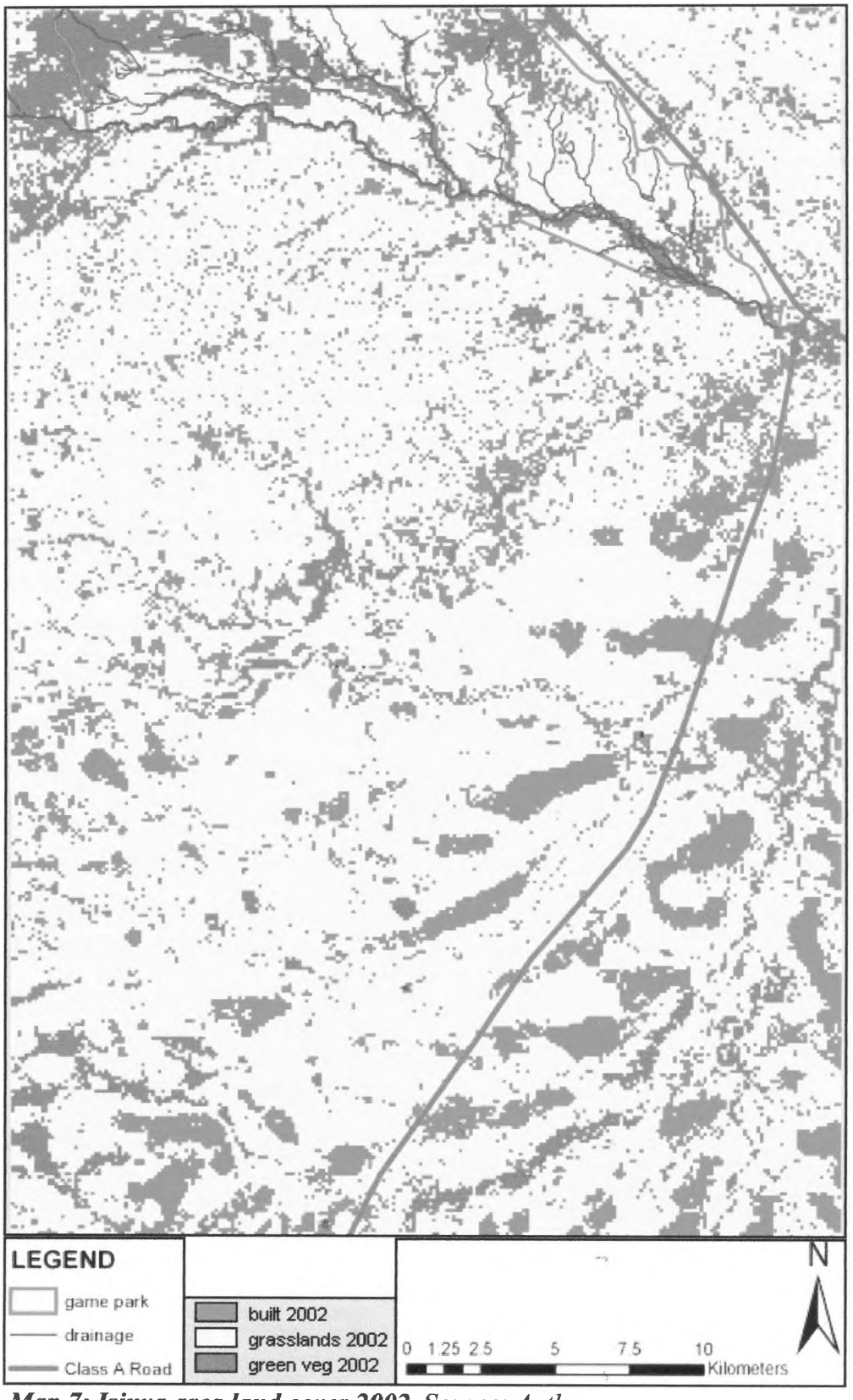
4.3 Land use changes

4.3.1 Spatial land use changes over time

This study set to show spatial trends of land use changes in Isinya between 1979 and 2009 with intervals of ten years each corresponding to human population census counts. However, the Landsat TM images obtained for this analysis were for 1976, 1987, 1995 and 2002. From these, only images of 1995 and 2002 were finally found suitable for the study as the rest had cloud cover over the area of interest. Land cover analysis using ERDAS Imagine 9.3 to detect different cover classes gave the following results.



Map 6: Isinya area land cover 1995. *Source: Author*



Map 7: Isinya area land cover 2002. *Source: Author*

Artificial land cover mapped as built has significantly increased between 1995 and 2002 as shown in maps 7 and 8. The greatest land covers change occurred in the Northern part of Isinya division and along the Namanga road. From the field visits, the dense new built up land cover in the North can be attributed mainly to new settlements and quarries. Developments are spreading from the nearby Kitengela into the rural interior of Isinya. In the South, flower farms account for majority of new areas. Ribbon development along the (international) road from Nairobi to Namanga border is also evident from the map. These developments have greatly fragmented and reduced the migration corridor size hence affecting the population of the migratory wildlife.

4.3.2 Land use by households

Land use and land cover have greatly changed from natural open grassland with wildlife and livestock grazing to residential and crop farmland. Up to 77.5 % of the households living in Isinya division (outside the town centres) own their own parcels of land with dominant individual parcel sizes ranging between 2 to 5 acres (35%) closely followed by sizes greater than 10 acres (33%) as in Figure 10 below. On these parcels, other than residential, land use activities carried out alongside include crop farming, cattle rearing, poultry keeping, leasing land to mining companies for quarrying and development of rental houses. Of these land uses, majority of the respondents practice rain-fed crop farming, mainly growing maize and beans.

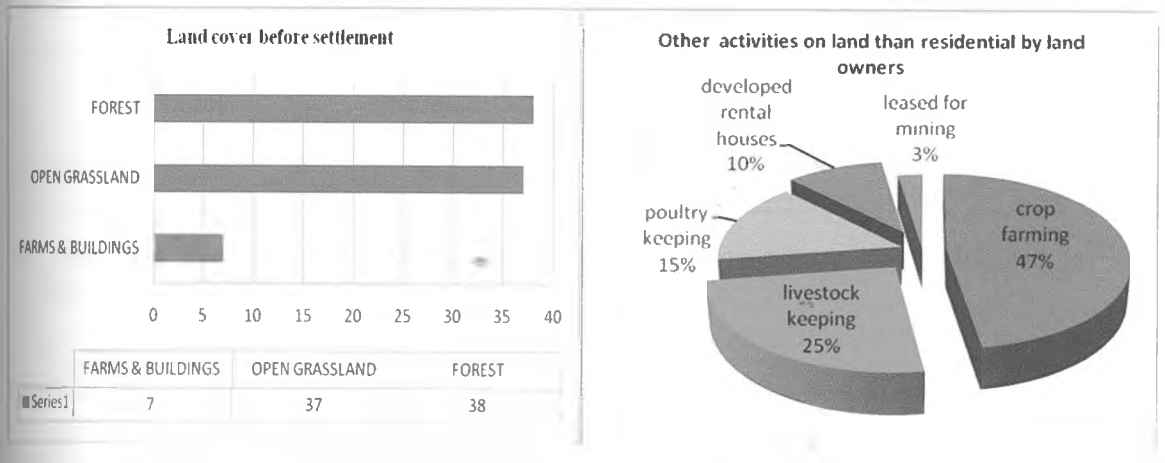


Figure 10: Land cover before settlement and current land uses by households
Source: Field survey,2008.

The dominance of individually owned parcels is an outcome of subdivisions and the dominant land use carried out alongside residential purpose corresponds to the high proportion of immigrants with their new economic/land use activities in the area. The proportion of households keeping livestock can be attributed to the indigenous Maasai community who still hold to pastoralism and have not greatly subdivided their land parcels either, forming the majority with land sizes in excess of 10 acres. One of the respondents, for instance, had 165 acres of land where he only has his homestead and grazes his herds of cattle.

Responding to what attracted them to settle in the area, majority of immigrant respondents (see Figure 11) cited the cheap cost of land (relative to other parts near the city) in the area as their major attraction. Other attractions were the uncongested nature and natural environment while some cited a proposed development of new Kitengela town as why they have bought land in the area. The existence of this last reason was however denied by the Physical Planning Officers in the area.

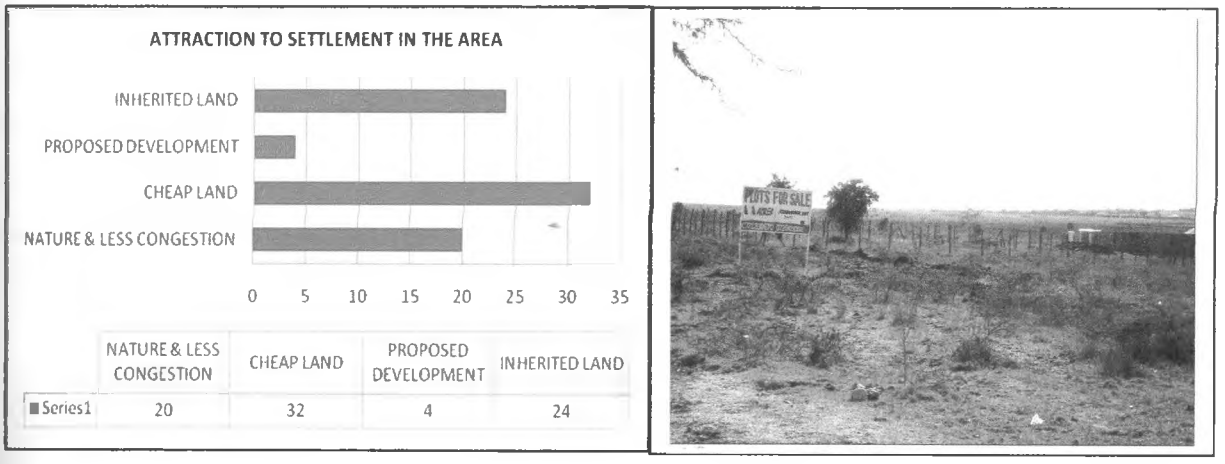


Figure 11: Attraction to settlements in the area and an advertisement of plots for sale
Source: Field survey, 2008.

As high as 65% of the respondents have subdivided their land showing that land subdivision has been enormous in the area. It is also notable that majority (30%) of those who have ever subdivided their land were not restricted to any particular size. This is in

line with the admission of the area Physical Planning Officers that there has never been

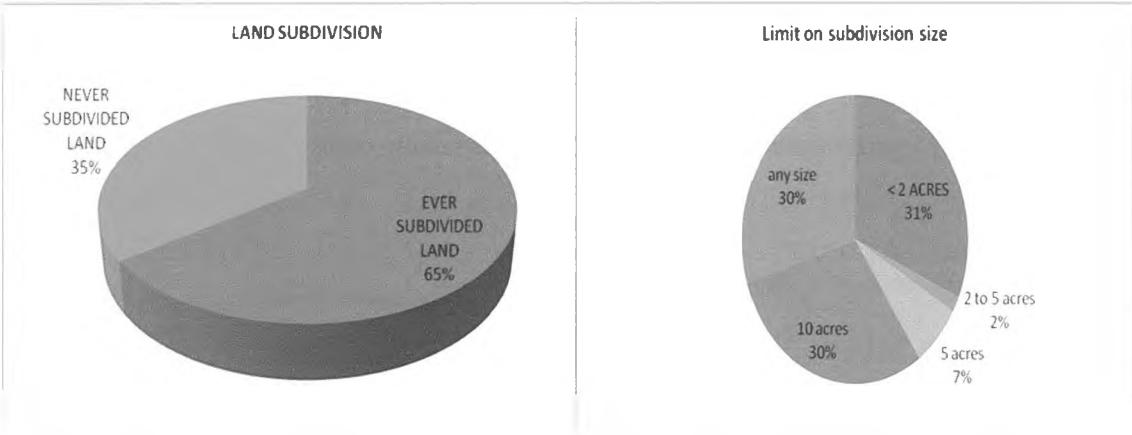


Figure 12: Land subdivision limitation in Isinya. *Source: Field survey,2008.*

any development plan for the area neither has there been any limit to subdivisions.

With no development plan to guide developers in the area, subdivisions and other developments have been unplanned. This has exposed the corridor to high fragmentation and the incompatible land uses undertaken in the area. Land use and even land cover change can further be inferred from what has been replaced by the current human settlement and other activities. Most respondents replaced forests and open grassland (47.5% and 46.3% respectively) and also fenced their parcels (as in Figures 13 and 14) implying great reduction in the area available both for wildlife and livestock hence the corridor area. Only 8% of the respondents had not fenced their land while majority did so in the 1990s.

Figure 13: Newly subdivided plots under construction (Left) and fencing in progress (Right). *Source: Field survey,2008.*

The leading reason for fencing is the protection of both people and their properties against wildlife (Figure 14). This finding is similar to earlier studies in other parts of the greater Kitengela conservation area (Oimbo, 2002). However, boundary demarcation has also emerged as a major reason for fencing. This can be explained by the high subdivision of land into relatively smaller sizes necessitating precise boundary demarcation.

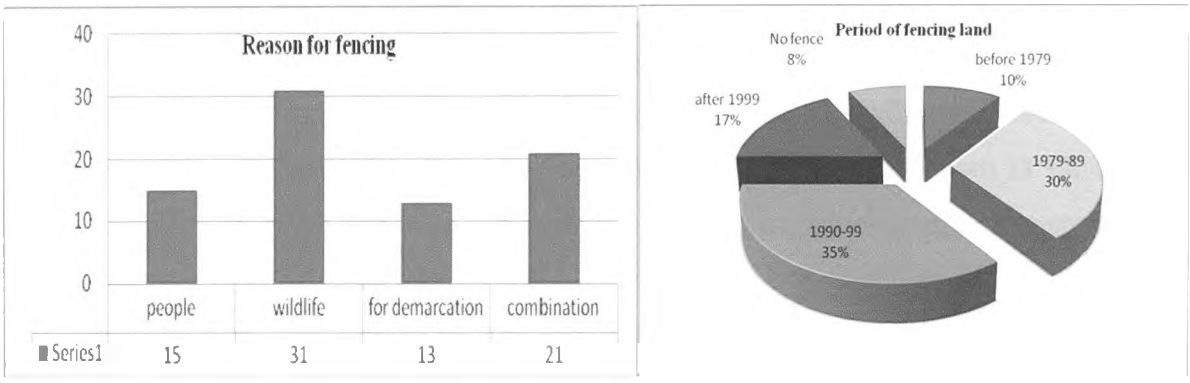


Figure 14: Reason for and period of fencing. *Source: Field survey, 2008.*

4.3.3 Human settlement support infrastracture in Isinya

Alongside the expansion of urban settlements should be the expansion of the necessary support infrastructure like roads, water and sewerage and solid waste management system. The new urban settlements in Isinya division still lack these. According to most of the respondents' rating, very few new roads have been opened up in the area while pit latrines, open dumping and burning are the dominant waste management methods (Figure 15) being used.

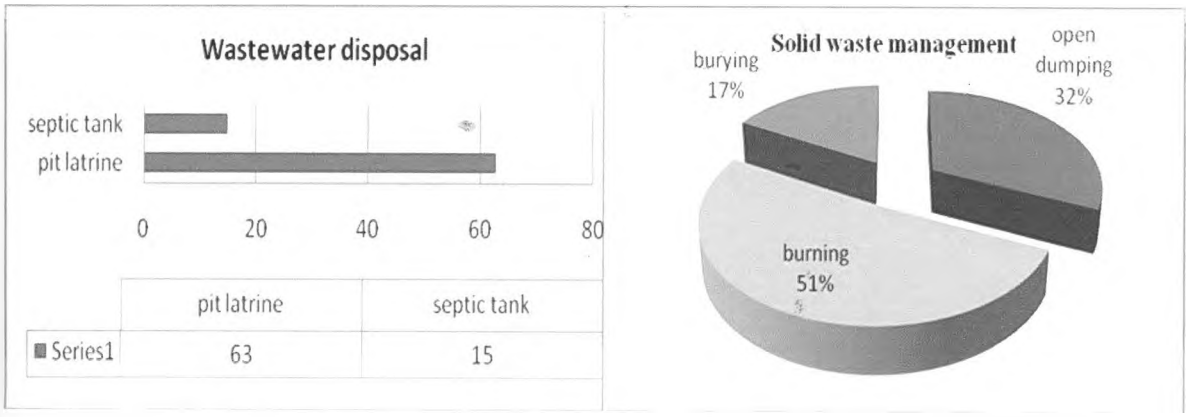


Figure 15:Means of waste disposal in sub urban Isinya. *Source: Field survey, 2008.*

Access to most new settlements and even quarries is mostly through hapharzardly opened "roads" (Figure 16) posing dangers of increased environmental degradation. The spread of unplanned transport infrastructure in Isinya has manifold impacts on the enviroment. From observation, it directly takes up land, fragments natural areas, destroy grass cover, and spreads noise, dust and other forms of pollution, especially by lorries moving into and from the quarries near the national park. Enhanced soil erosion, for instance, was conspicous in areas with the abandoned roads.

Continued managemnt of wastes in the current approach will also create more environmental problems as already experienced in certain areas as shown in Figure 16 below. Apart from crops grown in farms, people are also introducing alien tree species in Isinya, especially eucalyptus and grivellia. These have the potential to negatively affect the vegetation community in the area as they propagate both naturally and artificially. All these pose dangers to both people and animals including wildlife.

Figur 16:Access road and open disposal of plastic wastes in the area

Source: Field survey,2008.

Even though crop farming is the current leading household land use alongside residential homesteads and among the enterprises in the near future most of the respondents (49%) intend to develop rental houses(Figure 17) as the urban population and demand for the same increase.

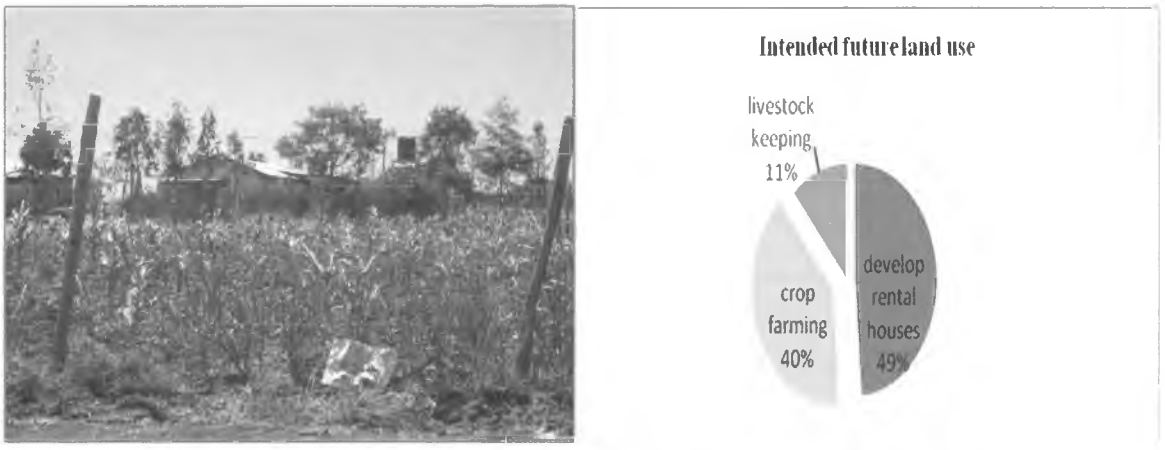


Figure 17: A farm behind a homestead with exotic tree species and intended future land use by households. *Source: Field survey,2008.*

This has serious implications for the future of the already fragmented wildlife corridor as its total blockage by more subdivsions and urban settlements of high density is eminent. With increased human settlements, the problem of wildlife noise at night is also likely to increase.

4.3.4 Land use by enterprises

Apart from the household level, interaction between human and wildlife in the corridor area also takes place at the enterprises level. Enterprises can be seen as investments by either individuals or groups/companies. In isinya, a high proportion of the enterprises sampled (34.8%) were engaged in large-scale irrigated flower farming. Other major enterprises were mining, cultivating other crops, ranching and poultry keeping as shown in figures 18 to 20 .

Table 4: Frequency table for nature of enterprises in Isinya division

Nature of enterprise business	Frequency	Percentage
Floriculture	8	34.8
Other crops	5	21.7
Mining	5	21.7
Ranching	3	13.0
Others	2	8.7
Total	23	100

Source: Field survey, 2008.

Figure 18: Intensive ranching in Isinya. *Source: Field survey, 2008*

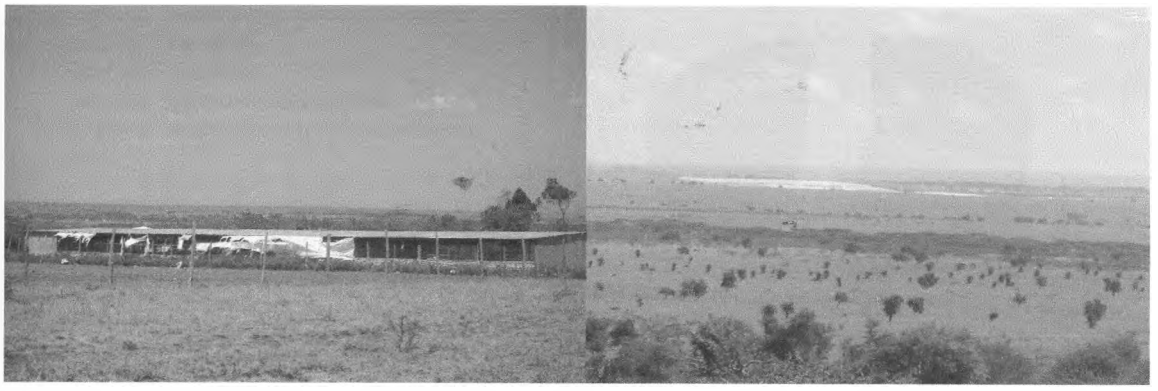


Figure 19: Small scale poultry farm and flower farm in the background (Right)
Source: Field survey, 2008.

Most mining enterprises are located closer to the Nairobi Natioal Park and are mainly dealing in extraction of building stones. Horticultural farms are spread throughout Isinya division. Mostly attracted by cheap land and its relatively low price in the area (Figure 21), these enterprises have also contributed significantly to land use change and fragmentation in the area and is affecting its use by wildlife as a corridor. Each enterprise involved in farming and mining require a large area.

Figure 20: Quarrying in Kitengela location, Isinya, near the national park
Source: Field survey, 2008.

According to the sampled enterprises, almost half of them (48.0%) are on more than 20 acres of land each (see Figure 21). Among the enterprises, most quarries visited were not fenced as opposed to other enterprises. This may be attributed to the low level of danger or none at all posed to their activities by wildlife. However, on the other hand they take up large areas of land that would have been used by wildlife for grazing and migration apart from exposing the wildlife to injuries and even death in the excavated mines, a condition that may be worsened if they are filled with water.

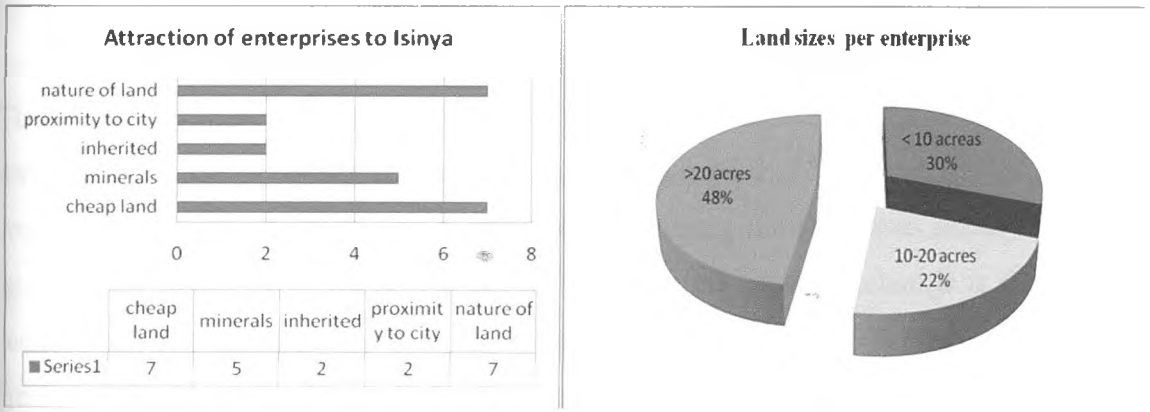


Figure 21: Attraction of enterprises and their land ownership by size. *Source: Field survey, 2008.*

The agricultural enterprises face great challenges from wildlife. Farm destruction, for insatnce, is the leading reason as to why most of the sampled enterprises were fenced (54%). According to a respondent from (Faraja) one of the farms:

"*Giraffes often break the fence to look for water inside the farm. Once inside they cause damage to plastic water pipes and tanks and even our crops*"

Wildlife also face challenges from the agricultural enterprises. Apart from fragmentation of the corridor, these enterprises use agrochemicals that have the potential of polluting surface water sources. Isinya division is within the catcment area of the rivers in the wildlife corridor as well as Mbagathi river which forms the southern boundary of the park and is greatly used by wildlfe even from the park. With most enterprises involved in irrigation-based farming, there is also a new front of human-human conflicts in Isinya over the land based ground water resources. According to one of the respondents:

"*the flower firms have the financial ability and are sinking deeper boreholes, than those sunk by the local communities, to irrigate their farms. This is concerning us as some of our boreholes have gone dry while theirs have water*"

The findings on the threats of wildlife in Isinya from agricultural pollution, mainly from the horticultural chemicals, are similar to those experienced in Lake Nakuru National Park due to farms in the catchment areas of Lake Nakuru (Mhlanga and Mares, 1976). These findings however, differ in some aspects when compared to those found in other areas. The population dynamics driving land use change in Isinya is different from that found in Tsavo conservation area where farming in marginal areas was mainly attributed to increased sizes of the native population. In Isinya the land use change is due to large increase in immigrant population and changed land tenure policy from communal to freehold. This is characteristic of urbanization influence in the area as opposed to the purely rural characteristics experienced in the Tsavo area.

A recent study by ILRI reveals that similar findings in Maasai Mara National Reserve where land use change has taken place between 1989 and 2003, with mostly wheat farms and lodges replacing pastoralism. In the process wildlife numbers have been declining due to fragmentation of the migration corridors linking the reserve to wildlife dispersal areas surrounding it. ILRI looks to pastoralists as the solution to this problem. Pastoralists have co-existed with the wildlife for decades and their main economic activity can support retention of land necessary for the wildlife corridor as stated below:

"We know from thousands of years of history that pastoral livestock-keeping can co-exist with East Africa's renowned concentrations of big mammals. And we look to these pastoralists for solutions to the current conflicts," said Carlos Seré, Director General of ILRI. "With their help and the significant tourism revenue that the Mara wildlife generates, it is possible to invest in evidence-based approaches that can protect this region's iconic pastoral peoples, as well as its wildlife populations." (Adopted from the Sunday Standard, April 27, 2009)

The establishments of the above enterprises have a further impact on urbanization in Isinya. The flower farms and quarries are likely to be attracting more people into the area looking for jobs. These people are likely to reside in the small urban centres in the division like Isinya and Kitengela while some may end up buying the relatively cheap land from the locals for settlement or other activities. At the same time, the locals attracted to work in the enterprises may also shift from pastoralism and easily sell their land. In this way the enterprises can also promote further land subdivision and fencing.

Comparing these findings to the experience of areas outside Kenya, the newly settled households due to urban sprawl are also fragmenting wildlife corridors in American states. However, there is a difference in the interaction between wildlife and people. Whereas in America such households tend to attract wildlife into their suburban neighbourhoods to improve the quality of their life (Adams, 2006), in Isinya people are doing the opposite by fencing out the wildlife. This can be explained by the differences in

the value attached to wildlife in these different areas with the latter having negative perception of wildlife. Similarly, it can also be explained by the land uses practised in Isinya that may be the leading source of conflict with wildlife as opposed to the American case where it is mainly residential with only flower gardens. Another difference in impacts of urban sprawl on wildlife corridor is with respect to the type of pollution. For Isinya pollution threats are from agrochemicals whereas threats from air pollution and introduction of new plants and animal species to the ecosystems are the dominant in other countries (Kerr 2007; and Reynolds, 2008).

4.4 Institutions

The key institutions involved in Nairobi National Park are the a) ministry of lands' department of physical planning, b) KWS, c) African Conservation Center, d) East African Wildlife Society, e) FoNNAP and d) kitengela land owners association. The following are findings from the sampled institutions.

4.4.1 Department of Physical Planning: Ministry of Lands, Kajiado district and Olkejuado County Council

Under the Physical Planning Act of 1996 and the Local Government Act of Kenya, the physical planning departments in the ministry of land and of local authorities are charged with the responsibility of land use planning and control of development According to these departments in Kajiado district and Olkejuado County Council, Isinya area is not a wildlife corridor, but land that is privately owned under freehold tenure. This has complicated the management of land uses in the area especially as far as the integration of wildlife conservation is concerned.

Similarly, the area has never had a land use or physical development plan further complicating the situation as there are no any development guidance criteria in place to aid decision-making on acceptable land uses in the area. According to them, KWS did not take the initiative to acquire the portion of land that is claimed to be used by wild animals for dispersal and migration, which it should have done long time ago. The continued use

of the area by wildlife has been dependent on the willingness of the local land owners to allow wildlife in their land despite the numerous problems they have been encountering in this regard.

The major threat to the "wildlife corridor" is the enormous uncontrolled land subdivisions that have been going on in the areas, especially in the neighbourhood of Kitengela town. Associated with these is the encroachment of incompatible land uses, especially crop farming in the newly settled areas, increased quarrying of building stones which is also carried out in the area to support the urban encroachment through provision of building materials. Other activities include poultry farming and floriculture. While the indigenous are rapidly selling their land parcels to immigrants, they are losing their economic backbone, pastoralism, as there is evidence that some people who sold their land are worse off a few years later.

Despite these challenges, the departments initiated a participatory land use planning in 2004 with other stakeholders including the local communities and KWS. In their proposed plan, land subdivision is to be limited to 60 acres while acceptable land uses will be development of rural homes of not less than 5 acres and ecotourism activities. The adoption of this proposal has, however, hit a major snag due to unwillingness of the locals to accept it especially because of their resentment with the KWS. It is this proposal that is currently used to provide guidelines for any physical development in the area and which has enabled them to slow down the subdivision rates.

4.4.2 Kenya Wildlife Service -KWS

KWS is a state corporation mandated to conserve and manage the country's wildlife resources under the Wildlife (conservation and management) Act of 1989. It is the custodian of protected areas used for conservation as well as of all wildlife including those outside the protected areas.

According to KWS, there have been changes in land use in Isinya attributed to land tenure policy shift from communal to private ownership which is also the cause of human-wildlife conflicts in the area. The current conflicts were non-existent when the Maasai were pastoralists. The change in land tenure system has attracted land owners from other communities who have settled in the area. The number of group ranches in the area, for instance, increased from 7 in 1984 to 12 in 1990 and further to 22 by 1996. These increases went hand in hand with accelerated land sales and speculation influenced by the area's proximity to the city of Nairobi. Subdivisions, urban sprawl, fencing and cultivation in the park's vicinity have greatly reduced the available land for wildlife. Human-wildlife conflicts arise when the migrating species fail to move back into the park from their dispersal areas. They destroy fences and crops in a bid to secure their historical routes to move back into the park. Livestock are killed by predators and other wild animals spread diseases to the livestock and even cause deaths.

In Isinya, KWS has different projects towards sustainable conservation. These projects include awareness creation on conservation through community-based educational services, patrolling the area to control problematic wildlife by transferring them to the park (a role 18.8% of households admitted to calling for their help). To control problematic lions, for instance, KWS through the Community Wildlife Services department which was created to ensure protection of wildlife outside protected areas started a project of Lion proof *boma*. This project aims at preventing lions' predation on livestock. KWS has also included the conservation lease programme initiated by FoNNaP in its Nairobi National Park management plan (2005-2010) as a viable community conservation tool on private lands.

If the current situation is not addressed, the park is on its way of becoming an amalgam of the city centre which has rapidly expanded in the last few years. However, under private ownership, plans to have land for use by wildlife can only be negotiated and not imposed. The current attempts of management by KWS are hampered by conservation illiteracy among the locals, financial limitations, and low personnel capacity among other

challenges. Omondi, P., a researcher with KWS in an interview with KTN on April 27, 2009 said the problem in Isinya has been caused by lack of a land policy and lack of planning and population growth has just exacerbated it. Without any immediate action, the decline in animal numbers due to patching of their corridor area will see us lose the park. According to Omondi, one of the solutions is for the government to buy the land as is being practiced in Tanzania.

4.4.3 African Conservation Centre-ACC

ACC is an initiative with the aim of bringing together people and skills with the capacity to conserve wildlife. It has established wildlife associations, land trusts and wildlife sanctuaries in different conservation areas across the country. According to ACC land use has completely changed from pastoral and wildlife use to agriculture (flower farms, maize and eucalyptus plantations), urban residential areas, urban centers, commercial quarrying and airstrips. These changes have been occasioned by the transformation of land ownership from communal/group ranches before 1980s to individually owned parcels. This led to subdivisions and fencing that reduced grazing areas making pastoralism-the preferred land use-expensive. Individual ownership facilitated land sales. The population increase in Nairobi has also raised the monetary value of land in the area with prices being particularly high (about Kshs. 800,000 per acre near Kitengela town and areas adjoining the Nairobi-Namanga road compared to areas far away from the urban canters and the road (about Kshs. 400,000 per acre). The impacts of land use changes include reduced grazing area, increased pollution to rivers and general environment emanating from industries and flower farms.

Cultural and land use practices have changed. There is confusion on which land use system can be applied-livestock/wildlife or urbanization and conflicts are many- e.g. between *Jamii Bora* housing project and conservationists that initially led to stoppage of the project by NEMA. The project which involves construction of a new town, Kaputiei, in Kisaju location, has however been granted license after *jamii bora* appealed to the high court following NEMA's rejection.

The selling of land to new immigrants has resulted in resource utilization conflicts-water shortages and pollution. Selling land has been expressed by ACC as a downward spiral, the "Maasai sold their wealth to buy poverty". There is evidence that some people who sold land are worse off a couple of years later. Parcels of land with which the local people are left are too small and those who sell land have few investment opportunities to make use of the money. The Kajiado district physical planning department also expressed similar fears.

According to ACC relevant institutions and other law enforcement agents are reluctant to enforce minimal land parcel sizes in the area and have created corruption and unplanned settlements. However, other findings in this study reveal that no plan and therefore such minimal parcel sizes exist. Lack of enforcement therefore cannot be blamed as opposed to lack of a plan. ACC recommends formulation of a land policy and plan for the area as a solution to the problems. Similarly, it recommends establishment of land trusts by the Maasai, which should establish the criteria and basis for land use, so that the common community interests are taken care of.

4.4.4 East African Wildlife Society-EAWLS

The EAWLS is a membership-based conservation. Founded in 1961, the organization's work involves provision of conservation education and research, involving communities in conservation initiatives and influencing conservation policy reform through advocacy and publicity. According to EAWLS, new land use forms and practices incompatible with wildlife such as land subdivision for sale, fencing, quarrying, intensive livestock production under paddocking, and flower farms and other crops grown under irrigation have led to increased land fragmentation thereby reducing the land available for wildlife migration and dispersal in Isinya.

These new land uses have been introduced by immigrants who have also changed the lifestyle of the indigenous Maasai especially by the introduction of cross breed cattle.

Due to the high costs of maintaining these new breeds, the Maasai are also increasingly fencing their parcels to keep wildlife at bay and to avoid competition for pasture and reduce spread of diseases.

4.4.5 Friends of Nairobi National Park-FoNNaP

FoNNaP is a non-profit making society founded in1995 whose objectives include , among others, promotion of the retention of the wild and indigenous nature and biodiversity of Nairobi National Park, including its ecosystem; encouraging and building partnerships with rural communities bordering the park and its migration routes; and influencing decisions on activities that might have detrimental effects on the park.

FoNNaP pays pastoral families $4 (approximately Kshs. 320) per acre per annum not to fence, develop or sell their acreage. Strictly voluntary, the program currently leases 8,500 acres from 117 families; another 118 community members, with more than 17,000 acres, are waiting to join. The program has a master plan which aims to lease and conserve 60,000 acres—enough to allow the seasonal migration of wildlife to and from Nairobi National Park. Official adoption of the Master Plan would greatly facilitate local and international fund raising efforts to enable the lease programme to be further expanded, extending the benefits from this innovative approach to wildlife conservation to more landowners. The GEF of the World Bank and USAID have expressed interest in funding this innovative programme if the Master Plan is adopted. Currently the society is experiencing problems of inadequate finance to expand its operations. Another problem facing this initiative is the increasing land subdivision. Immigrants, for example, have as small land parcels as ¼ acre which do not qualify for the programme support and are also not economically beneficial due to low returns at the current rates. According to FoNNaP if this program fails and more fences and buildings go up, the annual migration of wildebeest and other animals will be halted, provoking the crash of the Athi-Kaputiei ecosystem.

4.4.6 Kitengela Land Owners' Association

The association discourages selling and fencing of land along the migratory routes. The current chairman, James Turer, said,

"This fencing will kill all the wild animals. Everyday people buy land here and fence them pushing wildlife to nowhere. Migration becomes difficult, even calving is a problem. We will end up losing the park. Wildebeest and other animals that use the land in Isinya are declining. As wildlife disappear, so would the Maasai herd".

Summary

From these institutional stakeholders in conservation of wildlife in the area, it is emerging that land subdivision due to the expanding urban influence with increased land values to the locals are major forces behind land use change in the area. Individual land ownership has encouraged sales and the introduction of alien land uses like irrigation farming, floriculture and intensive livestock production all which are supported by the proximity to urban centers. Quarrying, however, can only be attributed to the availability of building stones in the area with urban growth only providing a readily accessible market for the products used in the construction industry. Land use changes appear to have occurred in stages, the initial one being a shift in land policy from communal to private ownership. This was followed by sub divisions, sales-mainly to immigrants, and eventually the new land uses/developments. It is these latter stages that are attributable to urbanization. Ready land market is provided by the urban population, both in Nairobi and Kitengela. Part of this expanding urban population is acquiring land in Isinya for settlement leading to urban sprawl into the area. Alongside settlement, they also carry out other developments like crop agriculture and poultry farming. According to these institutions; change in land tenure policy from communal to private ownership is seen as the trigger of all these other forces behind the land use changes in Isinya.

Lack of land use planning as identified by the physical planning departments at the Olkejuado County Council and Kajiado District Physical Planning Office is also a major contribution to the land use changes and hence challenges to sustainable conservation. It has emerged that the wildlife corridors in question were never identified and set aside to serve their vital role in conservation. Lack of land use plan means lack of any

development guide for the area hence the current conflict-dominated interactions between people and wildlife and the fragmented corridor.

According to the approach being undertaken by FoNNaP, a management option requiring people to relocate on compensation from their current settlements is likely to be a difficult option in the future given the levels of land subdivision. This is due to the likely resistance it will encounter. According to the respondents, only a quarter of them are willing to relocate under such circumstances (see Figure 22). It also relies on good will to finance it while the land owners will also find it difficult to withstand pressure to sell their land at the increasingly high prices on offer making its long term viability risky. Despite the current conservation lease programme by FoNNAP target of leasing 60,000 acres for migration of animals, there is no indication as to the appropriate corridor width.

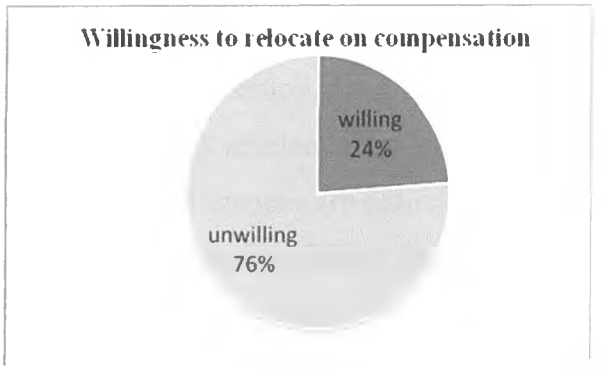


Figure 22: Willingness to relocate from the corridor. *Source: field survey. 2008.*

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In conclusion, it is necessary to pose the question as to whether Nairobi National Park is sustainable in the face of rapid urban population growth and land use changes in its migratory corridors. In Isinya there is a highly complex and dynamic landscape, where both extensive and intensive livestock rearing, wildlife conservation, small-scale rain-fed agriculture, large-scale irrigated horticulture, quarrying and residential and commercial development compete as alternative land uses. The land use changes are reducing the area available for migratory wildlife and traditional livestock grazing, hence the number of wildlife it can support. Given the sustainability criteria defined earlier, the park is likely to experience wildlife population problems, especially of the migratory species like wildebeests and zebras. This is due to the eventual but unintended enclosure of all its wildlife within the park, with the new land uses/developments in the corridors. An enclosed small-sized park is likely to result in an ecological crisis. This renders the conservation of Nairobi National Park unsustainable since its component parts do not meet the sustainability criteria.

Land use changes and fragmentation of the wildlife corridor contribute to other problems to the local people, especially the native Maasai community. With their grazing land leased to quarrying companies or sold to immigrants for farming, and residential development among other uses, the Maasai in Isinya have lost and continue to lose their economic base of pastoralism, a problem further exacerbated by conflicts over resources like water between them and the flower farms. Some of them are also adopting crop cultivation in the area which is unsuitable for rain-fed agriculture.

Delays in developing an appropriate land use plan for Isinya will see the number of landowners in the area increase. With many owners and numerous fenced plots supporting various land uses the wildlife corridor will be completely blocked, and management initiatives such as the current conservation lease and others that may be

adopted later on will encounter enormous challenges for having to deal with a large number of land owners first.

5.2 Recommendations

This study recommends the following planning alternatives towards managing the land use changes and their threats to the sustainability of Nairobi National Park. They are categorized into immediate and long term options.

Immediate

- Stopping of land subdivision in the remaining areas is necessary. There is an urgent need to zone Isinya division appropriately limiting land sizes and land uses compatible to wildlife conservation. Examples of such compatible land uses are pastoralism, eco-tourism, conservation agriculture, and River Athi watershed management for water quality and soil conservation. The County Council of Olkejuado is appropriately placed to enforce this option in collaboration with the local communities, KWS, ministries of agriculture, livestock development, and tourism among other stakeholders. For instance, by using zoning as a tool to retain the corridor land.
- Encourage the locals to lease land to KWS while still being allowed to use it for grazing their livestock as piloted by FoNNaP. The leased parcels should not be fenced while an effective and efficient conflict management mechanism is put in place.
- Consolidation of subdivided parcels by removal of the fences

Long-term

- A policy should be formulated requiring purchase of the land comprising the Isinya corridor by the KWS or requiring annual compensation of land owners in the corridor for use of their land by wild animals while they avoid using the land for incompatible activities. The government can alternatively acquires the migratory corridor land compulsorily and have it under the custodian of KWS (see appendix IV).

- Promote compact development of Kitengela town through planned, relatively high density development with well defined urban growth boundaries to ease encroachment pressure on the migration corridor.
- Development of Nairobi Metropolitan Open Space System (NMOSS) as an integral component of the city's spatial plan seeking to conserve the region's natural resources and better coordination of open space systems of local governments within the metropolitan region. The system should be an interconnected network of open spaces that also support the interaction between social, economic, and ecological activities while enhancing and sustaining both human settlements and ecological processes.

Alongside the above, enforcement of regulations related to developments like sinking of boreholes should be strengthened to reduce inequitable access to underground water and hence conflicts over it. Working with the private sector to ensure that open space networks are considered during development is also important. Finally, using conservation easements, land can be protected from incompatible developments without the need for public purchase.

5.3 Application of findings

The findings of this study have the potential to help in guiding land use planning; both at the local level of Olkejuado County Council and at the regional level like the Nairobi metropolitan area. It can also provide an early warning of possible urban and peri urban development conflicts with conservation land use at such different levels. Trends in land use changes in Isinya can be used to target priority areas for the expansion of the current conservation leasing programme and to provide information through raised awareness about the threats of human activities in the area to wildlife conservation in Nairobi National Park. The findings can also be used to attract funding for conservation initiatives in the area from donors to KWS and its other partners like FoNNaP.

Another area of potential application is identifying when and where projected urbanization and or population growth together with concomitant land use change will adversely impact conservation of natural environments. Predicting specific types of conflicts over land-based resources between projected urbanization/population growth and natural environment e.g. pastoralism vs. intensive agriculture, urban settlements vs. wildlife in proximity to conservation areas or corridors is vital in aiding decision making.

Lastly, it also permits planners to consider cumulative conflicts over several areas, identifying wildlife habitats/corridors, which would otherwise be overlooked. This is very important in Kenya where over 80% of wildlife is still outside the protected areas (Ogendi, 2002; Otuoma, 2004) while human population and settlements growth is ever increasing. Olkejuado Country Council, for instance, can play a major role in retaining the wildlife corridor and hence conservation of Nairobi national park. Because development decisions are local, this information can be used by the council to explore its potential role in designing vital contributions towards the preservation of the area's natural heritage and sustainable conservation of Nairobi National Park. The council can consider the current patterns of land cover change when making its decisions.

5.4 Area for further research

From this study the following areas have been identified as requiring further studies.

- Determination of appropriate corridor size should be done for the migratory wildlife of Nairobi National Park for effective and optimal land use and allocation planning. This will ease planning and avoid unnecessary allocation and reservation of either too small or too large land sizes given the high demand and competing uses in the urban area.
- Sustainability of the land lease programme in retaining the wildlife migratory corridor.
- Impacts of large scale irrigation farming on the environment in Isinya.

REFERENCES

Adams, C. E., Lindsey, K. J., and Ash, S. J. (2006). *Urban wildlife management*. U.S.A, Taylor and Francis

Bush, M.B. (2000). *Ecology of a changing planet*. New Jersey, Prentice Hall

Campbell, S. (1999). "Planning: Green Cities, Governing cities, just cities? Urban Planning and the construction of sustainable development". In *The Earth scan reader in sustainable Cities*, pp. 251 – 273

Catanese, A.J. and Synder, J.C. (1988). *Urban Planning*, York, McGraw–Hill New Jersey

Chen, H., Beisi, J., and Lau, S. Y. (2008). "Sustainable urban form from Chinese compact cities: challenges of a rapid urbanized economy", In, *Habitat international,* Vol. 32, No. 1.pp 28-40

Choguill, C. L. (2008). "Developing sustainable neighbourhoods", In *Habitat international*, Vol. 32, No. 1, pp 41-48

Cloke, P. J. and Park, C.C. (1985). *Rural Resource Management*. London, CroomHelm

Central Bureau of Statistics. (2006). *Statistical Abstract*, Nairobi, Government Printer

Conner, N. (2005). "Some benefits of protected areas for urban communities: a view from Sydney, Australia", In T. Trzyna (Edt). *The Urban Imperative*, California, California Institute of Public Affairs

Cullen, P. (2003). "Perspectives of the future of urban ecosystem education", In A. Berkowitz, C. Nilon, and K. Hollweg (Edts.). *Understanding Urban Ecosystems*, New York, Springer, pp 465-475

Dahiye, Y. M. (2001). *Community based wildlife conservation and research project in southern Garissa and Ijara districts*. National museums of Kenya. Unpublished

Davidson, J and Wibberley, G. (1977). *Planning and the Rural Environment*, London, Pergamon Press

Debra, R., Boon, R., Croucamp, P and Myles, M. (2005). "Resource economics as a tool for open space planning in Durban, South Africa", In T. Trzyna, (Edt). *The Urban Imperative*, California, California Institute of Public Affairs

Furr, M. R. (2008). Testing the statistical significance of a correlation, Wake Forest University
www.wfu.edu/furr

Government of Kenya. (1978). *Human Settlements in Kenya: a Strategy for Urban and Rural Development,* Nairobi, Ministry of Lands and Settlements

Government of Kenya. (1989). *The Wildlife (conservation and management) Act.* Nairobi, Government printer

Government of Kenya. (2002). *Kajiado district development plan 2002-2008,* Nairobi, Government printer

Government of Kenya. (2007). *Vision 2030,* Nairobi, Ministry of Planning and National Development

Karisa, C. D. (2002*). A conservation ethic for sustainable urban communities in Kenya: Southern Nairobi integrated River basing planning and management strategy*, University of Nairobi , Unpublished M.A Thesis

Katzshner, T., Oelofse, G., Wisemsn, K., and Jackson, J. (2005). "The City of Cape Town's Biodiversity Strategy", In T. Trzyna (Edt). *The Urban Imperative*, California, California Institute of Public Affairs

Kerr, J. (2007). *Human population dynamics in protected areas*, Ecuador, The nature conservancy
http://www.parks in peril.org/files/population

Korir, W. (2006). *Nairobi national park: cities ecosystems and biodiversity,* Nairobi, A paper presented at the Africities summit of 18th -24th September, 2006 at KWS headquarters

KWS. (2005). *Strategic plan 2005-2010: preparing for the opportunities ahead*, Nairobi, KWS

KWS. (2007). *Annual report: our heritage, our future*, Nairobi, KWS

Kumar, R. (2005). *Research methodology: a step by step guide for beginners*, London, Sage publication,

Mhlanga, L. and Mares, W. (1976). *Development and the Environment in East Africa*, Nairobi, Institute for Development Studies

Mwamfupe, D. (1998). "Demographic impacts on protected areas in Tanzania and options for actions", In *Parks*, Vol. 8, No.1

Mwangi, S.W. (2000). "Partnerships in urban environmental management: an approach to Solving environmental problems in Nakuru, Kenya", In *Environment and Urbanization*, Vol. 12, No. 2 pp 77 – 92

Muasya, R. M. (1998). *The cause and effects of Tsavo wildfires*, University of Nairobi, Unpublished Msc. Thesis

Mugenda, O. M., and Mugenda, A. G. (2003). *Research Methods: Quantitative and Qualitative Approaches*, Nairobi, Acts Press

Newman, P. (2006). "The environmental impact of cities", In *Environment and Urbanization*, Vol. 18, No. 2. pp 275 – 295

Ngene, S. M. (2002). *Vegetation of Nairobi national park- a report of an ecological monitoring programme*, Nairobi, KWS/USAID

North Carolina Wildlife Resources Commission. (2008). *Statewide conservation strategies*
http://www.ncwildlife.org/pg07_wildlifespeciescons/WAP

Obudho, R. A. (1979). "The Nature of Kenya's urban demography", In *Africa Urban Studies*, Pg 83 – 108

Ogendi, G. (2003). *Wildlife Management in Kenya*, (Unpublished paper)

Oimbo, S. M. (2002). *Management Options For Human –Wildlife Conflicts In Kitengela Game Conservation Area, Kajiado District,* University of Nairobi, (Unpublished M. A Thesis)

Omondi, P. (1984). *The impact on Nairobi National Park of changes in land use in adjacent areas*, University of Nairobi, (Unpublished M.A. Thesis)

Omondi, A. and Ryan, P. (2007). "Recent papyrus swamp habitat loss and conservation implications in western Kenya", In *Wetlands ecology and management, Vol.* 15, No. 32, pp 1-12

Otuoma, J. (2004). *Effects of wildlife-livestock-human interaction on habitat quality in the Meru Conservation Area, Kenya*, Nairobi, ILRI

Pollock, N.C. (1974). *Animals, environment and man in Africa,* England, Saxon House Ltd.

Prins, H., Grootenhius, J., and Dolan, T. (2000). *Wildlife conservation by sustainable use*, London, Springer

Reynolds, J. (2005). "California cities and the protection and restoration of Yosemite national park", In T. Trzyna (Edt). *The Urban Imperative*, California, California Institute of Public Affairs

Saggerson, E. P. (1991). *Geology of Nairobi area*, Nairobi, English press

Satterthwaite, D. (1999). *Sustainable cities,* London, Earth scan

Scott, M. (1963). *Soil of Nairobi-Thika-Yatta-Machakos area*, Kenya, Department of Agriculture

Sekaran, U. (1992). *Research methods for business: a skill building approach*, New York, John Wiley and sons

Tuts, R. (1998)." Localizing Agenda 21 in small cities in Kenya, Morocco and Vietnam", In *Urbanization and Environment*, Vol. 10, No. 2, pp. 175-189

UN-HABITAT. (2003). *Human Settlements Conditions and Trends*, Urban Observatory Unit
http://www.unhabitat.org/habrdd/global.html

USDA Forest Service. (2000). *International programmes report*
http://www.fs.fed.us/global/globe/africa/tanzania.html

Wallnau, L. B., and Gravetter, F. J. (2002). *Essentials of statistics for the behavioural sciences*, Canada, Wordsworth

Wildlife Management Institute. (2005). *Conservation economy,*
www.wildlife managementinstitute.org/index.php/?

APPENDICES

APPENDIX I

ENTERPRENUERS' QUESTIONNAIRE/INTERVIEW SCHEDULE

Questionnaire Number____ Date_____

NOTE: ***The information that you will give here will be used strictly for academic purposes and will be treated with high confidentiality. Your assistance will be greatly appreciated***

SECTION A: RESPONDENT'S DETAILS

1. Business' Name (optional) _____

2. Name of respondent (optional) _____

3. Year starting the business _____

4. How many people work here? _____

5. What is the nature of your tenancy?

☐ Owner occupier ☐ rental

6. How big is the size of your land (in **acres**)? ----------

7. Were you born here? ☐ Yes, in the year 19----- ☐ No

8. If no, when did you move into this area?

☐ Before 1969 ☐ 1969-1979 ☐ 1979-1989

☐ 1989-1999 ☐ after 1999

SECTION B: **LAND ISSUES**

9. What attracted you to settle in this area?

---

10. Did you encounter any problems in acquiring this piece of land from any organization?

☐ Yes (answer question 13 and 14) ☐ No (skip question 13 and 14)

11. What were the major problems?----------

---

12. How did you solve the problems above?

---

13. What occupied this land before you developed it?

---

14. Have you ever sub- divided the land since you acquired it?

☐ Yes (answer question 17) ☐ No (skip question 17)

15. What was the smallest size allowed?

☐ Less than 2 acres ☐ 2acres ☐ 5acres ☐ 10 acres

☐ Other size (state) ----------

16. When did you fence the land? ----------

17. Why did you fence it?

---

18. What other activities do you carry out on this land?

---

19. What can you say about the roads condition when you first came here?

☐ There were none ☐ Very bad

☐ Good ☐ Very good

20. What can you say about the number of roads that have been opened up since you settled here?

☐ Very few ☐ many ☐ very many

21. What do you use for waste water disposal?

☐ Sewer line ☐ septic tank ☐ Pit latrine

22. How do you dispose of you solid wastes?

---

23. What do you intend to use the land for in the future?

SECTION C: HUMAN –WILDLIFE INTERACTIONS AND THE FUTURE

24. What can you say about the number of wild animals in this area:

When you first settled? ☐ Many ☐ few

Nowadays? ☐ Many ☐ few

25. What can you say about the variety of wild animals in this area?

When you first settled ☐ many ☐ few

Nowadays: ☐ Many ☐ few

26. What are the major benefits you experience from the wildlife around here?

---

27. What are the major problems you experience from the wildlife around here?

---

28. How do you respond to/manage these problems?

---

29. How do other organizations help you to solve these problems?

---

30. What long term solution would you suggest to alleviate the problems?

---

31. What do you intend to use your land for in the future?

---

32. How do you plan to manage wildlife problems if they persist in the future?

---

33. Have you ever visited the Nairobi national park?

☐ Yes ☐ No

34. What are your reasons for the answer to question 33 above?

---

33. Would you relocate when compensated to another area to give way for wild animals?

☐ Yes ☐ No

THANK YOU

APPENDIX II

HOUSEHOLD QUESTIONNAIRE

Questionnaire Number____ Date_____

NOTE: ***The information that you will give here will be used strictly for academic purposes and will be treated with high confidentiality. Your assistance will be greatly appreciated***

SECTION A: RESPONDENT'S DETAILS

1. Name (**Optional**) ----------

2. Age

☐ 16-25 ☐ 26-35 ☐ 36-45 ☐ 46-55 ☐ over 55

3. Sex ☐ Male ☐ Female

4. What is your Occupation? ----------

5. Where do you work?

☐ Athi River ☐ Kitengela ☐ Nairobi ☐ Machakos ☐ Others –

6. What is the size of your household? (Number of residents only) ----------

7. What is the nature of your tenancy?

☐ Owner occupier ☐ rental

8. How big is the size of your land (in **acres**)? ----------

9. Were you born here? ☐ Yes, in the year 19----- ☐ No

10. If no, when did you start living in this area?

☐ Before 1969 ☐ 1969-1979 ☐ 1979-1989

☐ 1989-1999 ☐ after 1999

SECTION B: LAND ISSUES

11. What attracted you to settle in this area?

---

12. Did you encounter any problems in acquiring this piece of land from any organization?

☐ Yes (answer question 13 and 14) ☐ No (skip question 13 and 14)

13. What were the major problems?----------

---

14. How did you solve the problems above?

---

15. What occupied this land before you developed it?

---

16. Have you ever sub divided the land since you acquired it?

☐ Yes (answer question 17) ☐ No (skip question 17)

17. What was the smallest size allowed?

☐ Less than 2 acres ☐ 2acres ☐ 5acres ☐ 10 acres

☐ Other size (state) ----------

18. When did you fence the land? ----------

19. Why did you fence it?

20. What other activities do you carry out on this land?

---

21. What can you say about the roads condition when you first came here?

☐ There were none ☐ Very bad

☐ Good ☐ Very good

22. What can you say about the number of roads that have been opened up since you settled here?

☐ Very few ☐ many ☐ very many

22. What do you use for waste water disposal?

☐ Sewer line ☐ septic tank ☐ Pit latrine

23. How do you dispose of your solid wastes?

---

20. What do you intend to use the land for in the future?

SECTION C: **HUMAN –WILDLIFE INTERACTIONS AND THE FUTURE**

21. What can you say about the number of wild animals in this area?

When you first settled: ☐ Many ☐ few

Nowadays: ☐ Many ☐ few

22. What can you say about the variety of wild animals in this area?

When you first settled ☐ many ☐ few

Nowadays: ☐ many ☐ few

23. What are the major benefits you experience from the wildlife around here?

---

24. What are the major problems you experience from the wildlife around here?

---

25. How do you respond to/manage these problems?

---

26. How do other organizations help you to solve these problems?

---

27. What long term solution would you suggest to alleviate the problems?

---

28. What do you intend to use your land for in the future?

---

29. How do you plan to manage wildlife problems if they persist in the future?

---

30. Would you relocate when compensated to another area to give way for wild animals?

☐ Yes ☐ No

THANK YOU

APPENDIX III

INSTITUTIONAL QUESTIONNAIRE/INTERVIEW SCHEDULE

Questionnaire Number____ Date_____

NOTE*: The information that you will give here will be used strictly for academic purposes and will be treated with high confidentiality. Your assistance will be greatly appreciated*

RESPONDENT'S DETAILS

Organization's Name _____

Designation of Respondent _____

Name of respondent (*optional*) _____

Year of joining the organization_____

SECTION A: LAND USE AND CONSERVATION ISSUES (Kitengela migration corridor)

1. What are the roles of your organization in brief?

2. Which land use activities have been/are being carried out in the corridor area?

3. What do you think has encouraged the above land use activities in the area?

4. What urban related problems haves/are being experienced while promoting conservation in the area?

5. What benefits do the area residents gain from the wildlife in the area?

6. Which human-wildlife conflicts are common in the area?

7. What factors are encouraging these conflicts?

8. What impacts do the above land use changes and human-wildlife conflicts have on:
    a) Wildlife habitat?

    b) Wildlife population and movement (*give examples of the seriously affected species*)?

    c) Natural water sources in the area?

9. Do you have a system of monitoring any of the above changes?

10. If allowed to continue, what do these activities imply on the conservation and sustainability of the Nairobi National Park?

11. How are you handling theses conflicts for the benefit of both people and wildlife?

12. With increasing urban growth and development, which land uses can be allowed in the area?

SECTION B: MANAGEMENT

13. Who has been responsible for the uncontrolled development in the area?

14. Do you have consultations with this authority concerning the developments?

15. If yes, what have been the achievements of these consultations towards enhancing conservation?

16. What is your organization doing in the area towards solving the conservation challenges posed by the changing land uses in the area?

17. What difficulties are being experienced by the organization in addressing these challenges?

18. What can you suggest as the better policy intervention towards managing theses challenges posed by urban population growth and land use changes?

19. Which department/organization should be responsible for this to succeed?

20. What roles should these departments play in the new set up?

THANK YOU.

APPENDIX IV

COMPULSORY MIGRATORY CORRIDOR LAND ACQUISITION

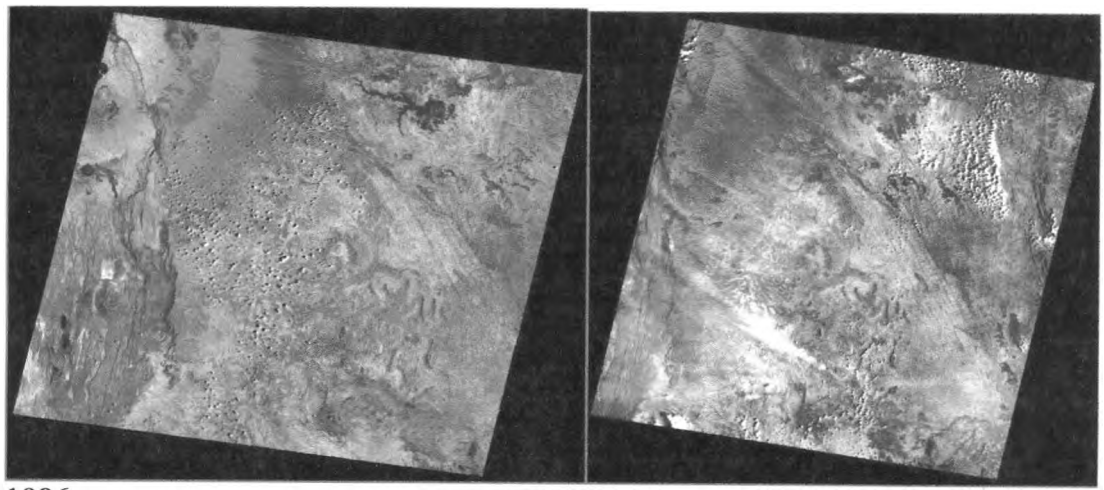
Compulsory land acquisition for the benefit of the public is founded legally in the Land Acquisition Act, Cap 295 of the laws of Kenya. In this case, sustainable conservation of Nairobi National Park should be seen as a public interest, given the associated benefits. In land use planning, compulsory land acquisition is a government tool for two major purposes: land banking and resettlement or redevelopment.

Land banking facilitates acquisition of land for urban development, private or public, in advance need so that land can be acquired relatively cheaply. It also serves to influence the direction of urban development e.g. advance acquisition followed by urban infrastructure development will definitely affect the direction of urban growth. Land redevelopment/clearance is done to pave way for major public works like dams, roads, among others. It may, for instance, be clearance of slums for redevelopment of a green village or of a new capital as done in Abuja, Nigeria (Kariuki, 2009).

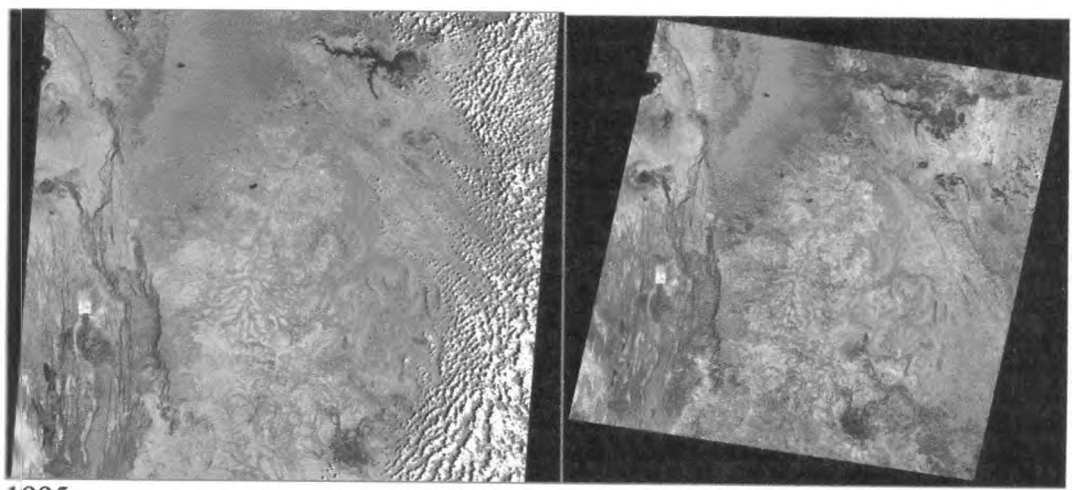
There may however, exist some shortcomings of this approach. One is the likelihood confrontation between the government and KWS on one hand and the affected land owners and developers on the other. There may also be the stigmatization of this approach by the affected community as undesirable. These therefore call for careful handling by engaging and encouraging the participation of all stakeholders while the compensation process should be as flexible, transparent and responsive as possible.

APPENDIX V

LANDSAT IMAGES USED



1986 1976



1995 2002

APPENDIX VI

CONDUCTING SIGNIFICANCE TEST FOR CORRELATION

Step	Description
1	Compute the observed statistic(correlation-r) based on the samples' data
2	Compute the observed t-value, based on the sample correlation(r) and sample size(n) i.e. observed $t = r\sqrt{1-r^2} \times \sqrt{n-2}$
3	Obtain the critical t value by referring to a table of t distribution, based on a two-tailed significance of 0.05 and $df = n-2$
4	Compare the observed t and the critical t value
5	Make a decision about the hypothesis. when: observed t value> critical t value, reject Ho observed t value< critical t value, fail to reject Ho

Source: Adopted from Furr, 2008.