
**PLANNING FOR SUSTAINABLE UTILIZATION AND CONSERVATION OF URBAN
RIVER CORRIDORS IN KENYA: A CASE STUDY OF THE NAIROBI RIVER**

*In what ways can
we sustainably
utilize and
conserve urban
river corridors in
Kenya?*

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DECLARATION

By:

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I hereby declare that this thesis is my original work and to the best of my knowledge has not been previously presented in this or any other University for an award of a degree or any other purpose.

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DEDICATION

To He who said, “Let there be.....,” and there was.....

INSPIRATION

We need to lasso our common sense. The rains bring us trees and flowers; the droughts bring gaping cracks in the world. The lakes and rivers sustain us; they flow through the veins of the earth and into our own. But we must take care to let them flow back out as pure as they came, not poison and waste them without thought for future,” (Al Gore, 1992).

[Adapted from Earth in the Balance: Ecology and the Human Spirit]

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ABSTRACT

This study focuses on planning for sustainable utilization and conservation of urban river corridors in Kenya, a case study of Nairobi River. The study was borne out of the need to protect Nairobi River corridor from prolonged degradation through pollution of various kinds, which have impacted negatively on the ecosystem of urban riverine environment as well as socio-economic development of the urban inhabitants including their rural counter parts downstream.

The study was carried out as a case study and focused on Nairobi River Corridor specifically on the section of the river corridor defined by Pumwani Road and Lamu Road; located in Nairobi city, the capital city of Kenya. The river was purposively sampled because of its historical significance in the establishment and the development of Nairobi City with the city deriving its name from this river. The study investigated the main challenges hindering sustainable utilization and conservation of the Nairobi River Corridor, examined the type of river degradation occurring in the study area, and the main causes of the observed river degradation. It further sought to identify the policy, legislative and institutional measures in place and the gaps for sustainable utilization and conservation of the said river corridor besides assessing the available Political, Economic, Social, Technological, Environmental and Legal (P.E.S.T.E.L) options for its sustainable utilization and conservation.

Two groups of respondents comprising of direct users of the river corridor (*informal group*) - with a population of about 650 persons and indirect users of the river corridor (*formal group*) - with a population of about 545 persons, were engaged in the study. Stratified and systematic sampling methods were employed to obtain a sample size of fifty six (56) and fifty four (54) respondents for informal and formal groups respectively. Key government ministries and departments totaling ten (10) were also purposively selected and involved in the study. Primary data was collected through structured questionnaires, personal interviews, field observations and photography; while secondary data was obtained by reviewing of pertinent literature materials. Results of data analysis were presented using frequency distribution tables, bar charts/graphs and pie charts.

The study established that the river corridor has been left out as a common pool resource which is exploited by anyone who asserts his or her rights to do so. Consequently, it has lost its utility value and is not used for the city's appropriate needs despite its potential to do so. Its waters for instance, cannot be used for commercial, agricultural, domestic, industrial, amenity or recreation purposes. In view of this, the study recommends adoption of enhanced pollution control mechanisms such as proper garbage/waste collection and management, surveillance of the river corridor and relocation of the existing water-polluting socio-economic activities away from the river channel. The study further recommends adoption of appropriate planning interventions such as replanting of the riparian reserve with river-based plant materials, clear zoning/ demarcation of the riparian reserve and orientation of existing and new buildings towards the river corridor to reduce its risks of encroachment and illegal dumping of waste since this will promote surveillance of the river corridor. It further calls for promotion of public awareness and involvement of the users in the entire conservation scheme. To this end, this study has been designed to evolve conservation lessons that are widely expected to apply in other river corridors that fall within the same bracket of degradation.

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LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|--------|--|
| CBD | Central Business District |
| CBO | Community Based Organizations |
| CCN | City County of Nairobi |
| EIA | Environmental Impact Assessment |
| EMCA | Environmental Management Coordination Act |
| GIS | Geographical Information Systems |
| GOK | Government of Kenya |
| MEWNR | Ministry of Environment, Water and Natural Resources |
| NCC | Nairobi City County |
| NCWSC | Nairobi City Water and Sewerage Company |
| NEMA | National Environmental Management Authority |
| NGO | Non-Governmental Organization |
| NRBP | Nairobi River Basin Projects |
| PHA | Public Health Act |
| PPA | Physical Planning Act |
| PPP | Private Public Partnership |
| SPSS | Statistical Package for Social Scientists |
| UN | United Nations |
| UNCHS | United Nations Centre for Human Settlements |
| UNEP | United Nations Environmental Programme |
| UON | University of Nairobi |
| WAB | Water Appeals Board |
| WASREB | Water Services Regulatory Board |
| WRMA | Water Resources Management Authority |
| WSB | Water Service Boards (s) |
| WSP | Water Services Providers |
| WSTF | Water Services Trust Fund |

CHAPTER ONE:
INTRODUCTION

CHAPTER ONE: INTRODUCTION

1.0 Introduction

This chapter is the introductory part of the study and covers the following; Background to the study, Problem Statement, Research Questions, Research/Study Objectives, Research Assumptions, Justification and Significance of the Study, Scope of Study and Limitations of the study. Structure of thesis is also part of this chapter.

1.1 Background to the Study

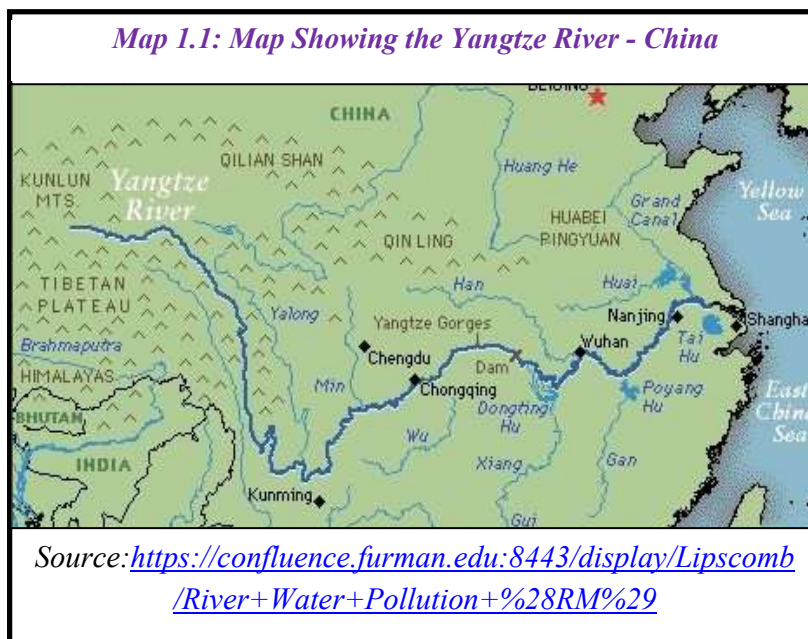
River water pollution is a serious problem all over the world. With growing populations and more chemicals and fertilizers being used and industries growing, our waters are becoming more and more contaminated. This is killing many plant and animal species that live in or around these rivers as well as providing polluted drinking water to people living near the rivers.

There are two types of river water pollution; namely, point source and non-point source pollution. Point source pollution is when a pollutant is emitted directly into a river in one point. An example of this would be an oil spill. Non-point source pollution is a gradual emitting of pollutants such as runoff from fertilizers near the river. Most of the polluted rivers in the world today are polluted by non-point source pollution. This includes runoff from farms and factories everywhere (River Water Pollution (RM), as retrieved from confluence.furman.edu).

River water pollution is prevalent in both developed and developing countries. The only variation is the extent to which this pollution has occurred and the measures that are being put in place by affected countries to mitigate further pollution. One would thus be forgiven to imagine that river pollution is a problem of developing countries only. United States of America, United Kingdom, Japan and China are good examples of developed countries that are currently grappling with issues of river water pollution. In China for instance, one of its main rivers (Yangtze River), has suffered severe pollution in the recent past despite its significance to the people of China and its pride of being the third longest river in the world. This river runs through 186 cities through the center of China and empties into the East China Sea near Shanghai.

Today, the Yangtze River is severely polluted causing damage to the surrounding environment as well as hurting the health of the people who come in contact with it. The Yangtze River is being polluted by sewage, agricultural waste, and industrial waste. It absorbs about forty percent of all of China's waste water. Thousands of people are getting sick from the polluted river and

many have gotten cancer. Furthermore, the Yangtze River is the only source of drinking water for the people in Shanghai and other cities along its banks. This means that over 300 million people in this area do not have access to clean drinking water. Another major effect of this is that as people continue to pollute this river, many of the plant and fish



species die and the Yangtze River could become a dead river. When temperatures rise and there is little rainfall, the water level decreases, making the concentration of polluted water that much greater. Thousands of fish and other species are dying because of this. So what is being done to help this situation? There is a huge problem. Not many people are doing anything. A lot of people in China refuse to acknowledge the fact that they have a problem with pollution and are doing little to nothing to solve this devastating problem. The Chinese government has tried to take action by examining the different places the pollution is coming from, investigating how much polluted water the Yangtze River can hold, and examining the waste water itself. The government is also issuing permits to big companies and limiting how much waste they can dump as well as taking action for companies dumping illegally. The problem is that the river is so big that it is extremely difficult to keep an eye on what certain companies are dumping into the river (River Water Pollution (RM), as retrieved from confluence.furman.edu).

In Kenya, rapid population growth, urbanization and industrialization have put enormous pressure on urban rivers though even rural rivers are not spared. Nairobi's Rivers, notably Nairobi, Ngong/Motoine and Mathare rivers are a good example of severely polluted rivers in our urban environment. According to NRBP Phase II Report (2003), discharge of untreated industrial effluent, raw sewage and solid waste from human settlements along the river courses has turned the once clear and pure water into a health hazard.

Owing to the position rivers occupy in the well-being of a society, the need to conserve them need not be emphasized. For this reason, the study was designed to examine the state of urban river corridors in Kenya with a view to recommend sustainable measures for their conservation.

1.2 Problem Statement

Urban river corridors in Kenya, despite their potential usefulness to the wellbeing of the society and environment, are in a degraded state. Majority of them today remain a major receptacle of both solid and liquid pollutants which have consequently led to a high deterioration of their waters and the ecosystem in general. As a result, water from these rivers can hardly be used for recreational, domestic, industrial or agricultural purposes and have thus discouraged emergence of potential development opportunities that are usually granted by these rivers. One such river corridor that has suffered and continues to suffer protracted neglect is the Nairobi River corridor. This is in spite of its potential use and historical significance in relation to establishment or development of Nairobi City in 1899, during the colonial period.

The Nairobi River corridor just like many other hapless river corridors in both developed and developing countries in the world, has continued to suffer unprecedented levels of pollution, thanks to the well-known polluting industries, developers, individuals and consequent inaction by the authorities charged with its protection. This river, which was formerly a fresh water river has been degraded to black liquid soaked with suspended and dissolved solid materials, raw sewage, used oil and grease, to name but a few. This indiscriminate disposal of waste into the river corridor has not only lowered its aesthetic and economic value, but has also affected the scenic beauty of the riverscape. Additionally, it has in the past led to the blockage and obstruction of the natural flow of the river and this has perennially resulted into floods especially during rainy seasons. Consequently, water from these floods has often overpowered the feeble riverbanks thereby causing disastrous effects to the adjacent land uses; including loss of lives and health risks as has previously been the case especially with slums/shanties located on the riparian reserve. Further, encroachment of the River corridor by undesired land uses such as motor-vehicle repairs, agricultural activities and informal settlements, have greatly interfered with the river's water quality, as well as negatively transformed the riverscape from its natural state to an alien one, devoid of natural character and form with few or no fauna and/or flora. There is therefore an urgent need to address all these issues in time, lest the future holds us fully responsible for destruction of this natural heritage.

In view of the above, this research was designed to generate information on exactly what is happening on the Nairobi River corridor. The lessons are widely expected to apply to other urban river corridors in Kenya owing to the city's environmental challenges. A major challenge of the research though is how to make the waters of Nairobi River as pure as they are at the source, which is Ondiri Swamp in Kikuyu Constituency.

1.3 Purpose of the Study

The purpose of the study was to investigate the challenges hindering sustainable utilization and conservation of the Nairobi River Corridor.

1.4 Research Questions

Some of the main questions forming the basis of the study were as follows:

- (i) What are the utilization and conservation challenges facing the Nairobi River Corridor?
- (ii) What is the nature of river degradation occurring on the Nairobi River Corridor, specifically on the section between Pumwani Road and Lamu Road?
- (iii) What are the main causes of the observed degradation on Nairobi River Corridor on the section between Pumwani Road and Lamu Road?
- (iv) What policy, legal and institutional measures are in place for sustainable utilization and conservation of Nairobi River Corridor?
- (v) What are the available Political, Economic, Social, Technological, Environmental and Legal (P.E.S.T.E.L) options for sustainable utilization and conservation of Nairobi River Corridor and such others?

1.5 Research Objectives

The following objectives formed the basis of the study:

- (i) To identify the utilization and conservation challenges facing the Nairobi River Corridor.
- (ii) To examine the nature of river degradation occurring on the Nairobi River Corridor, specifically on the section between Pumwani Road and Lamu Road.
- (iii) To investigate the main causes of the observed degradation of Nairobi River Corridor on the section between Pumwani Road and Lamu Road.
- (iv) To identify the policy, legislative and institutional measures in place for sustainable utilization and conservation of Nairobi River Corridor.
- (v) To assess the available Political, Economic, Social, Technological, Environmental and Legal (P.E.S.T.E.L) options for sustainable utilization and conservation of Nairobi River Corridor and such others.

1.6 Study Assumptions

The study was generally guided by the assumption that Nairobi River Corridor was in a degraded state and thus there was need for its sustainable conservation. Specific assumptions however included the following:

- (i) That Nairobi River Corridor was faced with utilization and conservation challenges and that there was need to mitigate these challenges.
- (ii) That the section of the Nairobi River Corridor between Pumwani Road and Lamu Road was degraded and the degree of its degradation was manifested by the physical and visual qualities of the river corridor.
- (iii) That the main causes of the observed degradation of Nairobi River Corridor on the section between Pumwani Road and Lamu Road could be brought under control through urban planning practices and management lessons advanced by the study.
- (iv) That the current policy, legislative and institutional measures in place for sustainable utilization and conservation of Nairobi River Corridor are inadequate.
- (v) That Political, Economic, Social, Technological, Environmental and Legal (P.E.S.T.E.L) factors influence sustainable utilization and conservation of Nairobi River Corridor and such others and if addressed could provide good results.

1.7 Study Justification

Although river corridors are largely viewed as essential agents of urban development, Nairobi River corridor has regrettably, contributed insignificantly to this. In this connection, the study was necessitated by the following;

- The need to prevent further river degradation on the study area caused by pollution from light industries, commercial activities and residential areas along the river corridor.
- The need to recover and reclaim additional recreation space for city residents as well as replace diminishing open spaces in the city by using Nairobi River Corridors as alternative area for active and passive recreation.
- The need to protect and conserve urban river ecosystem and bio-diversity which are threatened by the rapid urbanization activities.
- The need to enhance and diversify city's development opportunities especially for businesses fronting the rivers- through riverfront designs/planning and developments.
- The need to safeguard health and safety situations of the city's residents as well as that of the communities that live downstream.
- The need to improve the overall environmental quality of the city. With most of the urban areas currently being predominantly occupied by buildings and other hard surfaces leading to Urban Heat Island, the river corridor remains the only possible and viable option for a breathing space and enhanced micro-climate.

In conclusion, the need to protect urban rivers and their corridors cannot be overlooked. As such, the research explored utilization and conservation options for salvaging urban river corridors from their current degraded situation. Through this, it would be possible to protect human, animal and plant lives and also improve on the environmental quality of our urban areas as well as secure a cherished natural inheritance for future generations.

1.8 Significance of the Study

The last few decades have witnessed Nairobi City emerge as one of the most urbanizing cities in Kenya, with a multiplicity of land uses. This, coupled with rapid population growth, (often occasioned by rural-urban migration), and obsolete urban infrastructure, has caused detrimental damages on the natural resources of Nairobi City. The City's river basins have for instance, been severely polluted and only left to the mercies of God (Karisa, 2002). Nairobi River, though an important element to the city's well-being, has also not been spared and has experienced huge interference and destruction of its ecosystems. It is out of these concerns that the study was undertaken. To this end, the contribution of the study entails the following:

- ✓ Development of fresh/new knowledge to deal with the emerging challenges in the course of urban planning and management to avert further destruction of urban ecosystems. In this connection, the study provides valuable insights not only to the national government and county governments, but also to environmentalists and other stakeholders including urban residents on the need to conserve urban natural resources. At the county level, this particularly resonates with Section 10, Part Two of the Fourth Schedule of the Kenya Constitution, 2010 which tasks counties with implementation of specific national government policies on natural resources and environmental conservation, including (a) soil and water conservation; and (b) forestry.
- ✓ Fulfillment of our constitutional mandate whereby under the new structure of governance in Kenya, counties are required by law to enact local laws to manage the environment and natural resources. To that effect, the study is both significant and timely, for it gives empirical data, and planning direction that could be referenced in formulation of such laws. Nairobi City County Government is particularly posed to benefit much more from this study since the study area falls under its jurisdiction.
- ✓ Addressing river basin policy and enforcement missing links that existed in the defunct City Council of Nairobi leading to the "near death" situation of urban rivers within its

jurisdiction. This could be insightful to the new County Government not only in legislation, but also in enforcement of laid down spatial and other laws that affect the river basins.

- ✓ Reference point for best management practices for rivers. The study gives proposals that can be used as reference, and may set a backdrop for best management practices of urban rivers in the existing towns and cities, and future emergent ones as the country accelerates in economic and urbanization fronts across the 47 counties.
- ✓ Creation of a new/improved image of Nairobi city. Lately, the image of Nairobi City has been getting transformed through man-made infrastructure such as Thika Highway, the bypasses, sub-urban new estates, towns and 'cities', the proposed light rail commuter system, and the proposed Decker Highway along Uhuru Highway among others. From this perspective Nairobi River corridor as natural “infrastructure” could also contribute to this new "Image of the City".
- ✓ Development of new areas for urban residents to interact with nature. The major natural systems remaining within the core of the city are presently found only along the river basins. Though currently highly polluted and encroached, they are still viable as avenues to re-introduce healthy ecosystems, recreational venues, and 'places for slow life' for the city's residents.
- ✓ Presentation of potential planning and policy solutions which are timely and significant for sustainable conservation and utilization of Nairobi River corridor, that can also be used in other rivers in the city or in other urban areas in Kenya in this transition and change era ushered in by the Kenyan Constitution of 2010.
- ✓ Promotion of public awareness on the benefits of urban river corridors and development of new approaches for environmentally sound development and management of our river resources. As such the study evolves conservation knowledge for the future scholars and environmental conservationists for purposes of conserving and managing riverine environment effectively.

1.9 Scope of the Study

1.9.1 Theoretical Scope

River water can be used for consumptive and non-consumptive use (Shiklomanov, 1990 as quoted by UNCHS, 1995). Consumptive use entails water for irrigation, industrial, domestic fire-fighting, and hydropower generation, while non-consumptive use includes water for fishing, water transport, flood regulation, and recreational activities such boating, canoeing, water sports and angling. Since it may be a challenge to attain acceptable water quality for all the aforementioned uses, the research therefore limited itself on river conservation for the sake of non-consumptive uses as well as a few consumptive uses such as irrigation and hydropower generation.

The research also studied utilization and conservation challenges facing the Nairobi River Corridor, the nature of river degradation occurring on this area of study and the main causes of the observed river corridor degradation. It further looked at the policy, legislative and institutional measures in place for sustainable utilization and conservation of the Nairobi River Corridor as well as the available Political, Economic, Social, Technological, Environmental and Legal (P.E.S.T.E.L) options for sustainable utilization and conservation of Nairobi River Corridor and such others. To achieve the objectives of the research, the study laid its emphasis on both the users and supposedly managers of the river corridor.

1.9.2 Geographical Scope

Generally, the flow of rivers is unidirectional, meaning that their movement is one-way transport system. Therefore, the effects impacted on the upper parts of a river system are likely to be felt downstream/lower parts of the river corridor. Conversely, conservation measures initiated upstream are likely to have positive effects downstream.

Studying the whole course of the river corridor would have been tedious, time-consuming and most importantly, expensive. In this respect, the study was based in Nairobi city, the section of Nairobi river corridor defined by Pumwani Road and Lamu Road; covering Kamukunji area, Gikomba market area and Majengo informal settlements. Width-wise, the study covered the whole riparian land as defined by law, though the researcher extended this by up to about 70 metres more on both sides of the river channel, so as to unearth the interaction of the surrounding land uses with the riparian strip.

1.9.3 General Information about the Study Area

❖ Location

The study area is located in Nairobi City, the capital city of Kenya. In the urban context, it is located along the Nairobi River in the central city.

❖ Size

The entire site covers approximately 27 acres and covers the section of Nairobi river corridor defined by Pumwani Road and Lamu Road (about 1.8 km in length); encompassing Kamukunji area, Gikomba market area, Muthurwa area and Majengo area.

❖ Neighbourhood

The site is bordered by:

- *Central Business District (CBD) to the West and Buruburu Estate to the East.
- * Pumwani (Gorofani/Bondeni) Estate to the North and Muthurwa Estate/ City Stadium to the South.

❖ Immediate Neighbourhood

In the immediate neighbourhood, the site is bordered by:

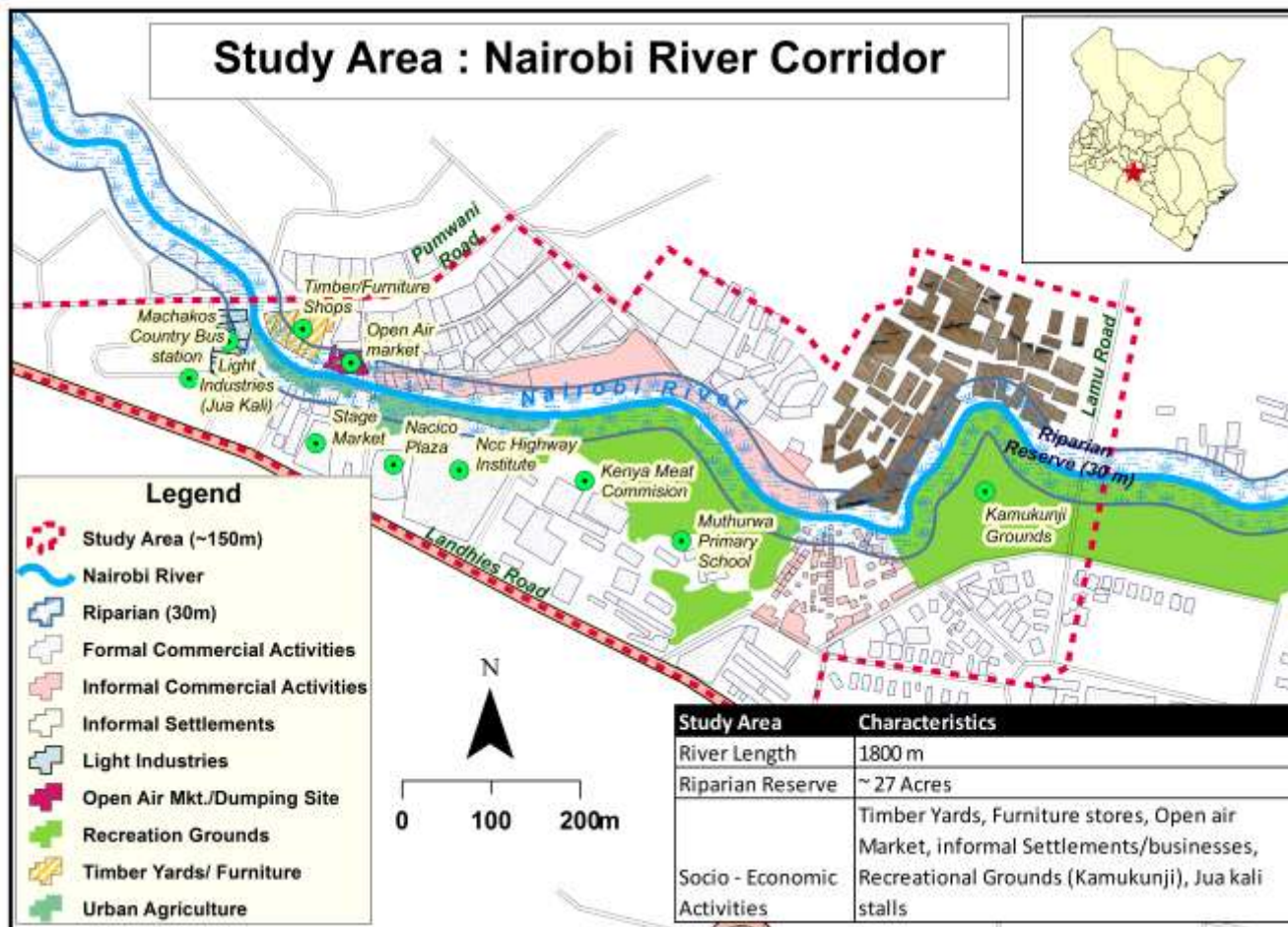
- * Kamukunji Police station, Jua Kali industries and part of Muthurwa to the South.
- * On the North the site is neighboured by Gikomba market and part of Majengo.

Map 1.2: Location of the Study

National Context: Kenya



Local Context: Pumwani Road – Lamu Road section of Nairobi River Corridor



Regional Context: Nairobi County



Source: Adapted from Google Earth & Survey of Kenya, 2014

1.10 Study Limitations

Some of the limitations that the researcher encountered during the course of the study included the following:

- (i) **Insecurity:** This was a major set-back as the study area is mainly inhabited by street urchins and informal groups who were a threat to our security.
- (ii) **Financial constraints:** Available funds were not adequate to cater for an in-depth study. This occasioned a reduction of the sample size and the number of data collection methods.
- (iii) **Limited time or duration for the study:** The time set (About fourteen weeks) for the study was inadequate for an exhaustive study of the chosen subject area. However, major efforts were made to secure a comprehensive coverage of the same.
- (iv) **Institutional bottle-necks:** It was difficult to get audience with some of the people earmarked for interview especially the institutions/key informants.
- (v) **Cover-up and limited information from some informants:** Some of the respondents were not willing to freely divulge sensitive information especially that touching on their interest on the river corridor.

1.11 Definition of Key Terms in the Study:

- ❖ **Anthropogenic Activities:** This refers to actions relating to, or resulting from the influence of human beings on let's say nature. Simply put, it refers to those activities that result from human actions, e.g. on rivers.
- ❖ **Conservation:** This entails any activity that is aimed at keeping resources from being damaged, wasted or lost.
- ❖ **Pollutant:** This refers to any solid, liquid or gaseous substance that has negative impact on our environment.
- ❖ **Riparian Reserve:** This refers to the strip of land adjacent to the banks of rivers.
- ❖ **River:** Natural water course with permanently running water or a natural stream of water that flows in a well-defined channel, course, or riverbed between the slopes of a valley.
- ❖ **River Corridor:** This refers to the strip of land along which rivers flow. It comprises the river channel and the adjacent land (riparian reserve), which have an existing or potential value related to the presence of the river. This value will include consideration for recreation, amenity and nature conservation, among others.

- ❖ **River Degradation:** It is the reduction in the chemical, physical and visual value of rivers. In our case, it refers to loss of utility value of rivers as a result of undesirable human activities on the river.
- ❖ **River Pollution:** It is the presence of foreign unnatural materials in river which would interfere unreasonably with one or more beneficial uses of that river.
- ❖ **Stakeholder:** A collective term referring to a group of individuals and/or institutions who in one way or the other, affect or are affected by something. In the context of the study it will be used to refer to the various resource persons, the river's adjacent business community, as well as its users.
- ❖ **Sustainable:** Used in reference to rivers to mean the ability of the river corridor to meet the river-related needs of the present urban residents without compromising its ability to meet those of the future residents.
- ❖ **Urban Rivers:** This refers to rivers traversing or crossing through urban areas. Nairobi River, in Kenya, is one of the many examples of such rivers.
- ❖ **Utilization:** This simply means consumption or putting into use. In the context of our study, the terminology is used to refer to the use of river water for both consumptive use (irrigation, industrial, domestic and hydropower) and non-consumptive use (water for fishing, water transport, flood regulation and recreation).

1.12 Structure of the Report

This research report has been classified into seven chapters with each chapter focusing on a different aspect of the study:

Chapter One: This chapter, being the first chapter of the study is called introduction and covers the following; Background to the study, problem statement, purpose of the study, research questions, research/study objectives, research assumptions, justification and significance of the study, scope of study and limitations of the study. Structure of thesis is also part of this chapter.

Chapter Two: This chapter features a critical review of available and relevant literature pertaining rivers as informed by the research/study objectives. The chapter is introduced by a look at definition of the term "river" and its related terminologies namely; the river corridor, the river basin and the river ecosystem. It also focuses on nature of rivers, as well as river pollution and its consequences to human society and environment in general. It further highlights essential considerations for sustainable conservation of urban rivers and their corridors. Conceptual framework to the study was also developed in this chapter. The chapter is then summarized by a

theoretical framework which identifies a research gap that forms the critical concern of the research being undertaken.

Chapter Three: This chapter looks at the background of the study area in terms of its location, area, socio-economic activities and neighbourhood. It also looks at the profile of its hosting constituency (Kamukunji Constituency). Also covered under this chapter is the historical development of Nairobi city and its physiographic and natural conditions which cut across the study area.

Chapter Four: This chapter basically addresses the methodology employed in the research. Central to this area is the research and sampling design, data needs and their sources, data collection methods, analysis and presentation.

Chapter Five: This chapter presents the analysis of data and findings of the study on the planning approaches for sustainable utilization and conservation of urban river corridors in Kenya. The first section of the chapter presents the socio-demographic data of the respondents, while the second section presents data on utilization and conservation challenges facing the Nairobi River Corridor, the nature of river degradation occurring on this area and the main causes of the observed river corridor degradation. It further outlines the policy, legislative and institutional measures in place for sustainable utilization and conservation of the Nairobi River Corridor as well as the available Political, Economic, Social, Technological, Environmental and Legal (P.E.S.T.E.L) options for sustainable utilization and conservation of Nairobi River Corridor and such others.

Chapter Six: This chapter entails implications of the research findings with reference to the objectives of the research. It gives a summary of the research findings as per the objectives of the study.

Chapter Seven: This chapter being the last chapter of the study draws conclusion from the findings of the study and then gives recommendations for sustainable conservation of urban river corridors. It also gives suggestions for further research.

CHAPTER TWO:
LITERATURE REVIEW

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter features a critical review of available and relevant literature pertaining rivers as informed by the research/study objectives. The chapter is introduced by a look at definition of the term “river” and its related terminologies namely; the river corridor, the river basin and the river ecosystem. It also focuses on nature of rivers, as well as river pollution and its consequences to human society and environment in general. It further highlights essential considerations for sustainable conservation of urban rivers and their corridors. Conceptual framework to the study was also developed in this chapter. The chapter is then summarized by a theoretical framework which identifies a research gap that forms the critical concern of the research being undertaken.

2.1 River and its associated terminologies

2.1.1 River

A river is a natural stream of water that flows in a well-defined channel, course, or riverbed between the slopes of a valley (Encyclopaedia Britannica Vol. 19, 1972).

River water can be used for consumptive and/or non-consumptive use (Shiklomanov, 1990 as quoted by UNCHS, 1995).

- *Consumptive use* entails water for irrigation, industrial, domestic and hydropower.
- *Non-consumptive use* on the other hand includes water for fishing, water transport, flood regulation and recreation.

Rivers generally flow through three topographical zones, namely; the *source* also known as *headwaters*, *the middle-order stream* and *lowland rivers*. These three river zones can also be considered as *zones of sediment production, transfer and deposition* respectively (Petts and Foster, 1985 as quoted by UNCHS, 1995).

a) Headwaters: Refers to the upland areas where streams or rivers are shallow and fast flowing. This zone is also called the zone of sediment production as its waters are capable of unearthing boulders, coarse gravel, rock outcrops and other debris, which form the primary load. Such load has considerable scouring potential leading to steep-sided valleys, typical of the upper reaches of the stream. In the case of Nairobi River, the headwaters zone refers to Nderi, Ondiri and Kabete swamps; the main springs of this river. Here the waters are of considerable quality and the residents still scoop up clear spring water for domestic consumption.

b) Middle order stream: Just as the name suggests, this refers to the central zones of a river. It is also known as zone sediment transfer or transport, as sediment input can equal output. Here the rate of flow is slower and size of the sediment is reduced into gravel. The middle order streams of Nairobi River are mainly found traversing the various parts of the developed city, including central areas of Nairobi (Chiromo, Ngara, Kamukunji and Gikomba).

c) Lowland Rivers: This zone can appropriately be called the zone of deposition, as it is at this zone that the river starts to deposit its loads as it meanders through flood plains. The zone is characterized by increased channel dimensions, with widths greater than the depths. As gradient decreases, the velocity may remain fairly constant, since the flow is unchecked by obstructions on the riverbank.

In deltas, river velocity is reduced and sediment is deposited to form an alluvial fan. Large river sediment is deposited on an alluvial plain or delta or in an estuary. Near the mouth of large rivers there is a transition zone where the river and marine processes overlap (Petts and Foster, 1985 as quoted by UNCHS, 1995). The lowland rivers of Nairobi River entail the section of the river past the city, all the way to the point where it joins Athi River. At this point, the river becomes a tributary of Athi River, also called Galana or Sabaki, which drains to the Indian Ocean.

2.1.2 River Basin

This refers to the combined catchments of all tributaries in one river system. River basins usually have an established physical boundary, except in floodplains and flat coastal areas, where the watershed boundary may change with flood events and in arid regions where rivers drain into deserts. River basins are a product of continual interaction between geological, atmospheric, and biological processes. These natural processes have established the form of our environment, and an understanding of these processes is fundamental to an assessment of how human activities modify the river basin environment. The river basin is a clearly defined topographical unit, but is also a complex and delicately balanced ecosystem, where natural processes of precipitation, erosion and biological activity lead to constant change. Surface water is an efficient transport mechanism and changes in land use, runoff or river flow can have effects throughout the basin.

2.1.3 River Corridor

According to Gardiner (1992), a river corridor is a strip of land along which rivers flow. It comprises the river channel, the river banks and adjacent land (riparian reserve). Some of the functions of river corridors in the environment and welfare of the society include:

- Boosting of socio-economic activities for urban residents. Rivers host fish and other aquatic life that supports the livelihood of thousands of city dwellers.
- Conservation of wildlife, landscape aesthetics and aquatic biology (flora and fauna).
- Rivers also aid in conserving ground water by recharging aquifers (water-bearing rocks).
- Provision of raw materials for basket weaving, rope making, etc. such materials are readily gotten from riverine trees such as *raphia farinifera*, as well as other plants such as hyacinth and reeds etc.
- Provision of amenity and water-based recreation opportunities such as angling, kayaking, swimming, boating, etc.
- Storage (reservoirs) for excess water e.g. wetlands around banks of rivers. These wetlands act as flood control mechanisms by absorbing storm water. Furthermore, these wetlands act as the last resort of water supply especially during dry weather.
- Transport of people and goods from one geographical area to another. In England for example, rivers have been used as a means of transport of human beings and timber for generations of time.
- Rivers help in conservation of riparian reserve and aquatic life that are prone to extinction.

2.1.4 River Ecosystem

This is said to consist of the river itself, its streams and tributaries. It is continuum linked by the transformation of energy, the transport and storage of nutrients by organic means. These processes depend to a large extent on the retention and cycling of nutrients by biological communities in the upstream areas. Within most rivers, the pattern of flow variation, water temperature and water quality, are dominant factors in controlling the distribution of species. River pollution, in particular has got a significant effect on species diversity. Higler (1990), as quoted by UNCHS (1995), observes that the physical changes that occur from source to mouth of a river result in changes in the type of plants, fish, invertebrates and algae. The river basin is also influenced by climate, basin vegetation, and water temperature.

In the headwaters (source) zone, water temperatures show little seasonal and daily variations, because of proximity to the river source and shading of streams and valleys. The fast-moving stream, a restricted temperature range, and limited nutrients, are unfavorable for species diversity. Bank vegetation also has significant influence on aquatic life, by shading the water and deposition of dead twigs and leaves in streams.

On the other hand, middle-order streams show much greater seasonal and daily temperature variation and favour a diverse fauna, while the effect of shading from riverside plants is low. Typical variations in the physical characteristics of middle-order also encourage species complexity, and a wide variety of stream invertebrates that rely on algae or rooted aquatic plants and organic matter transported from upstream.

In lowland rivers, the case is totally different; the large quantity of water, its depth and turbidity suppresses temperature variations, thereby, hindering growth of aquatic plants. This therefore, results into less species diversity (Petts and foster, 1985 as quoted by UNCHS, 1995).

Now, looking at the case of Nairobi River, the waters from the headwaters zone are of considerable quality and the residents of these areas still scoop up clear spring water for consumption and washing, meaning it is likely to favour species diversity in this zone; of course, keeping other factors such as temperature and variation in flow pattern, constant. It is however a totally different scenario with the middle order streams of Nairobi River whose water is subjected to high level of pollution; a condition that does not favour species diversity (Karisa, 2002). Similarly, on the low land areas of Nairobi city, the river (Nairobi River) is extremely polluted to an extent that it ceases from being clear waters and now becomes murky, incapable of supporting species bio-diversity.

2.1.5 Riparian Reserve

The word riparian comes from the Latin word "ripa" which means "bank" implying that the riparian reserve begins at the river bank. Other names given include; riparian vegetation, riparian buffer zone, riparian forest, riparian reserve, and riparian land. Riparian areas therefore are the areas adjacent to ditches, streams, lakes and wetlands (NEMA, 2011). The Ohio Department of Natural Resources; (ODNR, 2006) has provided a better definition of riparian as ***“Naturally vegetated land adjacent to water courses that, if appropriately sized, helps to stabilize stream banks, limit erosion, reduce flood size flows and/or filter and settle out runoff pollutants, or performs other functions”***. These areas, found in all regions in Kenya, support a unique mixture of vegetation, from trees and shrubs to emergent and herbaceous plants. The vegetation in riparian areas directly influences and provides important habitats for both aquatic and semi-terrestrial organisms. It builds and stabilizes stream banks and channels, provides cool water through shade, and provides shelter for aquatic species. The leaves and insects that fall into the water are a source of food for other biota (NEMA, 2011).

Although they account for only a small portion of Kenya's land base, riparian areas are often more productive than the adjoining uplands and are a critical component of the Region's/Province's biodiversity. Thus the protection of riparian areas is a vital component of an Integrated Water/Wetland Resource Management (IWRM) program. The integrity of a riparian area depends on, and is influenced by, the upland area as well as the upstream environment

Despite the benefits they provide, riparian areas have not received proper attention in Kenya, partly due to poor understanding of their roles including their interface-roles such as provisioning of buffers against storms, and pollutants among others. The situation has been aggravated by the sectoral and quite often conflicting policies touching on water/wetland management. It is noteworthy that a local definition exists within the various laws and policies, but such provide different dimension and emphasis based on each sector's mandate. As a result, many riparian areas have been alienated, encroached for settlement and agriculture, as well as converted into other developments (NEMA, 2011).

The specific purpose and intent of riparian areas is to provide economic benefits to communities by minimizing encroachment on watercourse channels and also reduce the need for costly engineering solutions such as dams, retention basins and rip rap to protect structures while reducing property damage and threats to the safety of watershed residents; and by contributing to the scenic beauty and environment of the community and thereby preserving the character of the community, the quality of life of the residents of the community and corresponding property values (ODNR, 2006).

Other roles of riparian areas are to:

- Reduce flood impacts by absorbing peak flows,
- Slow the velocity of flood waters and regulating base flow,
- Assist in stabilizing the banks of watercourses to reduce bank erosion and the downstream transport of sediments eroded from watercourse banks;
- Reduce pollutants in watercourses during periods of high flows by filtering, settling and transforming pollutants already present in watercourses;
- Reduce pollutants in water courses by filtering, settling and transforming pollutants in run-off before they enter water courses;
- Provide water course habitats with shade and food;
- Reduce the presence of aquatic nuisance species (hyacinth, algae)

- Maintain a diverse aquatic system and provide habitat to a wide array of wildlife by maintaining diverse and connected riparian vegetation.
- Dissipate noise from reservoir traffic and roads
- Increase property value;
- Reduce maintenance time and related costs and provide privacy.

2.2 Role of Rivers

Rivers play many roles on both the environment and the well-being of the society. These roles can be broadly categorized as ecological, economic, socio-cultural and recreational roles.

2.2.1 Ecological Roles of Rivers

Rivers are a source of water, and water is needed in all aspects of life. It is vital to every plant and animal form (UNCHS, 1995). Life processes are therefore vulnerable to changes in the quantity and quality of water.

2.2.2 Economic Role of Rivers

For people, fresh water is an essential resource, which has been freely available from the environment. It is an economic good as well as an engine of development. As noted by Mellquist (1992), water resource development has contributed greatly to economic and social growth of many countries, and this is one of the reasons why one or a few major interests often dominate the use and management of rivers. In Norway this development has been primarily aimed at promoting electricity production, while in western states of USA, at promoting agricultural irrigation. Similarly, as much as 80% of the water use in Utah and 90% in the New Mexico water use has been directly linked to irrigation and not to consumption or other purposes.

2.2.3 Socio-Cultural Role of Rivers

Man has revered and used rivers for both sacred and secular activities since early times. Thus to safeguard these interests, our ancestors were not slow to introduce management of water resources after they climbed down from the trees- first by throwing stone or half-gnawed thighbone at outsiders who came closer to their waterhole (Mellquist,1992). Later, more advanced “methods” supported by knives, axes and strategic marriages have been used to secure control of water resources. Today, the story isn’t much different; various social-cultural activities, such as baptisms are carried out in rivers. Other cultures view rivers as sacred elements, hence the need for their conservation.

2.2.4 Recreational Role of Rivers

Rivers have for many centuries provided an adequate context for recreation, in both the traditional and modern sense (Karisa, 2002). They are widely used for recreational activities such as angling, kayaking, swimming, boating and canoeing hence promoting public enjoyment and socialization.

2.3 Human Activities and their Impacts on Rivers and River Corridors

Man has used rivers more than any other type of ecosystem (Boon (1992). Rivers have been abstracted from, fished in, boated on, discharged into; their head waters have been diverted, their middle reaches dammed and their flood plains developed among other uses and abuses. River corridors are also not spared; most of them have been turned into dumping sites, agricultural land or settlements. These human activities are profoundly affecting river basin ecosystems, and the availability and quality of water resources (UNCHS, 1995). Indeed, most regions of the world face problems of loss of fresh water supply, degraded water quality, and pollution of surface and ground water.

Major problems affecting the quality of rivers arise from domestic sewage, industrial waste water, destruction of catchment areas, deforestation, shifting cultivation and poor agricultural practices. Kanu, Ijeoma and Achi, O.K. (2011) attributes these problems to increased population growth in many countries (especially African countries) over the last few years. They argue that population growth accompanied by a steep increase in urbanization, industrial and agricultural land use have entailed a tremendous increase in discharge of a wide diversity of pollutants to receiving water bodies and has caused undesirable effects on the different components of the aquatic environment and on fisheries. As a result, there is growing appreciation that nationally, regionally, and globally, the management and utilization of natural resources need to be improved and that the amount of waste and pollution generated by human activity need to be reduced on a large scale.

2.3.1 Utilization and Conservation Challenges Facing Rivers and River Corridors

The relationships between land use, water use and the environment are not simple. Douglas (1981), as quoted by UNCHS, (1995) argues that a managed river basin is a complex, socio-economical system, which forms part of a wider world economic system which can be affected by events and decisions elsewhere. He considers that many of the changes that we are concerned about are the side effects of technological progress, and that while public attention is directed

towards the environmental risks associated with the chain saw and bulldozer, slower people-induced changes are widespread and deserve at least as much attention.

A river is a continuous system and change in one part of the system has many environmental and ecological significations. For instance bank channelization leads to removal of bank and aquatic habitats, increases in the speed of over flow, and changes in the sediment load that may cause erosion in other parts of the river. Human intervention in this process can have far-reaching results and can exacerbate the natural patterns of change, bringing about both *deliberate impacts* and *inadvertent effects*. Deliberate effects of a river project may include impounding river water for irrigation, and creating hydropower potential, while inadvertent effects might be the inundation of land, the effect on local communities, downstream changes in flow, changes to the height of water table and ecological change. These in turn may give rise to changes in socio-economic activities such as agriculture.

2.3.2 Utilization and Conservation Challenges Facing Urban River Corridors in

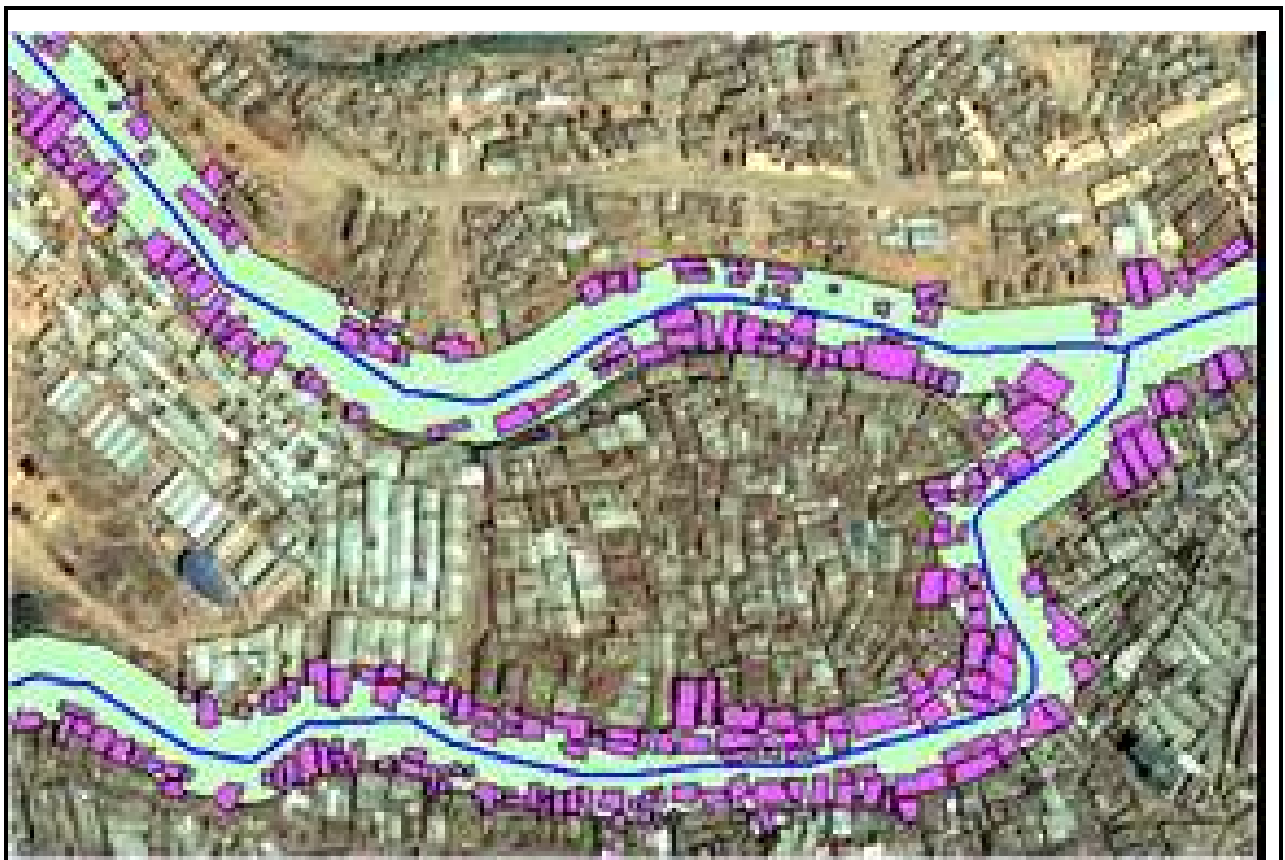
Kenya

Rivers are a source of water, and water is an important ingredient of development, and is essential for all economic activities. Access to water has often been a factor in promoting development whether in urban or rural areas (UNCHS, 1995). However, this reasoning is slowly fading away, as human activities particularly river water pollution have affected our rivers and their corridors beyond recovery; hence they are no longer responsible for progressive development, especially in our urban environment such as Nairobi City. This is greatly affecting utilization and conservation of these rivers. Some of the utilization and conservation challenges facing urban river corridors according to NRB Phase II Report (2003) include:

- Accumulation of solid waste and discharge of raw effluent into the river system thus rendering river water and immediate environment unusable. Nairobi River is polluted with uncollected garbage; human waste from informal settlements; industrial wastes in the form of gaseous emissions, liquid effluents, agro-chemicals, petro-chemicals, metals and over-flowing sewers. Industrial buildings, Informal economic activities such as markets and “JuaKali” commercial enterprises along the rivers discharge their wastes into this river. This situation has occasioned spread of water-borne diseases, loss of livelihoods, loss of biodiversity, reduced availability and reduced potential of this river becoming source of safe potable water, and the insidious effects of toxic substances and heavy metal poisoning which affects human productivity.

- Encroachment of the riparian reserve or river banks by informal (unplanned) settlements and other land-uses which make rehabilitation and restoration of the rivers difficult. This is because majority of the urban residents live or operate in highly congested informal settlements mainly located along the river banks. The riparian reserve of the Nairobi River is particularly encroached by numerous informal and formal settlements without adequate sewerage and sanitation services. A survey conducted showed informal settlements along a small stretch (5km) of the Ngong River riparian has 6,800 inhabitants.

Map 2.2: Aerial Map of Mathare Slums (Encroachment of informal buildings into the Mathare River)



Source: Karisa 2010, Courtesy of Pamoja Trust, 2008

Other utilization and conservation challenges facing Nairobi River Corridor include:

- Resistance from riparian communities since there is no alternative place for their relocation. This is exacerbated by political leaders from the affected areas who incite people against relocating from the riparian reserve. As such there is no political good will in the execution of works.
- Lack of a common and harmonized approach in the implementation and enforcement of all legislations on riparian reserve since various government institutions have got their

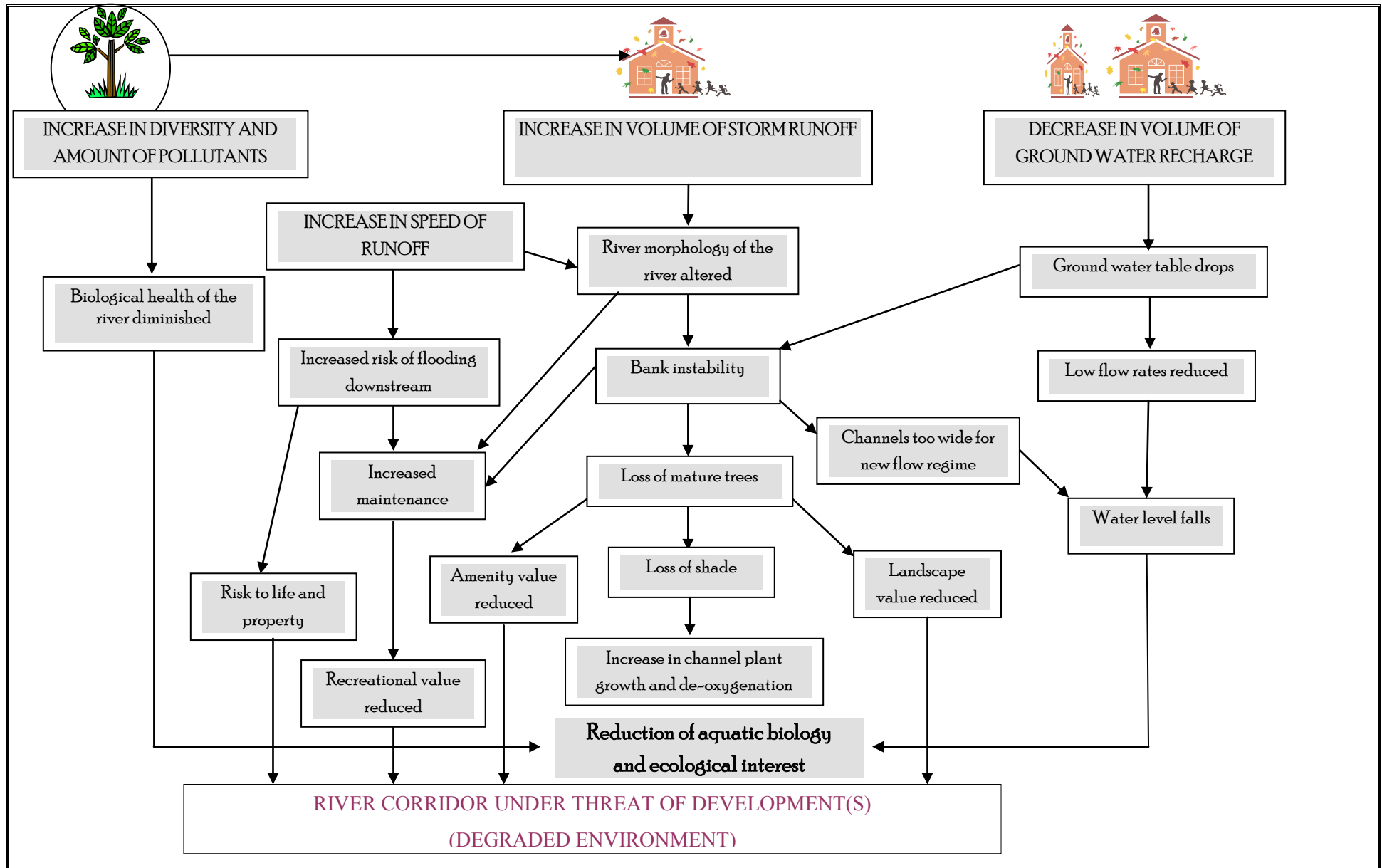
own dimensions of what constitutes a riparian reserve. There is therefore a need for eradicating the previous practice of applying sectoral policies in the management of riparian reserves both in urban and rural areas which create conflict among the institutions (NEMA, 2011).

- Inadequate technical and financial resources, poor institutional co-ordination and lack of clear river conservation implementation modalities.

2.3.3 Impacts of Urbanization on Urban Rivers and River Corridors

Urban development induces major changes in the run-off of precipitation, both by changing the configuration of natural drainage channels and because hard surfaces for roads, pavements, car parks, and buildings, inhibit the infiltration of runoffs into the ground (UNCHS, 1995 quoting Douglas, 1988; Oyebande, 1990). This was also noted by Gardiner (1992), as shown in figure 2.1 (Page 24). Drainage channels may be altered, there is increased risk of flooding, and aquifer recharge is reduced. In New York, For example, there is no longer any natural recharge to the Long Island aquifer because the island is completely developed.

Figure 2.1: Impacts of Urbanization on Urban Rivers (After Woolhouse, 1989)



Source: Gardiner, 1992

2.4 Nature of (Urban) River Degradation

River degradation encompasses pollution of various types, erosion of the banks, declining levels of water, siltation, encroachment of the riparian reserve et cetera (Gardiner, 1992). Other forms of river degradation include deterioration of water quality, increased flooding, and the loss of ecological resources. However, pollution is considered to be the main form of river degradation especially in urban areas. According to Solanes (1991), pollution entails addition of something to water that impairs its downstream use and, is generally associated with man's activities. Solanes further states that pollution of rivers and streams with chemical contaminants is for instance, one of the most critical environmental problems of the 20th century. This is a problem not only in urban areas, but also in rural areas, where agriculture is extensively practiced.

Urban river pollutants include both dissolved and suspended wastes. These include solid wastes such as domestic wastes, commercial, industrial and agricultural wastes. Other forms of river pollutants include treated and untreated raw sewage. On the other hand, we have effluents from urban industries that have recently been posing a great threat to the quality of urban rivers.

River pollutants can be classified into eight basic categories, namely; *organic wastes, infectious agents, plant nutrients, synthetic organic chemicals, inorganic chemicals, sediments, radioactive pollution and temperature increase* (Beck and Goplerud III, 1988 as quoted by Solanes, 1991).

Plate 2.1a, b & c: River pollution (Dumping of Waste on the River Corridor)



Source: Field Survey, 2014

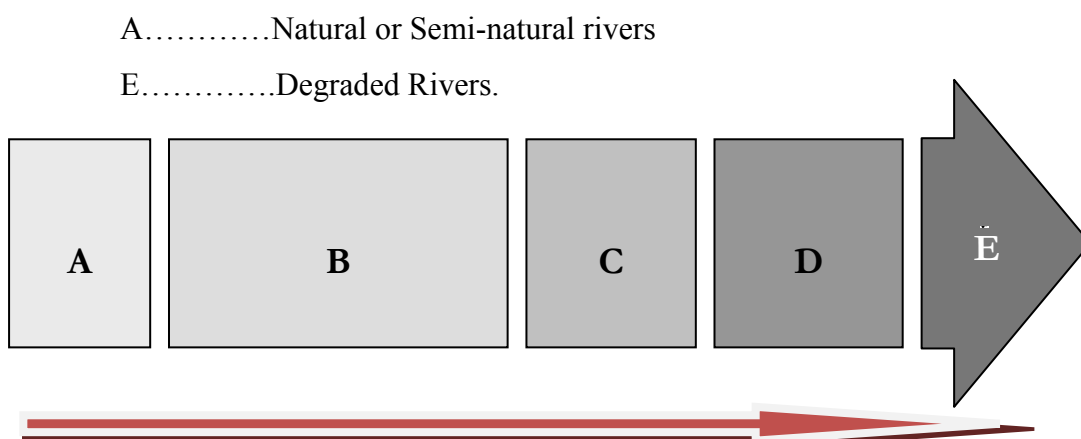
2.4.1 Urban River Degradation

Water quality in many urban river basins all over the world is being severely degraded. To make the matter worse, this has turned out to be a recurring problem; both in developed and developing countries (Gardiner, 1992). Furthermore, degradation of urban river systems is not confined to a particular geographic region of the world, but common to all areas subject to urbanization (Morley and Karr 2002).

2.4.2 Degree or Level of Urban River Degradation

The level of urban river degradation differs from one geographical area to the other depending on the socio-economic activities of these areas (Boon, 1992). In some areas we have rivers that are still pristine while in others we see cases of rivers which have been severely degraded to the extent that their recovery cannot be bet upon. This can best be illustrated by use of a hypothetical gradient devised by Boon (1992), as shown in Figure 2.2 below.

Figure 2.2: Sliding Scale on the Condition of Urban Rivers



Source: Adapted from Boon, 1992

Table 2.1: State versus Management Options for Urban Rivers.

| CHARACTERISTIC OF THE RIVER | AVAILABLE OPTION FOR CONSERVATION |
|-------------------------------------|---|
| A.....Natural or semi natural river | Preservation of the river; a leave-alone policy. |
| B.....Slightly degraded rivers | Limitation of Catchment’s development. |
| C.....Medium level of degradation. | Mitigation in which need for river regulation, abstraction and waste disposal is accepted. |
| D.....Highly degraded rivers | Restoration in which attempts are made to enhance the process of recovery. |
| E.....Extremely degraded rivers | Dereliction in which the river is totally degraded that the only conservation measure available is to accept the status quo. |

Source: Adapted from Boon, 1992

In Figure 2.2 above, at point A of the spectrum, the case is of preservation of the few remaining examples of natural or semi-natural systems. The end E of the spectrum (Figure 2.2) marks the end of the road for river conservation. This represents rivers that have become so degraded for one reason or another that in the short and medium terms the only management option is to accept status quo and direct resources towards restoration projects which have a fair chance of success (Boon, 1992).

The above model (Figure 2.2) is a useful tool to consider prior to undertaking of any conservation measures on our river corridors. This is important in that it illuminates the level of pollution in our urban rivers and therefore sets us to prepare for their respective conservation options accordingly. For instance, there are those river corridors that require conservation and those that should be left alone; that is the case for preservation, which may call for special management. Lake (1980) as quoted by Boon (1992), observes that preservation is particularly necessary especially in countries like Australia where we have few wild or pristine rivers left to conserve.

On the other hand, we can use the above model to illustrate the stages in which our urban river corridors have undergone or are undergoing since the establishment of urban centres. It is clear from history that the earliest civilization (such as the Sumerian and Egyptian civilization) begun on river valleys. This was because such locations offered ample water for both domestic and commercial activities as well as for growing crops needed to sustain urban life. It is with no doubt that the said rivers were in their natural state and their quality was good as illustrated at end A of the spectrum (Figure 2.2). From here, we now start seeing different scenarios of compromised quality of rivers and their corridors all arising from various anthropogenic activities in, on and adjacent our rivers. This commences with discharge of small amount of pollutants, and as the urban population and activities increase, this culminates in a total degradation of the river; a level at which its recovery not guaranteed.

Scheder et al (1973), as quoted by UNEP (1991) noted that water, particularly rivers, are both arteries and veins of urban life and this is of course, one of the driving forces that led to the establishment of Nairobi city. The presence of clean water from the river was a blessing not only to urban residents, but also to ecological processes in Nairobi city. It was specifically deemed that such water would meet the day to day needs of urban life; but this dream was short-lived. What was once a fresh water river corridor is now “black liquor” consisting of both dissolved and suspended waste materials (Karisa, 2002). In view of this, one is therefore left to wonder

whether there is any hope on life of this river corridor. The big question is: to what extent is Nairobi River corridor degraded and at what level of Figure 2.2 above, can we trace or locate this river corridor?

Appropriate answers to these questions should therefore set us on the kind of conservation measures we are likely to apply for a sustainable management and conservation of the River corridor. This however, should be a matter of urgency in order to avoid reaching the end of the spectrum (E) in the Figure 2.2; if by any chance we are not yet there!

2.5 Causes/Sources of Urban River Degradation

Over the last years, in many countries (especially African countries) a considerable population growth has taken place, accompanied by a steep increase in urbanization, industrial and agricultural land use (Kanu, Ijeoma and Achi, O.K., 2011). These human activities are profoundly affecting river basin ecosystems, and the availability and quality of water resources (UNCHS, 1995). Waste management however appears to be the main cause of river degradation especially in urban areas. Actually, improper management of vast amount of wastes generated by various anthropogenic activities appears to be one of the most critical problems of water especially in developing countries. More challenging is the unsafe disposal of these wastes into the ambient environment. Water bodies especially freshwater reservoirs are the most affected. This has often rendered these natural resources unsuitable for both primary and/or secondary usage (Kanu, Ijeoma and Achi, O.K., 2011).

2.5.1 Causes of River Degradation and their Effects in the Environment

Population explosion, haphazard rapid urbanization, industrial and technological expansion, energy utilization and wastes generation from domestic and industrial sources have rendered many water resources unwholesome and hazardous to man and other living resources across the world. Indeed, water pollution is now a significant global problem (Kanu, Ijeoma and Achi, O.K., 2011). Broadly, major problems affecting the quality of rivers arise from urbanization, deforestation, damming of rivers, destruction of wetlands, industries, mining, agriculture, energy use and accidental water pollution (Rand Water, 2014).

- a) Urbanization:** As more and more people move into cities and towns, a number of factors cause water degradation or pollution. These include the physical disturbance of land due to construction of houses, industries, and roads among others, chemical pollution from

industries, mines, etc., and inadequate sewage collection and treatment. Other factors include litter, (which causes disease and has a negative visual impact) and increase in fertilizers to grow more food. Use of fertilizers results in an increase in nutrients (nitrates and phosphates) in the water which causes enhanced plant growth (algal blooms). When this plant material dies and decays the bacteria uses the oxygen in the water. This lowering of oxygen levels results in the death of other water life that needs oxygen to survive, e.g. fish, etc. This process is called eutrophication.

- b) Deforestation:** Clearing land for agriculture and urban growth often leads to water pollution. When soil is stripped of its protective vegetation it becomes prone to soil erosion. This leads to an increase in the murkiness of the water which can block the gills of fish, stop bottom dwelling plants from photosynthesizing as the sun's rays cannot reach them, as well as cause an increase in disease as bacteria and viruses use the soil particles as a method of transportation.
- c) Damming of Rivers:** Damming of rivers can have an impact on water in that water flowing out of dams has reduced suspended material as a large amount settles to the bottom of dams, and is also depleted of nutrients besides often being more saline with detrimental effects on downstream agriculture and fisheries. Further, enhanced eutrophication may result due to the water spending a longer time in the dam. There is also increased evaporation in dams, especially those with a large surface area, such as the Vaal Dam, in South Africa.
- d) Destruction of Wetlands:** Wetlands are nature's way of cleaning water as well as damming water (they hold back water in summer and release it in winter). Destruction of wetlands destroys the habitat of many birds and fish, removes the natural filters capable of storing and degrading many pollutants, such as phosphorus and heavy metals, and destroys natural dams and causes flooding further downstream.
- e) Industries:** Industries are the major sources of pollution in all environments. Based on the type of industry, various levels of pollutants can be discharged into the environment directly or indirectly through public sewer lines. Wastewater from industries includes employees' sanitary waste, process wastes from manufacturing, wash waters and relatively uncontaminated water from heating and cooling operations. In Nigeria for instance, industrial effluent contamination of natural water bodies has emerged as a major

challenge. Estuaries and inland water bodies, which are the major sources of drinking water in Nigeria, are often contaminated by the activities of the adjoining populations and industrial establishments (Kanu, Ijeoma and Achi, O.K., 2011). According to Rand Water (2014) industries produce waste that can affect the pH of water (whether it is acid, neutral or alkaline), colour of water, amount of nutrients (increase in nutrients can cause eutrophication), temperature (increase or decrease in temperature can have an impact on temperature sensitive organisms living in the water), amount of minerals and salts (too much can cause health problems) and murkiness of water (can block fish gills; bottom dwelling plants cannot photosynthesize as the sun's rays cannot reach them; increase in disease as bacteria and viruses use the soil particles as a method of transportation).

- f) Mining:** Mines produce waste that can increase the amount of minerals and salts in the water (too much can cause health problems), can affect the pH of the water (whether it is acid, neutral or alkaline) and can increase the murkiness of the water.

- g) Agriculture:** Increases soil erosion due to the physical disturbance of soil and vegetation due to ploughing, overgrazing, shifting cultivation, poor agricultural practices, logging and road building. This affects the murkiness and the amount of salts and minerals in water, increases nutrients due to fertilisers and excreta, which contribute worrying amounts of nitrates and phosphates to water supplies (this can cause eutrophication) and increased pesticide use.

- h) Energy Use:** As human populations increase, more energy is required for human activities such as cooking, lighting, etc. In South Africa for instance, the majority of our energy comes from the burning of coal at power stations and results in greatly increased emissions of sulphur and nitrogen oxides into the atmosphere. These gases are the main cause of acid rain. Also the release of carbon dioxide, from the burning of coal, increases global warming.

- i) Accidental Water Pollution:** Accidental water pollution can arise from many sources (such as burst pipes and tanks, major leaks, fires and oil spills) and can cause varying degrees of damage, depending on the quantity, toxicity and persistence of the pollutant, and the size and adaptability of the water body.

2.5.2 Sources of Urban River Pollutants

In urban areas, industrial wastes, municipal or commercial wastes, have been identified as some of the major river pollutants. Industrial wastes contain toxic and polluting minerals, and untreated or partially treated domestic sewage contains organic pollutants. Pollution entering rivers and streams comes from two major sources: *Point source* and *Non-point source*. Point source involves those pollution sources from which distinct pollutants can be identified, such as factories, refineries or outfall pipes. In this case, pollutants such as urban sewage and industrial wastewater are usually conveyed by man-made conduits to a single place or disposal, hence easily identified. Non-point source on the other hand involves pollution from sources that cannot be precisely identified, such as runoff from agricultural or mining operations or seepage from septic tanks or sewage drain fields. Non-point sources are of diffuse character, difficult to identify and hydrologically highly variable (Solanes, 1991).

Agro-pastoral economies in the urban environments are also contributory factors to the degradation of urban rivers and their corridors. Runoff from urban agriculture contains fertilizers and pesticides which have adverse effects to the river basin ecosystems. Furthermore, wastes from their pastoral activities end up in rivers hence affecting the quality of these rivers. This understanding is therefore vital for effective planning of river conservation. Hence, radical new approaches are needed to counter the critical effects of river pollution for sustainable development and water supplies (Ibid).

River systems are the primary means for disposal of waste, especially the effluents, from industries that are near them. These effluents from industries have a great deal of influence on the pollution of the water body. They can alter the physical, chemical and biological nature of the receiving water body. Increased industrial activities have led to pollution stress on surface waters both from industrial, agricultural and domestic sources.

Wastes entering these water bodies are both in solid and liquid forms. These are mostly derived from industrial, agricultural and domestic activities. As a result, water bodies which are major receptacles of treated and untreated or partially treated industrial wastes have become highly polluted. The resultant effects of this on public health and the environment are usually great in magnitude.

High levels of pollutants in river water systems causes an increase in biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), total suspended solids

(TSS), toxic metals such as Cd, Cr, Ni and Pb and faecal coliform and hence make such water unsuitable for drinking, irrigation and aquatic life. Industrial wastewaters range from high biochemical oxygen demand (BOD) from biodegradable wastes such as those from human sewage, pulp and paper industries, slaughter houses, tanneries and chemical industry. Others include those from plating shops and textiles, which may be toxic and require on-site physiochemical pre-treatment before discharge into municipal sewage system (Kanu, Ijeoma and Achi, O.K., 2011).

Organic pollution of inland water systems in Africa, in contrast to the situation in developed countries of the world, is often the result of extreme poverty and economic and social underdevelopment. According to Tolba, it is in these countries that the quality of water, and often the quantity, is lowest, sanitation and nutrition the worst and disease most prevalent. Unfortunately, there are very few water quality studies for most African inland waters. In general, the available data come from scattered investigations, which were carried out by individuals and by very few scientific projects concerned with African waters. Few reviews exist on the state of pollution of African inland waters (Ibid).

Contributing to the menace of indiscriminate discharges of industrial effluents in receiving water bodies is the improper disposal of domestic wastes, particularly in urban centres of most developing countries. Open and indiscriminate dumping of solid wastes in drainages and riverbanks is one of the most critical problems facing many developing countries. Sewage effluents rich in decomposable organic matter, is the primary cause of organic pollution. Domestic wastes in the country like in many other developing countries may now contain modern environmental health hazardous substances thus posing additional risk to public health (Ibid).

2.5.3 Causes of River Degradation in Kenya

In Kenya, rapid urbanization, industrialization, poor urban planning and weak enforcement of the environmental laws has led to serious environmental degradation in our cities and towns. In Nairobi City for instance, rapid population growth, urbanization and industrialization have put enormous pressure on urban rivers though even rural rivers are not spared. Nairobi's main rivers, notably Nairobi, Ngong/Motoine and Mathare Rivers are a good example of severely polluted rivers in our urban environments. These rivers have borne the brunt of untreated industrial effluents, raw sewage and waste from commercial activities drain into the river. According to NRBP Phase II Report (2003), discharge of untreated industrial effluent, raw sewage and solid

waste from human settlements along the river courses has turned the once clear and pure water into a health hazard. Considerable amount of solid waste is particularly swept into Nairobi River during rain storms. An inadequate sewerage system has also led to illegal discharges into the rivers. The continued water pollution and environmental degradation of Nairobi river basin has led to health problems such as increased water borne diseases, respiratory complications, among others stress on immediate aquatic ecosystems as well as downstream, reduction of the economic value of premises along the river basin and reduction in the natural beauty of the river basin.

Accelerating pollution, in particular dangerously high coliform counts in all the rivers are destroying the aquatic system posing a serious danger to any household consumers of river water. High coliform counts have been a result of the regular tampering with sewage pipes upstream for the purposes of irrigation, while solid waste and raw sewage drain directly into the rivers from the riverside slums.

Untreated industrial effluents, dumping of textiles, waste packaging, and scrap metal have caused serious environmental pollution (NRBP Phase II Report 2003). Further, heavy metal pollutants enter the water streams right from the rivers' sources, posing great threats to crops irrigated with this polluted water. Water related diseases such as typhoid, amoebiasis and diarrhoea have become quite prevalent in these areas. In many parts of Nairobi, where no formal water or sewerage infrastructure exist, these contaminated waters are still being consumed by the river basin communities that depended on the river for their livelihood. This has become a major concern to the government of Kenya and environmental protection agencies.

Plate 2.2: Dumping of Solid Waste onto the Nairobi River Corridor



Plate 2.3: Direct Discharge of Sewer into the Nairobi River



Source: Field Survey, 2014

2.6 Policy, Legislative and Institutional Measures for Sustainable Utilization and Conservation of River/Water Resources in Kenya

2.6.1 National Policies for Conservation of River/Water Resources in Kenya

Some of the policies, for river/water Conservation in Kenya include:

2.6.1.1 The National Environment Action Plan Framework 2009–2013

Environmental Action Planning is a tool that aims at enhancing the integration of environment into development planning. In this regard, the Environmental Management Co-ordination Act (EMCA), 1999 provides for the formulation of the National, Provincial and District Environment Action Plans every five years. This document incorporates salient issues identified in various Districts and Provincial Environment Action plans. The National Environmental Action Planning (NEAP) highlights priority themes and activities for the country towards achieving sustainable development.

Chapter 2, sub-section 2.2 addresses the water resources whose main challenges are highlighted as soil erosion and siltation control, water catchments protection, ensuring compliance to water quality regulations, efficient water use strategies, management of invasive alien species, control of sand harvesting, management of trans-boundary waters, and regulated water abstraction and recommends for implementation of soil and water conservation measures, provision of incentives for conservation of water catchments, enforcement of EMCA, 1999 and other subsidiary regulations enforcement of Water Act 2002 and other related legislations, promotion of efficient water harvesting, storage and usage, implementation of best management practices on invasive species, implementation of sand harvesting regulations, enhancement of regional cooperation in management of trans-boundary waters, strengthening hydrological monitoring systems promotion of integrated water resource management, and development and implementation of appropriate compensation schemes for watershed ecosystem services.

2.6.1.2 Sessional Paper No. 6 of 1999 on Environment and Sustainable Development

The Sessional Paper was developed to set out comprehensive policy guidelines towards achieving sustainable development and in response to the increasing concerns regarding the effects of development on the environment. The paper highlights various challenges to sustainability under various broad categories. Under the water resources sector the paper notes the following challenges:

- Absence of comprehensive legislation on water quality and effluent standards;
- Absence of provisions for environmental impact assessments on water project programmes;
- Absence of guidelines delineating institutional responsibilities;
- Inadequate environmental requirements in the Water Act, for example in the management of wetlands;
- Inappropriate agricultural practices which have led to contamination of water courses and bodies through excessive use of agricultural pesticides and fertilizers;
- Inappropriate technologies for disposal of municipal liquid and solid wastes; and
- Inadequate policy incentives and mechanisms for promoting sustainable management and conservation of water resources including harvesting of surface water.

The paper recommends the following approaches:

- Revision of the existing legislation relevant to water resources, waste water and solid or refuse disposal and agricultural practices with a view to improve water quality;
- Emphasis be placed optimum usage , storage, conservation and recycling of water;
- Encouragement of industrialists through incentives and penalties to install pollution control and water recycling technologies;
- Formulation of guidelines and establish standards;
- Monitoring compliance with water undertakers and industrialists alike;
- Protection of the countries marine environment from oil spillage and waste dumping;
- Protection of water catchment's areas through conservation and management laws;
- Prioritization of water allocation in quantity and quality according to domestic, commercial and agricultural needs, and for sustenance of the environment; and
- Charging realistic rates for water usage and sewage discharge.

2.6.1.3 The National Biodiversity Strategy, 2007

Kenya is a party to the Convention on Biological Diversity (CBD). Under Article 6 of the Convention, Kenya is expected to report regularly on its national framework of action for the implementation of the Convention to ensure that the present rate of biodiversity loss is reversed, and that present levels of biological resources are maintained at sustainable levels for posterity, guided by the overall objective which is 'conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits'.

2.6.1.4 Sessional Paper No. 1, National Policy on Water Resources Management and Development

This Sessional Paper aims at achieving sustainable development and management of the water sector by providing a framework in which the desired targets/goals are set, outlining the necessary measures to guide the entire range of actions and to synchronise all water related activities and actors. It underscores the principle and recognition of the fact that the private sector offers invaluable potential, which has not been fully harnessed to contribute to sustainable development of the water sector. The basic area the Paper has addressed itself includes water resources management, water supply and sewerage development, institutional arrangement and financing of the water sector.

The Paper is guided by four (4) specific policy objectives covering the above-mentioned four basic areas. These have been set to guide the sector activities in addressing water management challenges. The objectives are as follows:

- To preserve, conserve and protect available water resources and allocate it in a sustainable, rational and economical way;
- To supply water of good quality and in sufficient quantities to meet the various water needs, including poverty alleviation, while ensuring safe disposal of wastewater and environmental protection;
- To establish an efficient and effective institutional framework to achieve a systematic development and management of the water sector; and
- To develop a sound and sustainable financing system for effective water resources management, water supply and sanitation development.

2.6.2 Legal Framework for Conservation of Environment, Water and Natural Resources in Kenya

2.6.2.1 The Constitution of Kenya, 2010

Article 42; Chapter 4 Part 2 of the Bill of Rights provides that every person has the right to a clean and healthy environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative and other measures. As such, the need to protect our rivers cannot be over-emphasized.

Article 69; Chapter 5 Part 2 on *Environment and Natural Resources* mandates the state to:

- a) Ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits;
- b) Work to achieve and maintain a tree cover of at least ten (10) per cent of the land area of Kenya;
- c) Protect and enhance intellectual property in, and indigenous knowledge of, biodiversity and the genetic resources of the communities;
- d) Encourage public participation in the management, protection and conservation of the environment;
- e) Protect genetic resources and biological diversity;
- f) Establish systems of environmental impact assessment, environmental audit and monitoring of the environment;
- g) Eliminate processes and activities that are likely to endanger the environment; and
- h) Utilize the environment and natural resources for the benefit of the people of Kenya.

Article 70; Chapter 5 Part 2 If a person alleges that a right to a clean and healthy environment recognized and protected under Article 42 has been, is being or is likely to be, denied, violated, infringed or threatened, the person may apply to a court for redress in addition to any other legal remedies that are available in respect to the same matter.

2.6.2.2 The Environment Management and Co-ordination Act, 1999

Part II of the Environment Management & Coordination Act, 1999 states that every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment.

Part VI Section 58 of the Act provides that the Proponent of a project shall undertake or cause to be undertaken at his own expense an *Environmental Impact Assessment (EIA)* study which shall be conducted in accordance with the Environmental Impact Assessment Regulations, Guidelines and Procedures .and a report shall be submitted to the Authority who in turn may issue a license as appropriate.

Part VIII Section 72 states that any person who upon the coming into force of this Act, discharge or applies any poison, toxic, noxious or obstructing matter, radioactive waste or other pollutants or permits any person to dump or discharge such matter into the aquatic environment

in contravention of Water Pollution Control Standards established under this Part shall be guilty of an offence.

Section 87 sub-section 1 states that no person shall discharge or dispose of any wastes, whether generated within or outside Kenya, in such a manner as to cause pollution to the environment or ill health to any person.

Section 88 provides for acquiring of a license for generation, transporting or operating waste disposal facility.

According to **Section 89**, any person who, at the commencement of this Act, owns or operates a waste disposal site or plant or generate hazardous waste shall apply to the National Environmental Management Authority (NEMA) for a license.

Section 90 states that no person shall discharge any hazardous substance, chemical, oil or mixture containing oil into any waters or any other segments of the environment contrary to the provisions of this Act or any regulations there under.

Finally, the Environmental Impact Assessment Guidelines require that, study be conducted in accordance with the issues and general guidelines spelt out in the Second and Third Schedules of the Regulations. These include coverage of the issues on Schedule 2 (Ecological, Social, Landscape, Land Use and Water Considerations) and General Guidelines on Schedule 3 (Impacts and their Sources, Project Details, National Legislation, Mitigation Measures, a Management Plan and Environmental Auditing Schedules and Procedures).

2.6.2.3 Environmental Management and Co-ordination (Water Quality) Regulations, 2006 (Legal Notice No. 120)

These regulations were drawn under section 147 of the Environmental Management and Co-ordination Act (EMCA) 1999.

Part III Section 11 states that no person shall discharge or apply any poison, toxic, noxious or obstructing matter, radioactive waste or other pollutants or permit any person to dump or discharge such matter into the aquatic environment unless such discharge, poison, toxic, noxious or obstructing matter, radioactive waste or pollutant complies with the standards set out in the Third Schedule of these Regulations.

Section 14 provides for the issuance of a license under this Act for persons who generates and discharges effluent into the environment and prescribes for quality and quantity monitoring in accordance with methods and procedures of sampling and analysis prescribed by the Authority, and shall submit quarterly records of such monitoring to the Authority or its designated representative.

Part IV Section 24 protects against discharge or applying of any poison, toxic, noxious or obstructing matter, radioactive wastes, or other pollutants or permit any person to dump or discharge any such matter into water meant for fisheries, wildlife, recreational purposes or any other uses unless such discharge, poison, toxic, noxious or obstructing matter, radioactive waste or pollutant complies with the standards set out in the Third Schedule to these Regulations.

2.6.2.4 Environmental Management and Co-ordination (Waste Management) Regulations, 2006 (Legal Notice No. 121)

The regulations are formed under sections 92 and 147 of the Environmental Management and Co-ordination Act (EMCA), 1999.

Part III Section 18 states that no owner or operator of a trade or industrial undertaking shall discharge or dispose of any waste in any state into the environment, unless the waste has been treated in a treatment facility and in a manner prescribed by the Authority in consultation with the relevant lead agency.

Section 19 to 21. The regulation applies to the wastes generated and drawn under the air quality regulations, water quality regulations and solid wastes generated by industries.

In **Section 24**, the regulation defines hazardous wastes their handling, storing, and transportation.

Section 26 states that every person who generates toxic or hazardous waste shall treat or cause to be treated such hazardous waste using the classes of incinerators or any other appropriate technology approved by the Authority.

2.6.2.5 Environmental Management and Co-ordination (Conservation of Biodiversity Diversity and Resources Access to Genetic Resources and Benefit Sharing) Regulations, 2006

Part II Section 4 states that a person shall not engage in any activity that may have an adverse impact on any ecosystem or lead to the introduction of any exotic species or lead to unsustainable use of natural resources without an Environmental Impact Assessment License issued by the Authority under the Act.

Section 5 advocates for the conservation of threatened species, their recovery and rehabilitation.

Section 8 provides for protection of environmentally significant areas which apply to any area of land, sea, lake or river to be a protected natural environment system for purposes of promoting and preserving biological diversity.

2.6.2.6 The Water Act 2002

The Act provides for the management, conservation, use and control of water resources and for the acquisition and regulation of rights to use water; to provide for the regulation and management of water supply and sewerage services;

It prescribes in accordance with which the water resources of Kenya shall be managed, protected, used, developed, monitored, conserved and controlled.

Part II Section 4 declares that every water resource is vested in the State, subject to any rights of user granted by or under this Act or any other written law.

Part II Section 7 establishes the Water Resource Management Authority (WRMA) whose mandate is to *regulate, manage and monitor water resources* in accordance with the act

Part II Section 11 of the act provides for the preparation of a National Water Resources Management Strategy in accordance with which the water resources of Kenya detailing how they shall be managed, protected, used, developed, conserved and controlled.

The Act provides for provision of a permit for any of the following purposes:—

- a) Any use of water from a water resource;
- b) The drainage of any swamp or other land;
- c) The discharge of a pollutant into any water resource; and
- d) Any purpose, to be carried out in or in relation to a water resource, which is prescribed by rules made under this Act to be a purpose for which a permit is required.

Owing to drought, natural changes, increased demand or other cause, the use of water under a permit, or the method or point of diversion or other manner in which the water is so used causes-

- a) Inequity;
- b) Deterioration in the quality of water;
- c) Shortage of water for domestic purposes; or
- d) Shortage of water for any other purpose which in the opinion of the Authority should have priority.

The permit as well may be revoked or withheld.

Section 94 (1) states that no person shall, without authority under this Act (Water Act, 2002)

- a) Willfully obstruct, interfere with, divert or obstruct water from any watercourse or any water resource, or negligently allow any such obstruction, interference, diversion or abstraction; or
- b) Throw or convey, or cause or permit to be thrown or conveyed, any rubbish, dirt, refuse, effluent, trade waste or other offensive or unwholesome matter or thing into or near to any water resource in such manner as to cause, or be likely to cause, pollution of the water resource.

The Act establishes the Water Regulatory Board with the following mandates

- To issue licences for the provision of water services;
- To determine standards for the provision of water services to consumers;
- To establish procedures for handling complaints made by consumers against licensees;
- To monitor compliance with established standards for the design, construction operation and maintenance of facilities for water services;
- To monitor and regulate licensees and to enforce licence conditions;
- To advise licensees on procedures for dealing with complaints from consumers and to monitor the operation of these procedures;
- To develop guidelines for the fixing of tariffs for the provision of water services; and
- To develop guidelines for and provide advice on the cost effective and efficient management and operation of water services.

2.6.2.7 Water Resources Management Rules, 2007

One of the outcomes of the water sector reforms has been improved regulatory framework for water resource management and use. In addition to the Water Act 2002, the main document

outlining the regulations is the Water Resource Management Rules 2007. The rules set out the procedures for obtaining water use permits and the conditions placed on permit holders. Sections 54 to 69 of the Water Resources Management Rules 2007 impose certain statutory requirements on dam owners and users in regard. Other sections within the rules indicate that Water Resources Management Authority (WRMA) can impose water quality sampling requirements from the water sources and impacts to the hydrology, water chemistry and river morphology downstream basin.

Section 16 of the Water Rules requires approval from the Water Resources Management Authority (WRMA) for a variety of activities that affect the water resources, including the storage of water in dams and pans. Approval by WRMA is conferred through a Water Permit. A permit is valid for five (5) years and must be renewed.

Section 104 of the Water Resource Management Rules requires certain water permit holders to pay water use charges. The intention of the water use charges was to raise revenue for water resource management, raise revenue for catchment conservation activities, improve efficiency of water resource abstraction and provide a system of data collection on water resource usage.

2.6.2.8 Public Health Act (Cap 242)

Part IX Section 115 states that no person shall cause a nuisance or shall suffer to exist on any land or premises owned or occupied by him or of which he is in charge of any nuisance or other condition liable to be injurious or dangerous to health. **Section 116** mandates Local Authorities to maintain cleanliness and prevent nuisances.

Section 118 defines what constitutes nuisance to include:

- a) Any street, road or any part thereof, any stream, pool, ditch, gutter, watercourse, sink, water-tank, cistern, water-closet, earth-closet, privy, urinal, cesspool, soak-away pit, septic tank, cesspit, soil-pipe, waste-pipe, drain, sewer, garbage receptacle, dust-bin, dung-pit, refuse-pit, slop-tank, ash-pit or manure heap so foul or in such a state or so situated or constructed as in the opinion of the medical officer of health to be offensive or to be injurious or dangerous to health; and
- b) Any noxious matter, or waste water, flowing or discharged from any premises, wherever situated, into any public street, or into the gutter or side channel of any street, or into any nullah or watercourse, irrigation channel or bed thereof not approved for the reception of such discharge.

Section 119 provides the medical officer of health, with power to serve a notice on the author of the nuisance if satisfied of the existence of a nuisance, requiring him to remove it within the time specified in the notice.

Section 129 states that it shall be the duty of every local authority to take all lawful, necessary and reasonably practicable measures:

- a) For preventing any pollution dangerous to health of any supply of water which the public within its district has a right to use and does use for drinking or domestic purposes (whether such supply is derived from sources within or beyond its district); and
- b) For purifying any such supply which has become so polluted, and to take measures (including, if necessary, proceedings at law) against any person so polluting any such supply or polluting any stream so as to be a nuisance or danger to health.

2.6.2.9 Land Act 2012

Section 11 (1) states that the National Land Commission shall take appropriate action to maintain public land that has endangered or endemic species of flora and fauna, critical habitats or protected areas. (2) It shall also identify ecologically sensitive areas that are within public lands and demarcate or take any other justified action on those areas and act to prevent environmental degradation and climate change.

Section 17 (1) states that a management body shall, on its own motion or at the request of the Commission, submit to the Commission for approval a plan for the development, management and use of the reserved public land vested in the management body. (2) Before submitting a plan to the Commission under subsection (1) a management body shall—

- a) Consider any conservation, environmental or heritage issues relevant to the development, management or use of the public land in its managed reserve for the purpose of that managed reserve; and
- b) Incorporate in the plan a statement that it has considered those issues in drawing up the plan;
- c) Submit an environmental impact assessment plan pursuant to existing law on environment; and
- d) Comply with the values and principles of the Constitution.

Section 111 (1) calls for just compensation for land acquired compulsorily - to be paid in full to all persons whose interests in the land have been determined.

Section 150 states that the Environment and Land Court established in the Environment and Land Court Act is vested with exclusive jurisdiction to hear and determine disputes, actions and proceedings concerning land under this Act.

2.6.2.10 Physical Planning Act (Cap 286)

Section 16 (1) provides for the preparation of a regional physical development plan by the Director within the area of authority of a county council for the purpose of improving the land and providing for the proper physical development of such land, and securing suitable provision for transportation, public purposes, utilities and services, commercial, industrial, residential and recreational areas, including parks, open spaces and reserves and also the making of suitable provision for the use of land for building or other purposes.

Section 24 (1) also provides for the preparation of a local physical development plan for the general purpose of guiding and coordinating development of infrastructural facilities and services for an area referred to in sub-section.

Section 30 (1) states that no person shall carry out development within the area of a local authority without a development permission granted by the local authority. (2) Any person who contravenes shall be guilty of an offence and shall be liable to a fine not exceeding one hundred thousand shillings (Kshs. 100,000/-) or to an imprisonment not exceeding five (5) years or both.

The Act also gives the local authority power to compel the developer to restore the land on which such development has taken place to its original conditions within a period of ninety (90) days. If no action is taken, then the council will restore the land and recover the cost incurred thereto from the developer.

Section 36 requires that the applicant of proposals for industrial location, dumping sites, sewerage treatment, quarries or any other development activity that will have injurious impact on the environment, submit together with the application an Environmental Impact Assessment Report. The Environmental Impact Assessment Report must be approved by the National Environmental Management Authority (NEMA) and followed by annual environmental audits as spelled out by Environmental Management Coordination Act (EMCA) 1999.

2.6.2.11 Urban Areas and Cities Act, 2011

Section 36 provides for every city and municipality established under this Act to operate within the framework of integrated development planning which shall:

- a) Give effect to the development of urban areas and cities as required by this Act and any other written law;
- b) Strive to achieve the objects of devolved government as set out in Article 174 of the Constitution;
- c) Contribute to the protection and promotion of the fundamental rights and freedoms contained in Chapter Four of the Constitution and the progressive realization of the socio-economic rights; and
- d) Be the basis for the preparation of environmental management plans.

2.6.2.12 IDP Act: Protection and Assistance to Internally Displaced Persons and Affected Communities Act 2012

❖ Prevention of Displacement:

Section 5 (1) states that the Government and any other organization, body or individual shall guard against factors and prevent and avoid conditions that are conducive to or have the potential to result in the displacement of persons. (2) The Government and any other organization, body or individual shall prevent internal displacement in situations of armed conflict, generalized violence, human rights violations, natural or human-made disasters and development projects.

Section 6 (3) states that displacement and relocation due to development projects shall only be lawful if justified by compelling and overriding public interests and in accordance with the conditions and procedures in Article 5 of the Protocol, Principles 7—9 of the Guiding Principles and as specified in sections 21—22 of this Act.

Section 21 (1) insists that the Government shall abstain from displacement and relocation due to development projects or projects to preserve the environment and protect persons from displacement by private actors.

(2) In exceptional cases, displacement and relocation due to development projects or projects to preserve the environment may be:

- a) Authorized and carried out in accordance with the applicable law; Justified by compelling and over-riding public interests in the particular case; and
- b) Conducted when no feasible alternatives exist.

(3) Where displacement and relocation cannot be averted, the Government shall minimize it, mitigate its consequences and assist and protect the affected persons as provided for in sections 7 and 8 of this Act;

4) Where the displacement is permanent, the Government shall provide the affected persons with durable solution as provided for in section 9 of this Act.

❖ **Procedures for Displacement Induced by Development Projects**

Section 22 (1) states that subject to displacement of persons due to development projects or projects to preserve the environment, the Government shall:

- a) Seek the free and informed consent of the affected persons; and
- b) Hold public hearings on the project planning.

(2) The decision to give effect to the displacement of persons shall give the justification for the displacement and demonstrate that the displacement is unavoidable and no feasible alternatives exist. The decision shall contain detailed justification on the alternatives explored.

(4) The Government shall ensure that the displacement is carried out in manner that is respectful of the human rights of those affected taking in particular into account the protection of community land and the special needs of women, children and persons with special needs. This requires in particular:

- a) Full information of those affected, their effective participation, including by women, in the planning, management of the displacement, and in defining suitable durable solutions;
- b) Provision of safe, adequate and habitable sites and to the greatest practicable extent, of proper accommodation; and
- c) Creation of satisfactory conditions of safety, nutrition, health and hygiene and the protection of the family unity.

2.6.3 Institutional Arrangement for Conservation of Water Resources in Kenya

In 2002 the water sector reforms in Kenya culminated in the passing of the Water Act; the Act, which was gazetted in October 2002, gained legislative force in 2003. The Water Act introduced new water management institutions to govern water and sanitation (water sector institutions). While water resources remained vested in the state, the water reforms saw the introduction of the commercialization of water resources as part of the decentralization process and the participation of stakeholders in the management of national water resources.

2.6.3.1 Ministry of Environment Water and Natural Resources

The Ministry of Environment Water and Natural Resources (MEWNR) is the ministry in charge of the water sector and is therefore responsible for the overall management of water resources and general government policy on the water sector in the country. The Ministry was established with the goal of conserving, managing and protecting water resources for socio-economic development (Ministry of Environment, Water and Natural Resources, 2014).

Under the water sector reforms, the Ministry transferred management of and operation of water services to the Water Services Regulatory Board (WASREB) from mid-2005. The Director of water was the person in charge of water services in the ministry but these powers and duties were transferred to the regional water service boards that are now licensed by the WASREB to provide water services in different regions across the country. The ministry and other state corporations that were involved in water supply such as the National Water Conservation and Pipeline Corporation also transferred their water supply facilities to these regional water service boards. NGOs, CBOs and any other community self-help groups are required to enter into agreements with the respective regional water service boards with regard to use of water supply facilities owned by the community organisations (Ibid).

2.6.3.1.1 Water Resources Management Authority (WRMA)

The Water Resources Management Authority (WRMA) was formed as one of the water sector bodies under the water sector reforms; the body was established under the Water Act 2002. The overall mandate of WRMA is to protect and conserve water resources. Water resources for purposes of the Water Act include lakes, ponds, swamps, streams, marshes, watercourses or anybody of flowing or standing water both below and above the ground (Water Resource Management Authority, 2014).

The functions of the WRMA include planning, management, protection and conservation of water resources. The WRMA is also authorized to receive and determine applications for water permits and monitor their compliance. There are currently six established regional offices in Kenya these are Athi catchment area in Machakos, Tana catchment area in Embu, Rift Valley catchment area in Nakuru, Lake Victoria South catchment area in Kisumu, Lake Victoria North catchment area in Kakamega and Ewaso Nyiro North catchment area in Nanyuki (Ibid).

The WRMA responsibilities extend to the management of water catchments. The Water Act establishes the Catchment Area Advisory Committees whose principal functions are to advise

the WRMA on water resources conservation, use and apportionment at the catchment levels. WRMA is also expected to implement policies and strategies relating to the management of water resources; these include the National Water Resources Management Strategy and Integrated Water Resources Management and develop management strategies for water catchment areas (Ibid).

2.6.3.1.2 Catchment Area Advisory Committee

Catchment Areas Committees are formed in areas such that have been designated as Catchment Areas in accordance with the Water Act 2002. A catchment Area is one that is the source of a water course for example (*examples to be confirmed from WSTF*). Advisory Committees are formed by the WRMA in consultation with the Minister for Water and Irrigation (presently Cabinet Secretary for Environment, Water and Natural Resources). Each catchment area committee has membership of not more than 15 persons. The Catchment Area Advisory Committees may include representatives of community groups such as farmers and pastoralists and NGOs within catchment areas. The members are normally persons chosen to represent the different community groups around the catchment area. Given the definition and meaning of a catchment area, it is highly unlikely that there can be a CAAC in Nairobi area (Water Resource Management Authority, 2014).

2.6.3.1.3 Water Resources Users Association (WRUA)

Water resource management includes the involvement of Water Resource Users Associations, formed by community members and groups in cooperation with Catchment Area Advisory Committees (CAAC) in water resource management and conflict resolution (Water Services Trust Fund, 2014).

2.6.3.1.4 Water Services Regulatory Board (WASREB)

The Water Services Regulatory Board is established under the Water Act and was operationalized in March 2003. The functions of the WASREB include the issuance of licences to Water Service Boards and to approve service provision agreements concluded between Water Service Boards and Water Service Providers. The Water Service Providers are the agencies that directly provide water and sanitation services to consumers. The WASREB is responsible for ensuring that water services and supply are efficient and meet expectations of consumers through regulation and monitoring of Water Service Boards and Water Service Providers. To standardize service provision, the Board has the responsibility of developing among others, tariff guidelines (Water Service Regulatory Board, (2014).

The Board is therefore supposed to oversee the implementation of policies and strategies relating to provision of water and sanitation services, these policies include the National Water Services Strategy (2007 -2015), Pro-Poor Implementation Plan for Water Supply and Sanitation, the specific functions of the WASREB include:

- Providing information about water and sanitation services.
- Regulating the provision of water and sanitation services; this is done through such methods as setting standards for the provision of water services, monitor compliance of facilities for water supply with the set standards
- Licensing Water Service Boards such as the Athi Water Services Board and other regional water service boards and approving their appointed Water Service Providers through service provision agreements;
- Setting the rules, establishing standards guidelines and monitoring the performance of Water Service Boards and Water Service Providers and enforcing regulations.
- Establishing technical, water quality and effluent disposal standards.

2.6.3.1.5 Water Services Trust Fund (WSTF)

The Government of Kenya, through the Ministry of Water and Irrigation established the Water Services Trust Fund (WSTF) under the Water Act 2002 to channel funding for its long-term objectives of developing water and sanitation services in areas of Kenya without adequate water. The main objective of the WSTF is to assist in financing capital costs of providing services to communities without adequate water and sanitation services. The WSTF focuses on reaching those areas that are underserved or not served at all such as informal settlements, the priority being given to poor and disadvantaged groups. The projects are funded through direct allocation by the Government and donations and grants that may be received from bilateral and multilateral development partners, organisations and individuals. The WSTF works closely with Water Service Boards to ensure that funds available reach poor, vulnerable and marginalised groups in the implementation of projects (Water Services Trust Fund, 2014).

2.6.3.1.6 Water Appeals Board

The Water Appeals Board is established under the Water Act, 2002 to adjudicate disputes within the water sector. The Appeals Board is made up of three persons, one appointed by the President on advice of the Chief Justice and two others appointed by the Minister for Environment, Water and Natural Resources. The Water Appeals Board can hear and determine appeals arising from the decision of the Ministry of Water and Irrigation, the WASREB and the Water Resources

Management Authority (WRMA) with respect to the issuance of permits or licenses under the Water Act (Water Appeals Board, 2014).

A matter is supposed to be lodged with the appeals board within 30 days of communication of the decision to the affected person unless there is a different regulation that provides for a different length of period or other condition. The decision of the Appeals Board is final; however where a matter touches on a point of law, an appeal from the WAB may be filed before the High Court of Kenya (Ibid).

2.6.3.1.7 Water Services Boards (WSB)

Water Service Boards (WSBs) are constituted under the Water Act 2002. The WSBs are responsible for the provision of water and sewerage services within their areas of coverage and are licensed by the WASREB. The WSBs are also responsible for contracting Water Services Providers (WSPs) for the provision of water services. WSB and WSP enter into service provision agreements that include but not limited to the supply area, development, rehabilitation and maintenance of water and sewerage facilities of the WSBs. The WSBs are responsible for the review of the water services tariffs proposals from WSP before submission to WASREB for consideration (Centre on Housing Rights and Evictions, 2010).

There are currently eight established WSBs namely, Athi Water Services Board, Tana Water Services Board, Coast Water Services Board, Lake Victoria South Water Services Board, Lake Victoria North Water Services Board, Northern Water Services Board, Rift Valley Water Services Board and Tanathi Water Services Board (Ibid).

2.6.3.1.8 Athi Water Services Board (AWSB)

The Athi Water Services Board serves Nairobi city. The main responsibilities of AWSB are to:

- Expand coverage with strong focus on improving access to water services in urban informal settlements and to the rural poor.
- Contribute to poverty reduction, promote gender equity, sensitize communities on good health and hygiene practices, promote HIV/AIDS awareness and conserve the environment
- Appoint viable and well managed Water Service Providers and ensure they have appropriate systems by undertaking the following:
 - o Enforce water quality monitoring

- o Ensure they have maintenance systems and procedures to minimise interruptions to water supplies
- o Ensure they have accurate and efficient billing system.
- o Ensure they are customer-focused in all their activities.
- o Monitor and evaluate performances against targets for the Board and Water Service Providers.
- o Build Capacities of Water Service Providers to embrace efficiency, accountability and responsibility in service delivery.

To ensure the appointed WSPs have appropriate systems, Athi Water Services Board (AWSB) commits to;

- a. Enforce water quality monitoring in all WSPs
- b. Undertake planning and infrastructure development and ensure WSPs have maintenance systems and procedures in order to minimize interruptions to water supply
- c. Require WSPs to have accurate and timely billing
- d. Ensure all WSPs to have a customer focus in all their activities and be responsive to customers' needs and complaints

2.6.3.1.9 Water Service Providers

The functions of Water Service Providers (WSPs) include the direct provision of water and sanitation services and the development, rehabilitation and maintenance of water and sewerage facilities of the WSB. The Water Service Providers act as agents of the Water Service Boards. Under the Water Act, Water Service Providers are defined to include companies, NGOs, other persons or bodies. Under the Interpretation and General Provisions Act, the implications are that for community groups to qualify as Water Service Providers they must be formally registered under the Societies Act, Chapter 108 of the Laws of Kenya to gain legal personality (Centre on Housing Rights and Evictions, 2010).

2.6.3.2 National Environmental Management Authority (NEMA)

The Environmental Management and Coordination Act (EMCA) enacted in 1999 was passed to ensure sound environmental management. The Act entitles every person to a clean and healthy environment with corresponding obligations to protect and manage the environment. The Act establishes the National Environment Council (NEC), National Environment Management Authority (NEMA), provincial and district environment committees, and the Public Complaints Committee. These organs create avenues for public participation. Although the NEMA and

WRMA are the lead agencies responsible for the control of pollution the WASREB and WSBs are expected to enforce water and effluent quality testing and publication of result by the water service providers (National Environmental Management Authority, 2014).

2.6.3.3 Kenya Bureau of Standards (KEBS)

The Kenya Bureau of standards is formed under an Act of parliament with the main purpose of ensuring that the standard of products that are produced locally and internationally for consumption meet set international and local standards (Kenya Bureau of Standards, 2014). Currently, water quality standards and monitoring in Kenya adhere to the WHO guidelines as provided in the Kenyan water quality standards developed by the Kenya Bureau of Standards. The KEBS has laboratories with modern facilities for carrying out the tests. The KEBS has the Quality Inspection department that handles formal complaints on quality of products and carries out investigations of such complaints (Ibid).

2.6.3.4 Ministerial Co-ordination

In addition to the development of key national policies on water and sanitation, a number of government ministries have complimentary mandates to the Ministry of Environment, Water and Natural Resources. These include;

2.6.3.4.1 The Nairobi City Water and Sewerage Company (NCWSC)

The Nairobi City Water and Sewerage Company (NCWSC) is the Water Service Provider in charge of water services in Nairobi area. The NCWSC was formed to take over provision of water and sewerage services from the former Department of Water and Sewerage in the City Council of Nairobi. The institutional responsibility for installation of water and sanitation infrastructure was handed over to the NCWSC for maintenance, while the Athi Water Services Board remained responsible for laying large scale infrastructure such as trunk mains (Nairobi City Water and Sewerage Company, 2014).

2.6.3.4.2 Nairobi City County

The Nairobi City County is one of the County Governments in Kenya. The county derives its mandate from the Urban Areas and Cities Act and other laws that define its roles, functions and powers. The main functions of the Nairobi City County are to provide and manage basic services to residents in Nairobi. These services include basic education, housing, health, water and sewerage services, refuse and garbage collection, urban planning and development control among other services (Centre on Housing Rights and Evictions, 2010).

As regards water and sewerage services, the water sector reforms required actual water and sanitation services to be provided by water service providers such as the Nairobi City Water and Sewerage Company. The Nairobi City County is however responsible for the construction and maintenance of drainage channels and all other waste water (Ibid).

Under the Public Health Act and County Government Act, the Nairobi City County is also charged with the responsibility of ensuring proper storage, collection, transportation, safe treatment and, disposal of waste (Ibid).

2.6.3.4.3 Ministry of Interior and Co-ordination of National Government

The Ministry of Interior and Coordination of National Government is responsible for monitoring and regulating the disbursement of finances to all public bodies and to manage fiscal activities on national economic policies. Its key role with respect to water and sanitation is the mobilization of sufficient funds for the water and sanitation sector (Centre on Housing Rights and Evictions, 2010).

2.6.3.4.4 Ministry of Land, Housing and Urban Development

These ministries are jointly responsible for the provision of basic services such as water supply housing and sanitation infrastructure all relevant to the attainment of an adequate standard of living (Centre on Housing Rights and Evictions, 2010).

2.6.3.4.5 Ministry of Education

Attention to hygiene and basic sanitation education is a shared value between the Ministry of Environment, Water and Natural Resources and the Ministry of Education. The Ministry of Education's attention to ensuring public education and training complements the Ministry of Environment, Water and Natural Resources. The training curriculum is expected to training of children and adults on water use, hygiene and basic sanitation as well as protection of water resources (Centre on Housing Rights and Evictions, 2010).

2.6.3.4.6 Non-Governmental Organizations

NGOs play an important role in advancing the right to water and sanitation and are necessary stakeholders in the water sector. There are a number of Non-Governmental Organizations that deal with the various aspects on the right to water and sanitation in Nairobi. It is important to note that while some NGOs will assist CBOs with infrastructure development, others work purely on advocating for the human right to water and sanitation (Ibid).

2.7 Political, Economic, Social, Technological, Environmental and Legal

(P.E.S.T.E.L) Factors in River Conservation

The question has arisen of whether the economic, social, political or environmental spheres should have primacy in the quest for sustainable development. Some writers suggest that environmental conservation should have primacy. This is mostly because the continuing existence of mankind depends on the preservation of the biosphere (Tisdell, 1991).

While the above relationship is undoubtedly very important, it does not entitle us to neglect the other spheres. This is because all these spheres or systems are interdependent. For example, economic systems impact heavily on the environment or the biosphere, and social and political systems influence the operation of economic systems. However, this interdependence is neither one-way nor linear. Interconnections are numerous and these systems often evolve or change together; co-evolution occurs (Gowdy, 1994).

In the quest to conserve global biological resources there has been a growing recognition that conventional scientific methods and institutional arrangements are not always effective in dealing with the biophysical complexities and socio-political dimensions of biodiversity issues. Meeting these challenges requires an integrated approach that combines scientific methods with societal values. Community based research promotes social change, by building the capacity of communities to find collective and culturally appropriate ways to achieve sustainable development on their own terms. Ecosystem management recognizes the interconnectedness of social and ecological systems and attempts to link science, policy and societal goals through interdisciplinary research and multi-stakeholder decision-making. (Johnson, et al, 2003).

2.7.1 Political Factors in River Conservation

Political approaches to conservation are varied. In Australia for instance, one of the episodes in the diverse history of the Macquarie Harbour region unfolded during the summer of 1982-3, when the village of Strahan battled to save the Franklin River. The issue dominated Tasmanian politics caused great rifts between those who supported the construction of the dam and those who sought the preservation of the wilderness values of the region. In order to stem the growing wave of concern over the construction of the dam, the Labour Government of Premier Doug Lowe sought a compromise, passing legislation that paved the way for the construction of a dam on the Gordon-above-Olga, an alternative that did little to appease either pro or anti dam groups. In 1981 a referendum was held in an attempt to resolve the issue, giving the Tasmanian people the opportunity to express their support for the construction of either the Gordon-below-Franklin

or the Gordon-above-Olga scheme. The option of no dams, however, was withdrawn. This resulted in a staggering 44% of the electorate casting an informal vote by writing, 'No Dams' across their ballot ticket (Gordon River Tour Operators, 1980).

'Rights-based approaches' (RBAs) to conservation are used world over. The RBA is based on human rights referring to norms that help to protect all people from severe political, legal, social, or other abuses. They are based on the understanding that all people are, by virtue of being human, inherently entitled to minimum standards of freedom and dignity, regardless of nationality, place of residence, gender, origin, colour, religion, language, or any other status. Human rights are often, though not always, recognized and expressed in national or international law. Customary rights are also important, and may or may not be recognised in such legal frameworks. Despite clarification and expansion of recognised rights over the years, their nature and scope remains contested. These rights through organizations or the locals are used to push for the local's agendas and issues (Campese J, 2009).

Human rights approach in Kenya aimed at contributing to improved water governance in Kenya through strengthened capacities of the duty-bearers (the formal and informal water service providers and the regulators) and right holders. It aimed at strengthening capacities of duty-bearers and right-holders (water users) to effectively engage in water sector reforms towards effective water governance. The outcomes were to ensure capacity of water actors to understand and participate effectively and meaningfully in the water sector reforms enhanced; water dialogue forum as feedback and complaint redress mechanisms/tool between right-holders and duty bearers established at the local community level; improved information sharing and dissemination to local level actors for effective engagement with sector reform processes (UNDP in Kenya, (2014).

Other approaches could include an approach adopted by the Grand River Conservation Authority (GRCA) that chose to involve government (municipality) representatives to maintaining government support. One benefit in having a Board made up of municipality representatives is that it places a much greater emphasis on going out to the municipalities and explaining how the programs run and how the budget and levy requests relate. This has led to much greater political support (Grand River Watershed, 2014).

2.7.2 Social Factors in River Conservation

A random Google search for figures with the text “river management” offers pictures of river stretches, channels and (artificial) lakes in their natural context. Although channels, bridges, sluices and hydropower dams are direct signs of human interventions, people are hardly found on these figures. The same focus can be found in river conservation. River conservation has traditionally been associated with geomorphologic and hydrological characteristics of rivers, the way run-offs and water scarcity could be managed properly and with the question how rivers can be understood in a more detailed way (Pahl-Wost et al., 2008). Nonetheless, considering the river system as a whole, social aspects are probably most decisive for the river’s appearance and the way it will be managed, as the pictures resulting from the Google exercise also show. Any sustainability problem can only be defined in relation to people’s perceptions, needs, desires and goals (Offermans, 2012). A well-chosen sentence of J. David Tabara as quoted by Valkering (2009) says: “*Rivers don’t have problems. Only people may have problems with rivers*”. People’s beliefs, norms and values determine whether something is perceived as a problem or not. Further, people are the one’s influencing the river system through water consumption, navigation, recreation, irrigation, pollution, land use and the implementation of various water management strategies. However, these social aspects are probably least understood in current river management research (Valkering, 2009).

Water management has always been adapting to changing conditions. Although mostly successful in the end, adaptation processes are often costly and accompanied by disturbances in society (for example after a flood) (Offermans, 2012). In the coming years, water management may be challenged more through expected climate change and socioeconomic developments. More techniques and knowledge may be available but increasing population and urbanization may also result in limited space and increasing exposure to poor water quality risk (Ibid). The challenge is to cope sustainably with future uncertainties in both the water system and the social system (Haasnoot et al., 2011). Uncertainties in the social system involve changing perceptions, goals and beliefs on water and the way water is ideally being managed (Offermans, 2012). Sustainable water management strategies are able to cope with future uncertainties or can easily adapt to changing situations (Offermans, 2012). To explore the sustainability of different water management strategies under an uncertain future we need to take into account a wide range of uncertainties in both the water and social system (Ibid).

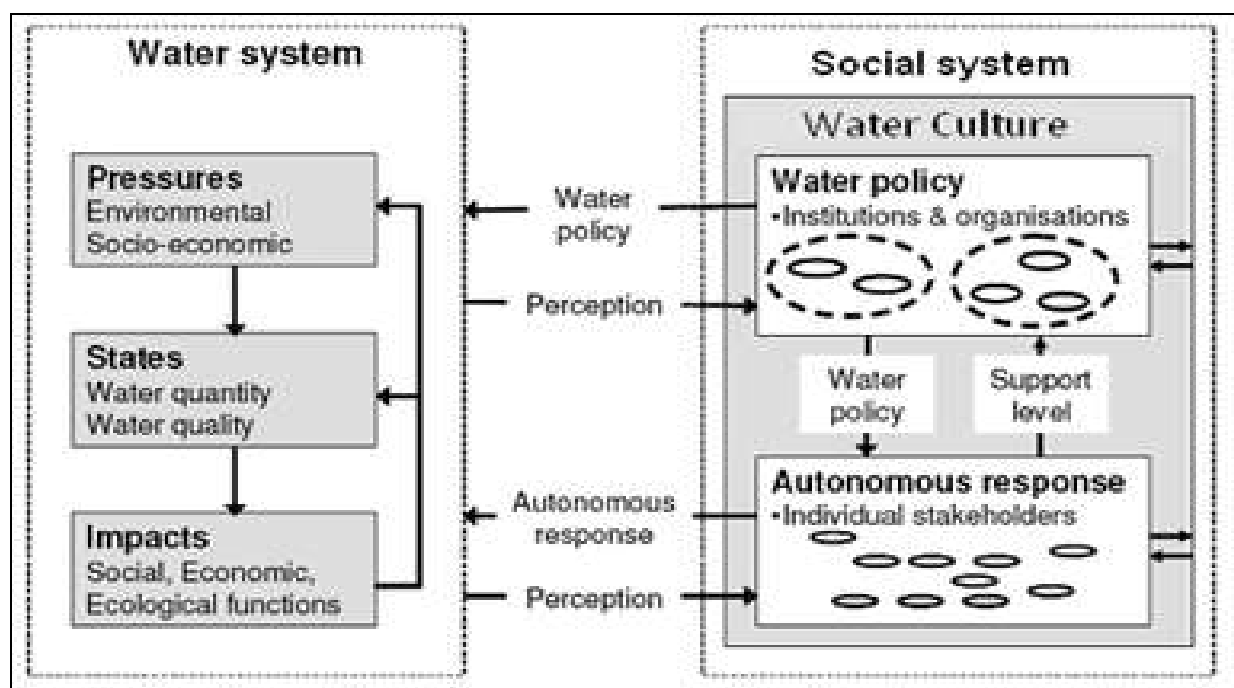
The PSIR concept, or Pressure - State - Impact - Response concept (OECD, 1993) provides an understandable but simplified overview on the interactions within and between society and the

water system in the form of an effect chain as shown in *figure 2.3* below. Environmental pressures such as climate change and land use changes influence the water availability. Socio-economic pressures determine the water demand and spatial claims. These factors influence the system state, including water quantity and water quality. The state has an impact on social, economic and ecological services, such as drinking water supply, agriculture and habitats. The responses, finally, are divided in water policy and autonomous responses. Water policy refers to practices, measures and implementations resulting from actions taken by policy institutions (local, regional, national or international). The autonomous responses include agricultural practices by farmers, the recreational use of water, lifestyle issues and patterns by the general public.

Water policy may change the water system directly or indirectly through individual stakeholders. Individual stakeholders may affect the water system directly and indirectly as well; directly through their water use and indirectly through the support given to specific groups within the policy arena (Valkering, 2009).

Policy makers may have excellent ideas on how to shape our water system, but without support from stakeholders and citizens it becomes very difficult to implement those ideas (Ibid).

Figure 2.3: Pressure - State - Impact - Response Concept



Source: OECD, 1993

2.7.3 Economic Factors in River Conservation

There is widespread belief that as economic growth proceeds, environmental quality initially deteriorates and subsequently improves, so that the relationship between environmental quality and per capita income levels forms a U-shaped curve, sometimes described as a Kuznets environmental curve. It is however becoming increasingly difficult to ignore the interdependence between economic systems and the natural environment. (Braat et al, 1987)

The way in which one economic system operates and evolves is influenced by the social, political and institutional framework of a country. This however evolves with and is influenced by the economic system. The economic system cannot be sensibly assessed in isolation from the social framework of a country and the state of its natural environment (Braat et al, 1987).

2.7.3.1 General Economic Value River Conservation to the Public

Research has shown that protected rivers can produce economic benefits beyond even those generated by industries. This firm belief is also asserted by Koberstein (1997), while supporting the claim that that revitalized and protected rivers can produce quantifiable economic benefits. The Missouri, Columbia, and Blackfoot Rivers in the USA provide examples of how rivers can attract new small businesses and recreation and tourism dollars to communities. Conversely, unprotected rivers tend to reduce economic benefits associated with rivers such as returns from recreation and tourism activities. This is best illustrated by a political and socio-economic analysis of Arkansas' Buffalo National River in the USA, which looked at the economic impact of four pollutants and their effect on recreational activity. Evidence from the analysis indicated that the "possible worst case" scenario, with pollution levels at a recorded maximum for each month of the year, this caused visitation to decrease by 44,000 visits per year, costing \$7.1 million dollars in gross revenue.

2.7.3.2 Economic Value River Recreation and Tourism

According to American Rivers (1998), they suggest that recreation and tourism should be allowed to generate more economic benefits on and along the river. They further argue that recreation and tourism benefits are underestimated.

Cordel et al (1990), discusses recreational expenditures in three National Park Service river recreation sites and the effects these expenditures have on local economic growth. Cordel studies three sites; Delaware Water Gap National Recreation Area in New Jersey and Pennsylvania, the New River Gorge National River in West Virginia, and the Upper Delaware Scenic and Recreational River in Pennsylvania and New York to conclude that spending by visitors to river recreation sites stimulates growth and activity in corresponding local economies.

2.7.3.3 Economics of Water Quality

Alauze (1999) looks at the economic implications of water quality on recreation values. An example of a 1000-km, toxic blue-green algae bloom which afflicted the Barwon and Darling Rivers in 1991 is used for discussion. This bloom occurrence was attributed to increased water use for irrigation, drought, and nutrient pollution (mainly phosphorus) from sewage treatment plants and other point sources. The cost of pollution function is unknown, but results suggest that if marginal costs of phosphorus removal are low, the equilibrium level of phosphorus at each location is likely to be below that which reduces the recreational value of the rivers.

Gramlich, 1977 looks at the demand for clean water; he takes a sample of 165 families' willingness to pay in the metropolitan area of Boston finds that costs and benefits of swimmable water in the Charles River are nearly equal. Determinants of willingness to pay were isolated using regression analysis. An estimate of aggregate benefits from improving water quality was developed from the regressions and compared to resource costs. The range of estimates for aggregate benefits is \$8.8-21.9 million, with an average of \$15.4 million, with total aggregate costs at \$16.7 million. Findings from interviews and questionnaires indicate that family income, education, proximity of home and workplace to the river, graduate student status, and probability of future residence were all positively correlated with willingness to pay.

Landry 1998 discusses the trend towards buying and leasing water rights for environmental protection as an important method for protecting river and stream flows in the western United States. This region has been experiencing an increasing number of market transfers of water to protect water quality, and fish and wildlife habitats. From 1990 to 1997, more than \$37 million was spent to lease 2 million acre-feet of water for environmental protection. State and federal agencies are responsible for most market transfers, but activity on the part of private organizations in acquiring water for in-stream needs is increasing. Also examined are recent developments of in-stream flow marketing in the western United States. Market information including price and quantity of water traded was collected from market participants. The average purchase and lease prices for the region are \$397 and \$30 per acre-foot, respectively.

Whithead et al uses a contingent valuation survey to measure the economic benefits of reduced agricultural non-point source pollution in the Tar- Pamlico River in eastern North Carolina. Surveys show respondents are willing to pay for improved water quality. Survey participants' age, number of children, income, and expected use are related to their willingness to pay. Regression results suggest that for open-ended willingness to pay response data, the Tobit

technique is preferred to the ordinary least squares method due to additional information contained in the Tobit decomposition. Results imply that aggregate benefits of improved water quality would be \$1.62 million each year, and the majority of voters would support a program that would raise up to \$1.06 million annually for water quality improvements.

2.7.3.4 Economics of Wildlife Habitat/Riparian

Crandall et al (1992) takes a brief review of economic techniques, including the travel cost method, contingent valuation method, and local economic impact analysis, is presented and applied to sites with in-stream flows and riparian ecosystems. Crandall et al focuses on a case study of Arizona's Hassayampa River Preserve. An examination of consumer surplus values for the site, with and without perennial stream flows, reveals a large potential loss of user benefits if stream flows diminish from steady perennial flows to intermittent seasonal flows. Contingent valuation methods are used in this study to estimate recreational and intrinsic benefits of improved river-water quality in selected river basins of Iowa and Illinois. Findings indicated willingness to pay for river-water quality is related to income and recreational participation, but not to other spatial or socioeconomic variables. Intrinsic values are found to be expressible as economic values similar to those of other public goods. In many instances, intrinsic and recreational values together are larger on a per-acre basis than the production of agricultural commodities (Lant et al, 1990).

The Guide for Establishing and Maintaining Riparian Forest Buffers, USDA addresses economic values of forested streams. The discussions include nutrient removal, stream temperature, erosion control, flood protection, property value, pollution prevention, recreational greenways, and wildlife habitat. Included are site-specific examples of economic impacts of riparian forest buffers. One example from Fairfax County, Virginia showed a reduction of \$47 million in costs related to storm water run-off by retaining riparian forest buffers and forested areas in the county. The economic value of riparian buffers presented in this study is based on reducing agricultural nonpoint source pollution and providing stream habitat protection. Physical characteristics (such as hydrologic, topographic, land use, and soil attributes) of the Coldwater Creek watershed, Missouri were studied to determine areas of the watershed where construction of riparian buffers would be most cost-effective. Geographic information systems (GIS) were used to identify these target areas. The findings indicated that riparian buffers have the greatest benefit along streams and rivers in crop production areas. Areas where buffer zones cover longer stream stretches and more acreage tend to have greater benefits than those buffer zones that are cover shorter stretches and less acreage, respectively. (Qui, Z. et al, 2001).

2.7.4 Technological Factors in River Conservation

2.7.4.1 Use of Geographic Information System (GIS) in River Conservation

With an increasing human population and a finite supply of water, management of rivers and their associated ecosystems is becoming an ever-more complicated issue for decision makers across the Nation. Our understanding of river systems has improved because of developments in both technology and scientific understanding of ecosystems. Models have been used to predict flow and manage river systems for decades. As our knowledge of ecosystem processes and our ability to collect more precise data increase, we find that we are data rich. However, multiple riverine geo-referenced data layers generally do not align to allow comparable results and outputs. Often, differences in the spatio-temporal dimension of existing data cause significant obstacles. The next important step in better managing our natural resources is to effectively combine datasets and multiple model inputs and outputs for an enhanced understanding of these complex systems (USGS, 2014).

Smart River GIS allows simultaneous views of river hydraulics, species-specific habitat, and fish population simulations, for a better understanding of complex ecological interactions. At the USGS Fort Collins Science Center in the USA, they used existing data sets from the South Platte River in Colorado to develop a prototype, multi-layered geographic information system (GIS) that resource managers can use to improve their understanding of river ecosystems and make better-informed management decisions (Breiby,2006).

The field data for this system can be collected for a separate, completed research project then the data is aligned in various model inputs and outputs and put into one geospatially referenced database, then used to develop visualization products to display the information to resource managers (Ibid).

The following data layers are combined, ensuring consistency in both spatial scale and geographic reference systems: physical river measurements (topography, flow, temperature, and geo-location), habitat characterization and location, and species life history (USGS, 2014).

These can now be used to inform various aspects of the river including flood plain management (Sheydayi, 1999), information management systems for watersheds (U.S. Environmental Protection Agency, 1997).

2.7.4.2 Use of Water Quality Monitoring Techniques in River Conservation

Monitoring and control of river water quality can be done using computing architecture implemented using current internet technologies. Based on the "intelligent agents" approach, the system includes several processing parts which can be deployed along the basin and constitute a distributed information system. In addition to a user-friendly graphical interface for developing the required configuration, the system can have different features for different type of users depending on their functions in the administration of the river system and the controlled discharges (wastewater treatment plants, water purification, dikes, etc.). The interaction with the system is through a normal web browser. (P. Cianchi, 2000).

2.8 Challenges, Approaches and Policies for Conservation of Rivers and River Corridors

2.8.1 Challenges

Human activities are profoundly affecting river basin ecosystems, and the availability and quality of water resources (UNCHS, 1995). Water is the basis of life; it is used for agriculture, hydropower, domestic supplies, industrial processes and cooling, and many other uses. Total water use has quadrupled in last forty years, to serve the needs of expanding populations, the demand of urban areas, and the requirements of the developed world. Technological achievements and increased scientific understanding in the twentieth century have led to massive exploitation of water resources, including dams built on new heights, artificial lakes with a water surface of thousands of square kilometers; irrigation schemes which now serve nearly a fifth of the world's cropland; and rivers such as the Mississippi flow for many kilometers above the levels of their floodplains.

We are therefore, challenged to protect water resources, water quality and aquatic ecosystems. Most regions of the world face problems of loss of fresh water supply, degraded water quality, and pollution of surface and ground water. Major problems affecting the quality of rivers arise from domestic sewage, industrial waste water, destruction of catchment areas, deforestation, shifting cultivation and poor agricultural practices.

2.8.2 Approaches

Aquatic ecosystems are distributed by water projects such as dams, river diversions and irrigation schemes. The objectives of conservation should therefore include; evaluating the environmental consequences of use of water, protection of river basins, maintenance of

ecosystem integrity and public health protection. Utilization of river resources should also be ideal; that is, it should be done in a manner that does not cause deterioration of its natural basis (Boon, 1992).

It follows that optimization of the use of resources, in a more modern meaning of the concept, often implies limiting the rights of economically weighty and historically important interests. We are often confronted by an almost hopeless balancing between user's interests, which can easily be calculated in money or a number of jobs, and those interests that cannot be measured at all or are difficult to compare. Again, these will often be the appearance of the landscape or concern for plant and animal life of which even scientists themselves do not know the entire ecological significance.

The conservation of river resources, either the whole river system or parts of it, is also a form of resource use and therefore a link in a total optimization process. Of course, the eternal question should be: what are we conserving and what are we protecting it from? River corridors and other watercourses can be protected from hydro power development, pollution etc. in favour of plants, wildlife, cultural relics, "scientific evidence", public access to outdoor life and recreational activities.

The world's rapidly increasing population is itself the greatest strain on the total resource capital. The pressure on water resources will in future increase at the same time as the availability and quality of water decrease. Since the link between resource management in general, water resource management and river management in particular is so strong, it seems obvious that the need for well qualified river managers will increase in the years to come if we hope to avoid being worse than we are today!

2.8.3 Policies

As observed earlier, pollution is an externality resulting from point and non-point source. Its control includes regulatory measures and economic incentives (Solanes, 1991).

Regulations involve setting standards of water quality, prescription of appropriate technology, determination of allowable concentrations at the source and setting standards of allowable concentration of pollutants of various types in the receiving body of water, such as rivers (Palange and Zavala, 1987 as quoted by Solanes 1991).

Economic incentives on the other hand, can consist of subsidies or charges on the polluter, that is, adoption of polluter pays principle. Formulation of a policy based on these of these measures will therefore foster responsibility among the users of rivers and their corridors and this will lead to sustainable management and conservation of these river corridors.

According to (Solanes, 1991) all the above can be combined through permit and charge system. Permits contain standards and limitations which are the essence of a pollution control programme. Technology based limitations provide standards that must be achieved before a pollutant is discharged. Such a move when adopted is likely to relieve Nairobi River from highly toxic pollutants, especially in the industrial zone, where it receives the worst bulk of pollutants.

However, it has often been argued that economic incentives and financial charges are more effective than regulations in securing water quality objectives. Freeman and Haven, (1973) as quoted by Solanes, (1991) observes that charges based on amount and kind of pollutants being discharged are strong incentives to pollution control. Pollution control therefore demands adequate planning and the granting of enforcing powers to implementing agencies and authorities.

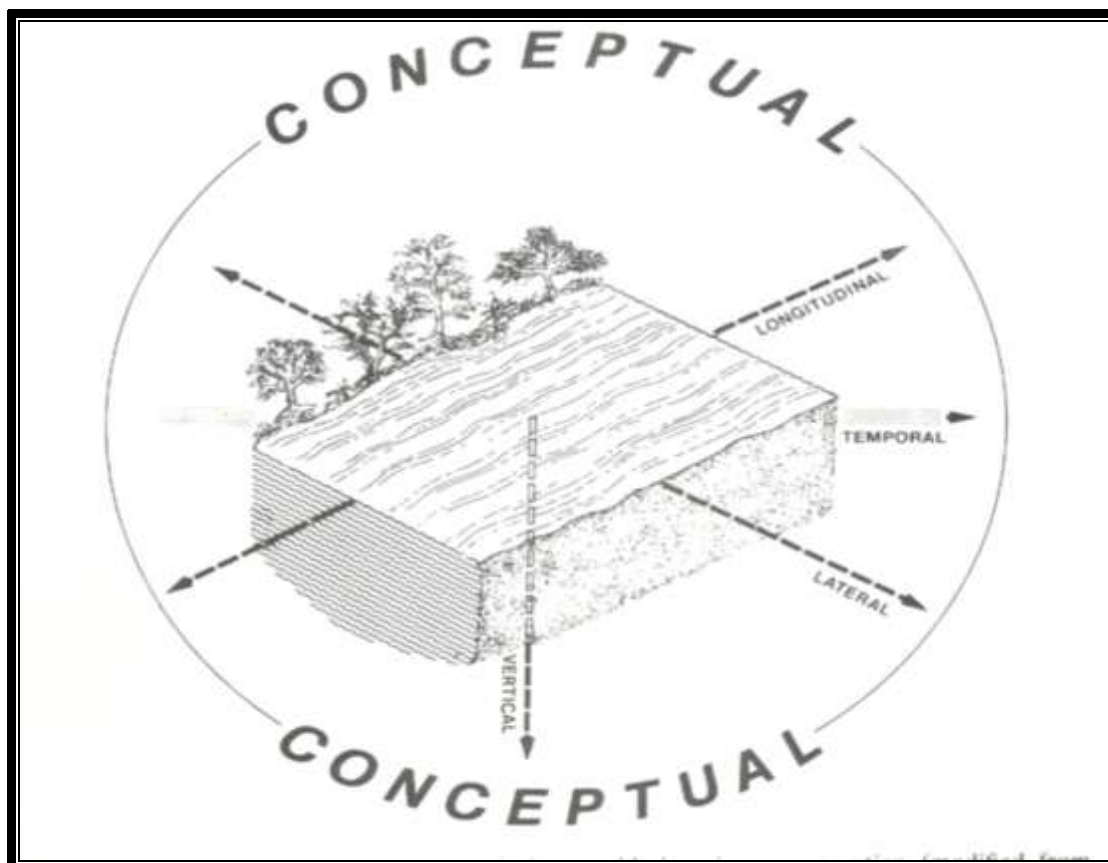
Legal actions for river control include a variety of public and private measures in administration and judicial fora (Solanes, 1991). Legal remedies include strict liability and accumulative fines. Institutional arrangements for the enforcement of pollution should include both national (central) and local authorities. The central authority should therefore set policies, objectives, standards and basic procedures. It should also monitor compliance to the set laws and policies. Local authorities on the other hand, should strive to enforce the set standards and policies. The central government should also regulate social behaviour to prevent and to ameliorate damages to rivers and their corridors. This can be attained by use of Police power as the legal tool. Police power can be exercised in preventive or reparative form.

The preventive exercise of police power demands the adequate regulation of certain activities to prevent deterioration of common pool resources such as river corridors. The reparative exercise on the other hand implies acts and orders tending to halt or stop activities injuring common pool resources. These orders are also referred to as *cease and desist orders*. In America such power is often invoked to control river and water pollution (Solanes, 1991).

2.9 Components of River Conservation

Ward (1989a) as quoted Boon (1992) describes flowing water ecosystem as four-dimensional; having **longitudinal**, **lateral**, **vertical**, and **temporal components**. This framework together with an additional **fifth dimension (conceptual dimension)** is an appropriate way of describing what needs to be included in any case of river conservation.

*Figure 2.4: A Five-dimensional Approach for Considering River Conservation
(Modified from Ward 1989a)*



Source: Boon, 1992

The above framework is therefore a useful tool for consideration by those aspiring to undertake river conservation strategies or projects both in rural and urban areas. Furthermore, it brings new understanding of what should constitute a river system for the purpose of effective and sustainable conservation.

i) The Conceptual Dimension

This can also be termed as the concept of 3Ps because it addresses basic questions of philosophy, policy and practice: *What are we trying to conserve?* *What priority should we give to the conservation of flora and fauna?* *How are we to assess the conservation potential of rivers?*

On this note, the subject of conservation is urban river corridors, but we are still left with two other unanswered questions! A thorough investigation of prevailing conditions of this subject should therefore form the basis for the answers to these questions.

ii) Longitudinal Dimension

River corridors can be viewed as linear systems in which pronounced physical, chemical, and biological changes occur from source to mouth.

According to Boon (1992), earlier studies of *longitudinal* dimension by Shelford, (1911), Illies and Botosaneanu, (1963); gave rise to classification schemes in which rivers were divided into discrete zones. Later studies produced the River Continuum Concept (Vannote et al, 1980). This pictures a river as a continuum of biotic adjustments and organic matter processing along its length, in response to the continuous downstream gradient of physical conditions. Although this model has not been without its critics, it has proved useful in explaining a wide range of observations on the functioning of stream communities.

The continuity of upstream and downstream reaches therefore becomes a vital concern for river conservation. In this regard, conservation of Nairobi River and its corridor should not only be based in the city centre but should also be extended to its source (Ondiri Swamp) as well as its mouth. This is important in that it is this continuity which can frequently be disrupted by the activities of man. For example, barriers to the migration of fish and invertebrates may be formed by reduced water flow due to over-abstraction, by a stretch of polluted river, or most notably by dam construction which may displace aquatic communities further along the river continuum (the serial discontinuity concept of Ward and Stanford, 1983).

iii) Lateral Dimension

This is mainly concerned with connection between a river and its valley; that is, the physical connection between the river channel and its valley. We are therefore called upon to include more than just the channel in any conservation scheme.

The role of tropical floodplains in the functioning of river ecosystems has been recognized for many years, even if not always respected by governments and developers, but for many industrialized nations floodplains systems have been damaged irreversibly before their significance has been properly assessed.

Floodplains fulfill many functions. Nutrients and organic matter transported from the river encourage the development of wetland plants, plankton and benthic invertebrates, in turn providing a rich food source for fish. However, benefits are not all one-way.

For some riverine invertebrates the seasonal flooding of adjacent land is essential for completing their life cycles (Boon (1992) quoting Hayden and Clifford, 1974). For others, organic matter such as detritus and plankton produced beyond the confines of the river channel re-enters it and acts as a valuable food supply.

From the extensive floodplains of some great tropical rivers to the smaller areas of wet woodland or marsh found alongside temperate streams, riverine wetlands provide a diverse range habitat and constitute an integral part of river system. Despite this, many have been deliberately destroyed, sometimes by drainage or by urbanization, often by flow regulation which isolates a river from its alluvial floodplain (Petts, 1987 as quoted by Boon, 1992). It is crucial; therefore, that the case for conservation extends laterally to incorporate hydrologically contiguous areas. Closer to the river, even a narrow riparian strip fulfills many functions, some of which have yet to be fully investigated. Bankside vegetation provides habitat and acts as a regulator of water temperature, light, seepage, erosion, and nutrient transfer.

Boon (1992) quoting Petersen et al, (1987), observes that if the ultimate procedure for conserving rivers is the proper planning and control of complete catchments, then the management of riparian zones constitutes an important first step. In some places, legislation already protects riparian strips, and this is not confined exclusively to first-world countries. Developing (third world) countries are also widely encouraged to observe such legislation, for proper conservation of the river ecosystem. In Sri Lanka, for instance, a Government Order stipulates that a specified width of land along either side of a stream should be retained as Crown Reserves whenever Crown land is sold or leased (Senayake and Moyle, 1982 as quoted by Boon, 1992), a move that has been particularly useful in helping to conserve the island's 15 endemic species of freshwater fish.

iv) The Vertical Dimension

The *vertical* dimension of river interactions includes not only the hydrological and chemical effects of groundwater on stream flow but also the organisms living within the substratum. Compared with other fields of stream ecology, little work has been done on this so called "hyporheic community."

However, a recent and remarkable observation by Stanford and Ward (1988) has shed new light on the vertical dimension of river systems. They collected riverine invertebrates, particularly stoneflies, in their hundreds from 10 m deep wells located in the flood plain of the Flathead River, as far as 2 km from the river channel. They concluded that the biomass in the hyporheic zone might well exceed the benthic biomass of the river. This introduces a whole new dimension into the functioning of river systems, and therefore into the case for river conservation.

v) The *Spatial* and Temporal Dimensions

These are relevant to the practicalities of how we conserve rivers, and in particular they emphasize the importance of including more than just the channel in any conservation scheme.

The *spatial* dimension therefore views rivers as a system comprising of the river channel and the adjacent land, including the river bank and the riparian reserve. This system is in essence the river corridor.

Ward's final dimension is a *temporal* one. The temporal dimension of the river systems is significant for many reasons. Channel morphology may alter naturally over long periods of time; even the more abrupt and man-induced changes downstream from impoundments may take decades to become apparent (Petts, 1980 as quoted by Boon, 1992); and within aquatic habitats organisms grow and develop in time spans from weeks to years, and aquatic communities develop in time scales of millennia.

The practical consequence of this is that river conservation should be planned from a long term perspective, especially as the effects of a development scheme on biotic populations may not become noticeable for many generations. However, this is not always easy. As Lee (1989) points out in reference to the Columbia River, it is difficult to get very far with adaptive management when government officials are appointed for terms that are shorter than the life span of a salmon.

2.10 The Way Forward for River Corridor Conservation

River basins are our natural assets; hence their conservation cannot be overlooked. It cannot be emphasized too strongly that river problems will not be solved in the rivers alone, because these problems for the most part originate in the rivers' catchments areas (Mellquist, 1992). Nevertheless, a better understanding of what happens in and along the rivers should provide "dry land" agencies with the guiding signals necessary for better resource exploitation and activity strategies and thus indirectly be part of overall river management.

Management of fresh water as a finite and fragile resource is of paramount importance, but this is hampered by fragmented responsibilities and poorly defined objectives. Will the authorities in individual countries be prepared to cope with these challenges? Some will, on the other hand, the poorer parts of the world will not manage to give these matters the necessary priority. Without any political undertone, it can be said that the developed countries are obliged to share their wealth with the poor if they want them to be capable of making ecologically correct choices.

Furthermore, there is also a need for a broader understanding that a resource cannot be exploited according to technical/economic criteria alone, and we must aim at long –term sustainable development and use of resources. This is presupposing the knowledge that resources are limited and that nature has its levels of tolerance, even though the perspective may be long by human scale. In other words, we must be willing to reduce financial profits in the short term compared to what has been usual within certain water-exploiting fields.

In addition, more importance must be attached to ecological evaluations in contrast to the traditional technical/economic calculations. It is true that added value is the lubricant that makes society's wheels go round, but so is the fact that the economist's time frame is far too short in relation to ecological response time and nature's levels of tolerance.

How shall we achieve the ideal goals of river management and conservation? Many old and toothless laws must be discarded and more appropriate ones drawn up so that it will be possible to intervene ahead of the development and before the problem arise. There are far too many examples of authorities retaining impotent set of rules that are hardly capable of sorting out problems later. Many administration bodies must also be forced to act from an overall point of view rather than just tending their own patches (Mellquist, 1992).

It is therefore crucial to understand that river management entails not only its conservation but, also its utilization. This of course should not deteriorate its natural basis. We need politicians who *dare*, bureaucrats who *want* and scientists/engineers who *can* .If there is not enough light at the end of the tunnel; it is our task to provide it (Mellquist, 1992). On this light, we may also say that we need planners who not only *dare*, *want* or *can* but also who facilitates.

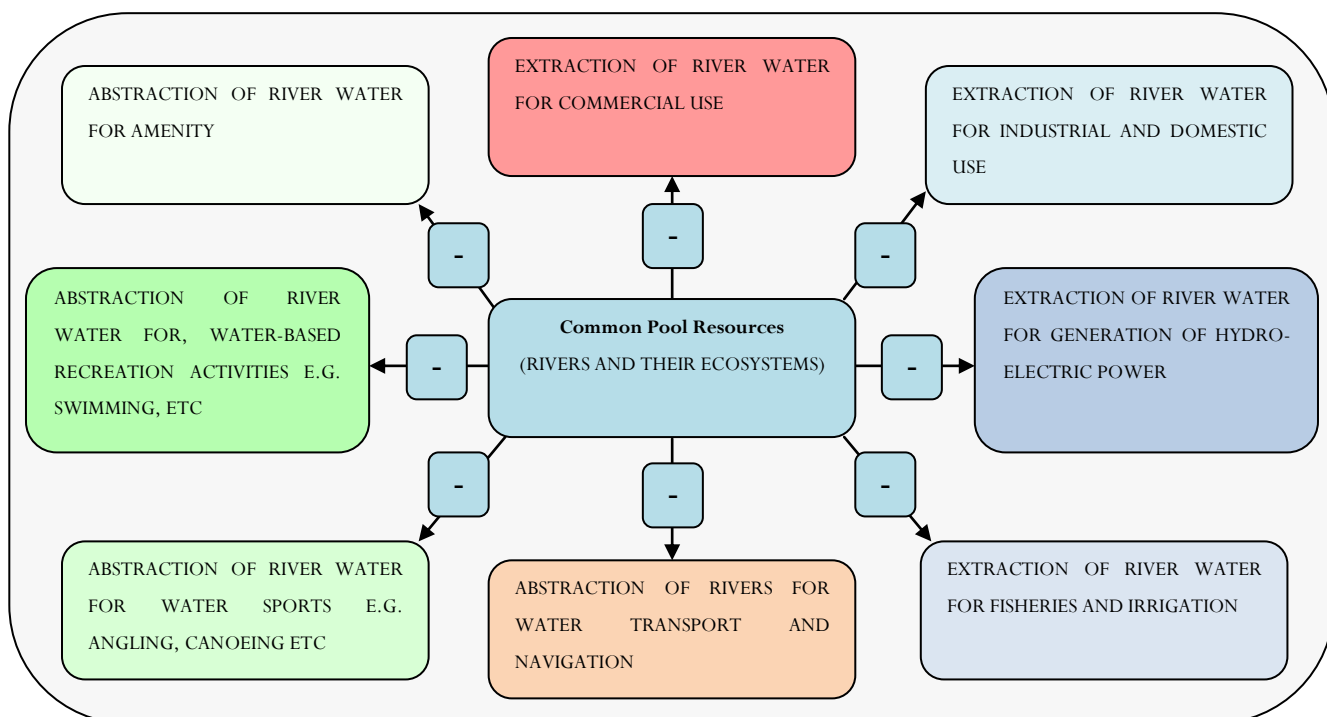
2.11 Theoretical Framework for River Conservation

Several years ago, ecologist Garrett Hardin invoked the analogy of the “commons” in support of his thesis; that as human population increased; there would be increasing pressure on finite resources at both local and particularly the global levels, with inevitable result of over exploitation and ruin. He termed this phenomenon, “Tragedy of the commons”; more specifically, this phrase means that an increase in human population creates an increased strain on our limited resource which jeopardizes sustainability. Hardin argued that common resources would be exploited by anyone who could assert their rights to do so.

2.11.1 Concept of “Commons”

The concept of “commons” is a useful tool or model to understand environmental management and sustainability. Common pool resources (sometimes designated common property”) include air, water, forests, minerals etc. These resources can be identified and quantified. In this connection, we have rivers which man has used since his early days. They provide water for commercial, industrial domestic and recreational purposes. They are also used for agriculture, hydro power and water transport, among many other uses. Concentration of these uses in a single river culminates into their over-exploitation., hence the tragedy of the “commons” as illustrated in figure 2.5 below:

*Figure 2.5: Concept of the “Commons”: The case of a River
(Exploitation of a RIVER for Various Purposes)*



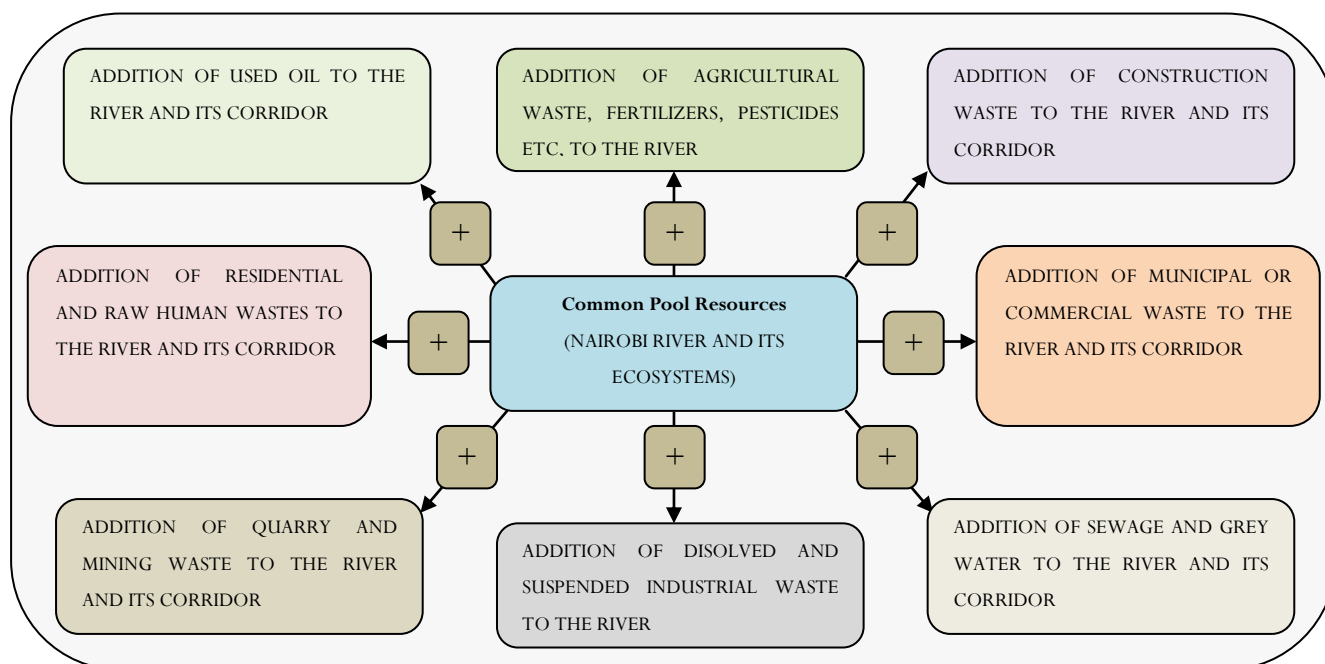
Source: Author, 2014

2.11.2 Concept of Commons in a Reverse Way

In a reverse way, the tragedy of the commons reappears in problems of pollution. Here it is not a question of taking something out of the common, but of putting something in the commons. This scenario is reflected in Nairobi River, whereby people have constantly been disposing their solid waste and effluents in the river. The rational man finds that his share of the costs of the wastes he discharges into the commons is less than the cost of purifying his wastes before releasing them. Since this is true for everyone; we are locked into a system of “fouling our own nest,” so long as we behave only as independent, rational free enterprisers.

The tragedy of the commons as food basket is averted by private property, or something formally like it. But the air and waters surrounding us can not readily be fenced and so the tragedy of the commons as a cesspool must be prevented by different means, by coercive laws or taxing devices that make it cheaper for the polluter to treat his pollutants than to discharge them untreated. We have not progressed as far with the solution of this problem as we have with the first. Indeed, our particular concept of private property, which deters us from exhausting the positive resource of the earth, favours pollution. The owner of a factory at the bank of a stream whose property extends to the middle of the stream – often has difficulty seeing why it is not his natural right to muddy the waters flowing past his door. The law always behind the times requires elaborate stitching and fitting to adapt it to this newly perceived aspect of the commons.

*Figure 2.6: Concept of “Commons” in a Reverse Way - As reflected in Nairobi River
(Gross Addition of Waste Materials on the RIVER)*



Source: Author, 2014

2.12 Case Study of Successful River Conservation/Restoration Initiative in the World

(The Lijiang River Basin Management, China)

❖ **Background information:**

Lijiang River is one of the most outstanding environmental features of Guilin City of China. In the late 1970s, the river suffered severe pollution from industrial emission and waste waters from a large number of polluting factories built on both sides of the river. Industrial sewage turned the originally clear waters to disgusting dark colour and the rivers water quality reduced to poisonous level below grade C of the Chinese Standards. This was a big blow not only to the river's ecosystem, but more so to the Guilin's residents, who believed that the waters of Lijiang River are the finest under heavens.

❖ **Intervention Measures for Lijiang River:**

To counter the escalating effects of pollution on the Lijiang River, serious campaigns had to be sphere-headed. Resolution Management activities were carried, thereby closing down 27 No. factories that contributed to severe pollution on the river. As a result, industrial output decreased by 10%. On the other hand, the fruits of the resolution were seen in that within 2 years, the river (Lijiang) was clear again, hence restoring pride in its name Lijiang, which literally translates as "beautiful river".

Note: Pollution and treatment of Lijiang River provided the Chinese with useful lessons and experience and for the first two decades, the community of Guilin has been exploring ways to coordinate environmental protection and economic development. Some of the efforts included renewal of old neighbourhood with emphasis on greening. A good example of this attempt is the Binjiang belt, and restoration of sewage treatment plants such as the Qilidian.

❖ **Positive Impacts on Restoration of Lijiang River:**

According to the Environmental Protection of Bureau of China, there has been a significance improvement on the air quality in the Guilin City and also water quality especially on the mainstream on the Lijiang River. The Lijiang River has managed to attain its original clear waters. Its water quality has managed to move from grade C to grade B level of the Chinese Standards and has been free from poisonous heavy metals for more than one decade. The city of Guilin has managed to be a major tourist attraction centre for both domestic and foreign tourists.

❖ **Negative Impacts on Restoration of Lijiang River**

Closure of some factories reduced industrial output by 10%, though, this picked up later.

The need for green areas led to demolition of old developments, which in turn created shortage of accommodation to the ever-increasing population of Guilin.

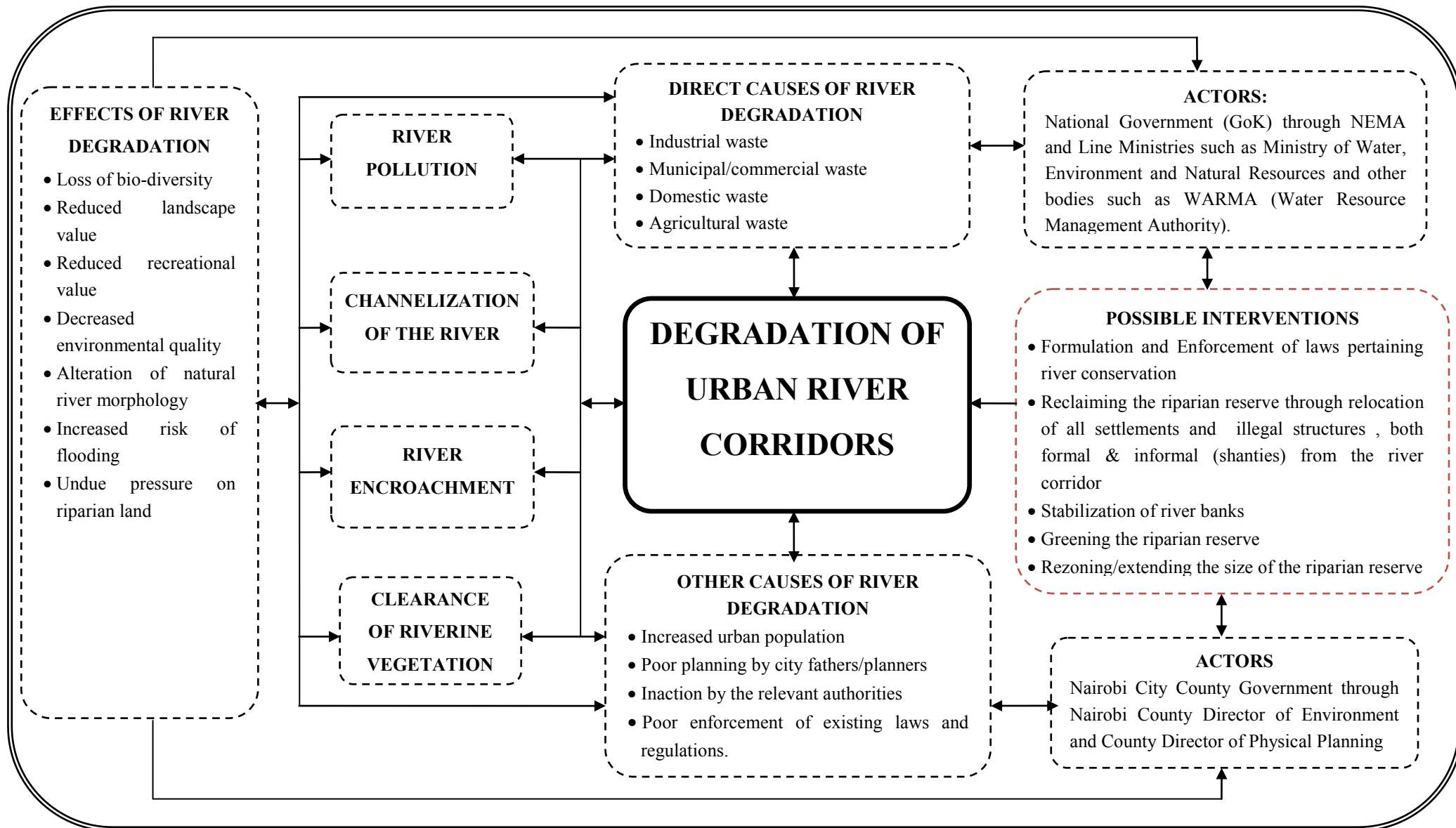
❖ **Lessons from Restoration of Lijiang River**

First, it is only incredible to imagine the determination it took for the Chinese Authority to close down so many factories in a small-medium sized city at the time their national economy was lagging behind those of the rest of the world.

Pollution of Lijiang River led to formal promulgation of China's Environmental Protection Law in 1979; first of its kind in Chinese history, hence marking a transition development from general policy to legislation for Environmental Protection.

It was also realized that economic development must coordinate with environmental protection and that growth should never be pursued at the expense of our environment. This experience was later used for management of the Huahe River Valley and a few valleys in the 1990s.

Figure 2.7: Conceptual Framework on Urban River Corridor Degradation



Source: Author, 2014

CHAPTER THREE:
BACKGROUND OF THE STUDY AREA

CHAPTER THREE: BACKGROUND OF THE STUDY AREA

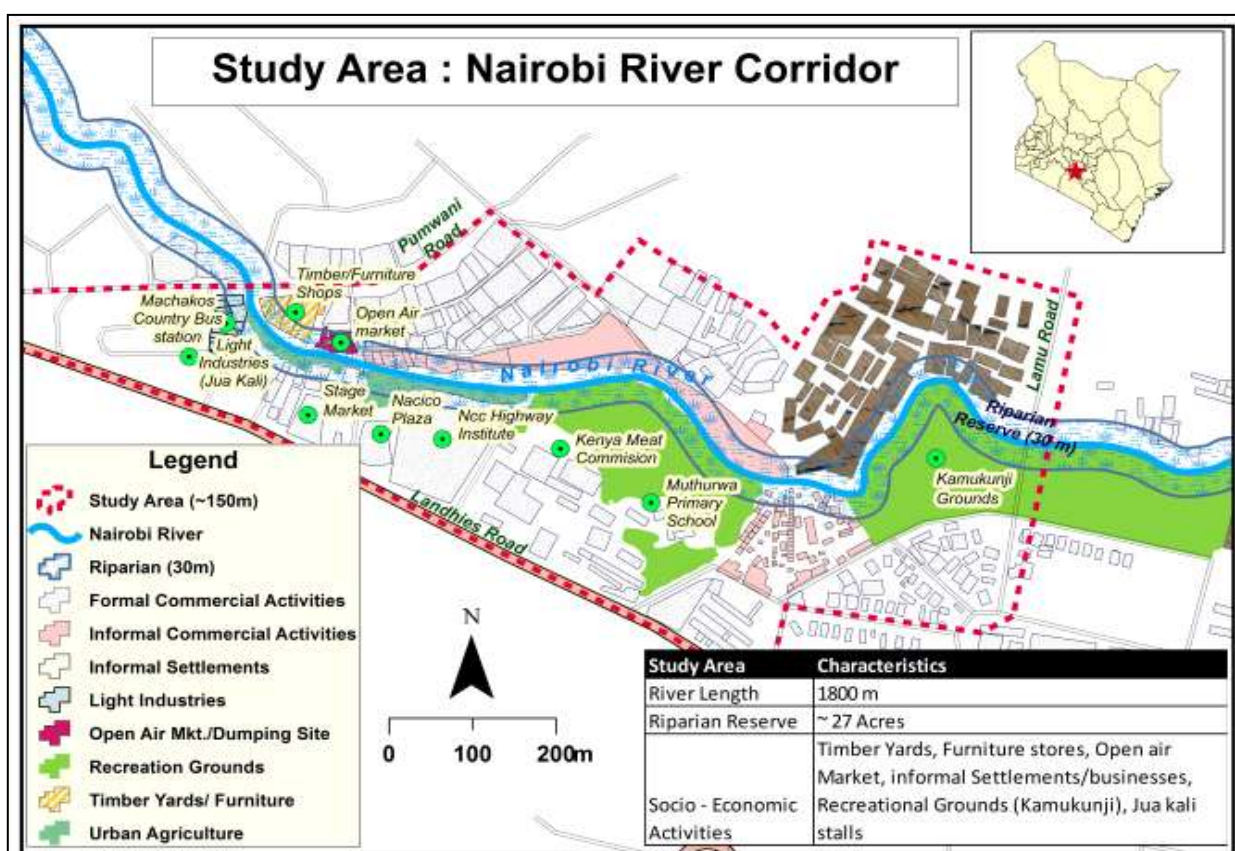
3.0 Introduction

This chapter looks at the background of the study area in terms of its location, area, socio-economic activities and neighbourhood. It also looks at the profile of its hosting constituency (Kamukunji Constituency). Also covered under this chapter is the historical development of Nairobi city and its physiographic and natural conditions which cut across the study area.

3.1 The Study Area

The study area is the section of Nairobi River defined by Pumwani and Lamu Roads of Nairobi City (the capital city of Kenya). It measures approximately 1.8 Km in length and covers approximately 27 acres. It is characterized by both formal and informal activities. Informal activities are mainly found along the river's riparian reserve, while the formal activities are carried out outside the riparian reserve.

Map 3.3: Map of the Study Area



Source: Adapted from Google Earth, 2014

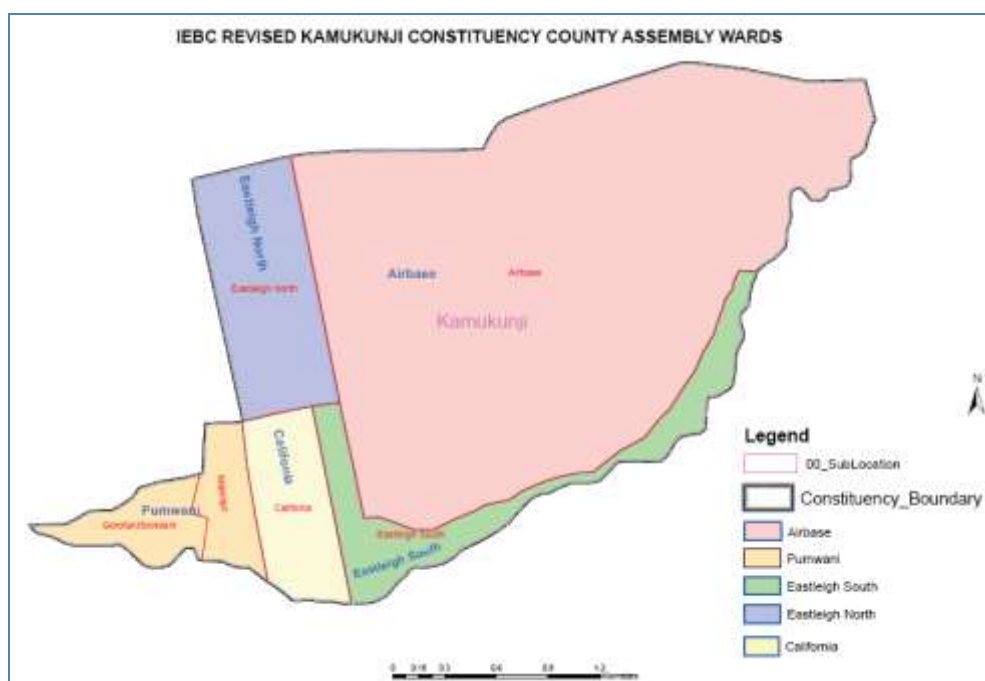
3.1.1 The Nairobi River

Nairobi River is a river flowing through the Kenyan capital city. It's the main river of Nairobi river basin. Nairobi river main stream bounds the northern city centre. The river has several tributaries including Ruiru River, Kamiti River, Rui Ruaka, Karura River, Gitathuru River, Mathare River, Kirichwa River and Motoine-Ngong River. The river passes through different activities within Nairobi such as agricultural, informal settlements and commercial, industrial activities within industrial area. These activities largely contribute to the contamination of the river. Nairobi has changed from a “place of cool waters” to one in which the water is no longer potable or fit for many other useful purposes.

3.1.2 Location of the Study Area

The study area is located in Kamukunji constituency, Nairobi city and encompasses Kamukunji area, Gikomba market area and Majengo informal settlements. It borders Central Business District (CBD) to the West, Buruburu Estate to the East, Pumwani (Gorofani/Bondeni) Estate to the North and Muthurwa Estate/ City Stadium to the South. According to Mitullah (2003), Nairobi itself in which Kamukunji is found, is located at the South Eastern end of Kenya's agricultural heartland, at approximately $1^{\circ} 9'S$, $1^{\circ} 28'S$ and $36^{\circ} 4'E$, $37^{\circ} 10'E$. It occupies an area of about 696km^2 (CBS, 2001) and the altitude varies between 1,600 and 1850 metres above sea level.

Map 3.4: Map of Kamukunji Constituency



Source: Independent Electoral and Boundaries Commission (IEBC), 2014

3.2 Profile of Kamukunji Constituency

Kamukunji Constituency consists of Central to Eastern area of Nairobi County Kenya. The entire constituency is located within the jurisdictions of Nairobi County. It borders Starehe Constituency on the North and West, Makadara on the East and Southern part, Embakasi on a corridor stretch to the East and a narrow section of Kasarani constituency. The constituency has an area of 11.7sq km of which half of the space is occupied by Moi Airbase. This leaves about only 5.8sq km space for human occupation, commercial centres and other social amenities (Kamukunji Profile, 2012).

3.2.1 Population of Kamukunji Constituency

The population of Kamukunji constituency is estimated at 261,855 (as per the 2009 population census) of which 124,935 are female while 136,920 are male. The region has an average population density of 45,147 people per sq.km (Kamukunji Profile, 2012).

3.2.2 Administration of Kamukunji Constituency

Administratively, Kamukunji is also a district and is divided into three administrative divisions: Pumwani, Bahati and Eastleigh divisions which are further subdivided into 9 (nine) administrative Locations and 18 Sub-locations. Before assuming District status Kamukunji District was known as Pumwani Division of Nairobi North District and prior to 1969 as Nairobi Central Constituency. For political purposes the constituency is divided into five (5) electoral political civic wards (Kamukunji Profile, 2012).

Table 3.2: Political Administrative Units (Wards) in Kamukunji Constituency

| No. | Name of Ward | Population (2009 National Census) | Area (Sq. Km) | Description |
|-----|----------------------|-----------------------------------|---------------|--|
| 1 | 1434 Pumwani | 37,602 | 1.40 | Majengo, Kamukunji, Shauri Moyo and Bondeni/Gorofani Sub-Locations of Nairobi County |
| 2 | 1435 Eastleigh North | 43,258 | 0.90 | Eastleigh North and Garage Sub-Locations of Nairobi County |
| 3 | 1436 Eastleigh South | 66,264 | 1.00 | Eastleigh South Sub-Locations of Nairobi County |
| 4 | 1437 Airbase | 43,168 | 5.00 | Maina Wanjigi and Airbase Sub-Locations of Nairobi County |
| 5 | 1438 California | 21,699 | 0.50 | California (New Pumwani Phase 1) Sub-Location of Nairobi County |

Source: Independent Electoral and Boundaries Commission (IEBC), 2014

3.2.3 Main Economic Activities in Kamukunji Constituency

Kamukunji district has three economic zones: The first zone is Pumwani division which is predominantly open markets hub and up-country transport terminus comprising of Majengo, Gikomba, Machakos Country Bus and the ever busy Marikiti (Wakulima) market. The second zone is Eastleigh division which is a commercial hub and middle and upper middle class residential sector with modern shopping malls, hotels, financial institutions and home to Moi Airbase. As a commercial and financial hub Eastleigh is its own city within Nairobi city. The last zone is the Bahati division with minimum business activities. Bahati division is predominantly a residential region for lower and middle class workers. It covers Bahati, Kimathi, Jerusalem, Uhuru and Buru-Buru phase 1 (Kamukunji Profile, 2012).

3.2.4 Climatic Conditions of Kamukunji Constituency

At 1,661mtrs (5,449 ft.) above sea level, Kamukunji constituency enjoys a fairly moderate climate. The altitude makes for some chilly evenings, especially in the June/July season when the temperature at times drop to 10 °C (50 °F). The sunniest and warmest part of the year is from December to March, when temperatures average the mid-twenties during the day. The mean maximum temperature for this period is 24 °C (75 °F). There are two rainy seasons but rainfall can be moderate. The cloudiest part of the year is just after the first rainy season, when, until September, conditions are usually overcast with drizzles. Given that Nairobi is situated close to the equator, the differences between the seasons are minimal. The seasons are referred to as the wet season and dry season. The timing of sunrise and sunset does not vary tremendously throughout the year due to Nairobi's close proximity to the equator (Kamukunji Profile, 2012).

3.2.5 Vegetation Characteristics of Kamukunji Constituency

Generally the constituency bears highlands characteristics with ever-green vegetation throughout the year. This feature has encouraged the otherwise illegal tendencies by residents especially along the Nairobi River that cuts across the constituency to engage in river bank agriculture. They mainly grow vegetables such as Sukuma wiki, spinach, tomatoes and yams for domestic use in such places as Kiambiu and Kitui informal settlements. Due to competition for space for both business and constructions to meet population increase, natural vegetation has greatly been interfered with suffice to mention incessant dumping, pollution and drainage of chemical waste into Nairobi River and its tributaries. The efforts by NEMA to restrict encroachment on Nairobi River banks by small business vendors has met with hostility and made environment conservation efforts untenable. There is therefore need to come up with measures to protect the environment and ensure that the natural and serene vegetation is restored in regions most affected.

3.2.6 Socio-Economic Activities in Kamukunji Constituency

Kamukunji constituency hosts some of the oldest residential areas in Nairobi. They include Majengo, Muthurwa, Shauri Moyo, Bahati, Eastleigh and Uhuru Estates. The constituency is both residential and commercial in nature with no serious manufacturing plants save for the Jua Kali sector. There are numerous formal and informal businesses taking place in the constituency: There are shops, open-air markets, Jua kali sheds and garages among others. Majority of the residents of Kamukunji are workers/employees in different government ministries, privately owned companies and commercial shops among others. Population growth coupled with high cost of living and the slow pace on the part of the government and other investors to generate employment has contributed to many residents resorting to all sorts of businesses and to find residence in places unbecoming for human habitation. The mushrooming of informal settlements within the constituency, construction of structures unfit for human occupation, and the sprawling construction of extensions within the City Council Estates is a manifestation of the residents' attempts at making it possible to exist in a hostile environment. In most of these Estates, business in illegal items, illicit brews, drugs, and to some extent small firearms and other dangerous weapons of mass destruction are traded and find their way into wrong hands. To a larger extent, business thrives in most parts of the constituency especially in Eastleigh, Gikomba, Burma, Muthurwa, Marikiti, Uhuru, Bahati, Shauri Moyo, Machakos Country Bus, Kitui, Kinyago and Kiambiu. Kamukunji is not an industrial estate but a business hub for manufactured and consumer goods (Kamukunji Profile, 2012).

3.2.7 Pattern of Settlement, Housing and Living in Kamukunji Constituency

Most in Kamukunji constituency people live in clustered Estates with planned pattern save for those in informal settlement areas such as Kinyago, Kiambiu, Kitui, Blue Estate and Majengo. Most of City Council residential houses are old model, built during colonial days for the blacks under the segregation and discriminative colonial laws. These Estates include the old Eastleigh, Majengo, Pumwani, Shauri Moyo, Bahati, Uhuru, Jerusalem, Biafra, the recently demolished Muthurwa and California among others. Some of the Estates built in the 70s and 80s include Kimathi, High-rise and Buru-Buru phase 1 which bear some face of modernity. In regions such as Eastleigh modern structures have been erected but without any uniform plan or pattern. Due to lack of proper planning and uniform architectural designs most parts of the constituency look congested, disorganised and more of a semi-urban or a suburb of the city of Nairobi (Kamukunji Profile, 2012).

3.3 The Nairobi City County

3.3.1 Historical Development of Nairobi City

Nairobi, previously known as “the city in the sun” because of its appealing environment takes its name from the Maasai phrase “Enkare nairobi”, which means “a place of cool waters”. The area was originally grazing land and a livestock watering point and there was no permanent African settlement by then (Nairobi City County Government, 2013). The city owes its birth and early growth and development to the Kenya Uganda Railway (KUR). The railhead reached Nairobi in May 1899 “enroute” to the present day Kisumu, part of what is now Uganda. By July 1899, it had become the headquarters of the Kenya Uganda Railway (KUR). This led to Nairobi’s growth as a commercial and business hub of the British East Africa Protectorate (Mitullah, 2003). By 1900, Nairobi had become a large and flourishing place with settlements consisting mainly of the railway buildings and separate areas for Europeans and Indians, the latter mainly consisting of railway builders and labourers (Ibid).

3.3.2 Population of Nairobi City

Nairobi city is estimated to have a total population of 3,138,000, accounting for 8.1% of the national population. The average population density excluding Nairobi National Park is 5,429 per km². The Central Division and Pumwani (Kamukunji) Division located at the centre have a much higher density than others in excess of 20,000 per km² (KNBS 2009).

3.3.3 Physiographic Features of Nairobi County

Nairobi is located at the South Eastern end of Kenya’s agricultural heartland, at approximately 1° 9’S, 1° 28’S and 36° 4’E, 37° 10’E. It occupies an area of about 696km² (CBS, 2001) and the altitude varies between 1,600 and 1850 metres above sea level (Mitullah, 2003). The western part of Nairobi is on high ground (approximately 1700-1800 m.s.l.). With rugged topography, the Eastern side is generally low (approximately 1600 m.s.l.) and flat (Saggerson, 1991). Key physical features include the Nairobi, Ngong and Mathare rivers and the indigenous Karura Forest in Northern Nairobi. The Ngong hills stand towards the West, Mount Kenya towards the North and Mount Kilimanjaro towards, South East. As Nairobi is adjacent the rift valley, minor earth quakes and tremors occasionally occur (Ibid). Land resources in Nairobi include forests, fresh water systems and a rich bio-diversity, all of which hold vast potential for development if managed sustainably. Many of the opportunities that they provide, such as agro-tourism, human settlements and a carbon sink for the city, are vital for the well-being of the residents of the city.

3.3.4 Climate

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

3.3.5 Drainage

Nairobi's main drainage follows the regional slope of the volcanic rocks towards the East, while subsidiary internal drainage into the rift region is confined to the western part. The lava plains east of the line Ruiru-Nairobi are underlain by a succession of lava flows alternating with lakebeds, streams deposits, tuffs and volcanic ash. These plains comprising mainly the Athi plains and the Northern section of the Kapiti plain extend West-wards, rising from 4900 ft. (1493m) at the Athi River to 6000ft (1829m) in the faulted region near Ngong. The lava plains are crisscrossed with steep-walled gullies and canyon-like gorges, such as those along the Mbagathi valley. Further East, this valley widens slightly where soft material is being actively eroded. Water draining East-ward from the hill area accumulates on the low-lying ground between parklands in the north and Nairobi south estate, forming a perched table above the Nairobi phonolite. The Kirichwa valley tuffs lying to the east of the highway function like a sponge and the contact between them and the underlying impermeable phonolite thus forms perfect aquifer, so much so that a number of channels containing water occur beneath Nairobi (Saggerson, 1991).

3.3.6 Soils

The rocks in Nairobi area mainly comprise a succession of lava and pyroclastics of the Cainozoic age and overlying the foundation of folded precambian schist's and gnesses of the Mozambique belt. The crystalline rocks are rarely exposed but occasionally fragments are found as agglomerates derived from former Ngong Volcano. Weathering has produced red soils that reach more than 50 ft. (15m) in thickness, a number of subdivisions are recognized in the nairobi according to drainage, climatic regions and slopes and other categories have been introduced for lithosols and regosols (Saggerson, 1991).

CHAPTER FOUR:
RESEARCH METHODOLOGY

CHAPTER FOUR: RESEARCH METHODOLOGY

4.0 Introduction

This chapter basically addresses the methodology employed in the research. Central to this area is the research and sampling design, data needs and their sources, data collection methods, analysis and presentation.

4.1 Research Design

The research took a case study approach since the researcher's concern was about one particular river corridor that has faced serious degradation despite its potential usefulness to the residents of Nairobi City and its rich historical viewpoint. In this case, the research focused on Nairobi River Corridor. The historical significance of the Nairobi River in the establishment and the development of Nairobi City is one of the key factors that led to the choice of the Nairobi River among other rivers in the city. Furthermore, Nairobi city derives its name from Nairobi River.

4.2 Key Target Population

The target population comprised of users of Nairobi River corridor and the neighbouring residences/business community adjacent to the river corridor in the study area. Others included key informants drawn from Ministry of Environment, Water and Natural Resources; National Environmental Management Authority (NEMA); Water Resources Management Authority (WRMA); Tana and Athi River Development Authority (TARDA); Nairobi River Basin Projects (NRBP); Department of Environment, Nairobi City County; Department of Physical Planning, Nairobi City County; Nairobi City Water and Sewerage Company (NCWSC) Ltd; Department of Integrated Waste Management, Nairobi City County and Department of Public Health, Nairobi City County.

The interviews in this research were in the form of structured questions administered in form of questionnaires to both the informal and formal group and also key informants. Survey questions were a combination of close-ended and open-ended questions both for the informal and formal group. However, questions to the key informants were open-ended. This was to enable the researcher gather as much information as possible. In this sense, both qualitative and quantitative data was collected, analyzed and interpreted.

Before embarking on the study, the researcher first made a reconnaissance visit to the study area to familiarize himself with the situation on the ground and delineate the geographical scope of the study. This was followed by a pilot study. The purpose of the pilot study was to enable the researcher to ascertain the reliability and validity of the instruments, and to familiarize himself with the administration of the questionnaires and therefore improve the instruments and procedures.

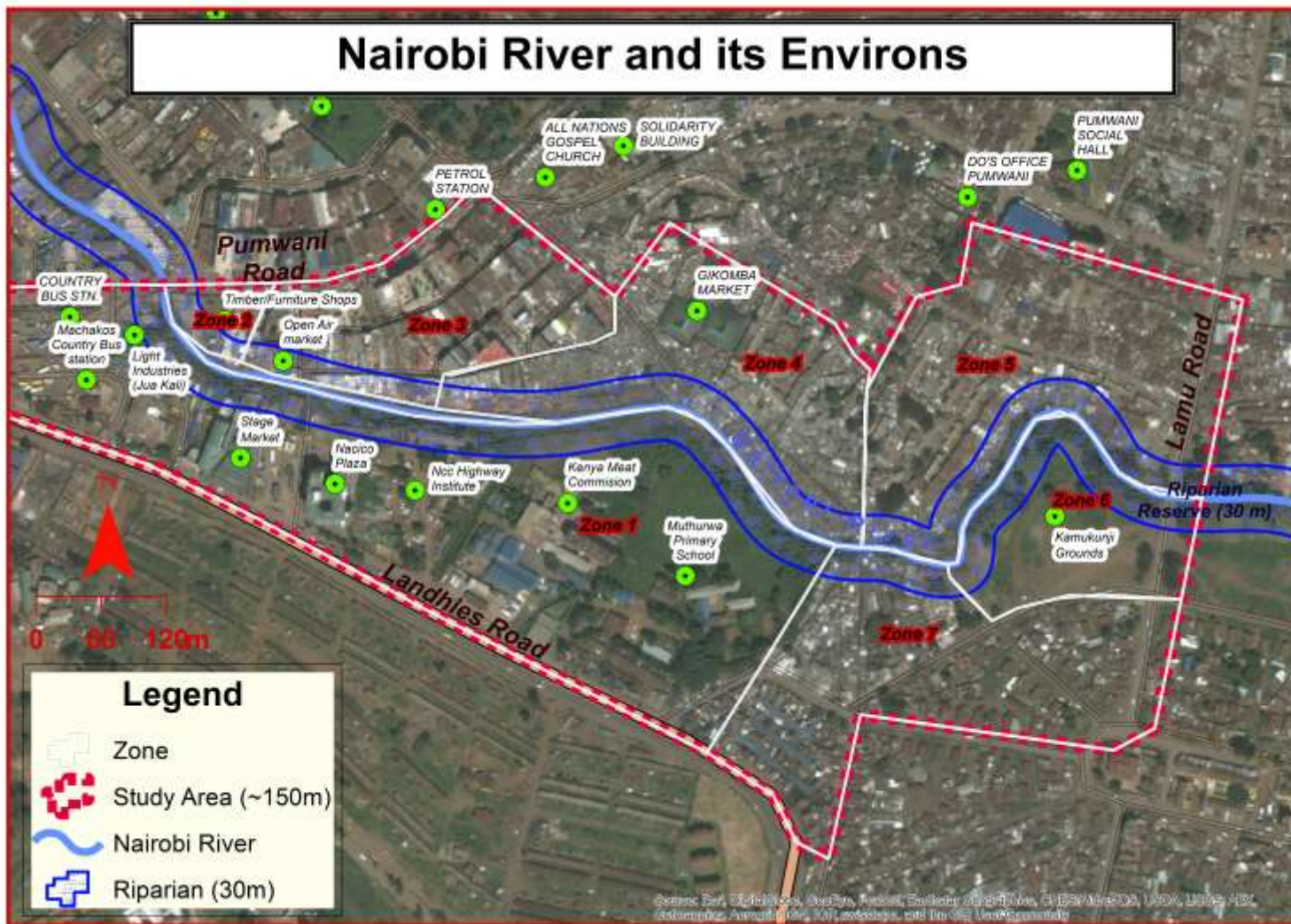
Generally, the study was organized along seven zones, delineated as per their socio-economic activities. The respondents were categorized into two; (i) Direct Users of the River Corridor (*Informal groups*) and (ii) the Indirect Users of the Nairobi River Corridor (*Formal Group*). The former refers to those found operating on the Riparian Reserve as defined by law while the latter refers to those with permanent premises along the river, but outside the Riparian Reserve. This entailed land uses located about 70m from the line of the riparian reserve.

Table 4.3: Socio-economic Activities in the Study Area

| Zone within the Study Area | Activities by Informal Group | Activities by Formal Group |
|-----------------------------------|---|--|
| Zone 1 | Urban Agriculture (Growing of Kales 'sukumawiki' and Spinach) | Light Industries (Jua kali industries) |
| Zone 2 | Timber and Furniture Shops | Timber, Furniture and Hardware Shops |
| Zone 3 | Open Air Market for fresh agricultural produce and cereals temporary Dumping site | Extension of open air market and Hardware Shops |
| Zone 4 | Informal Commercial activities such as sale of second hand clothes and shoes | Formal commercial Activities such as Glass, Hardware, Tyre and General shops |
| Zone 5 | Low income settlements/residential units and kiosks | Low income settlements and residential units, kiosks and a worship centre (mosque) |
| Zone 6 | Public Recreational Ground mainly for relaxation | Public Recreational Ground mainly for relaxation |
| Zone 7 | Informal Commercial activities such as sale of cheap household goods e.g. cutlery | Formal commercial Activities such as Fast food, Glass, Hardware and General shops |

Source: Author, 2014

Map 4.5: Aerial Map of the Study Area (Pumwani - Lamu Road section of Nairobi River) and its Environs



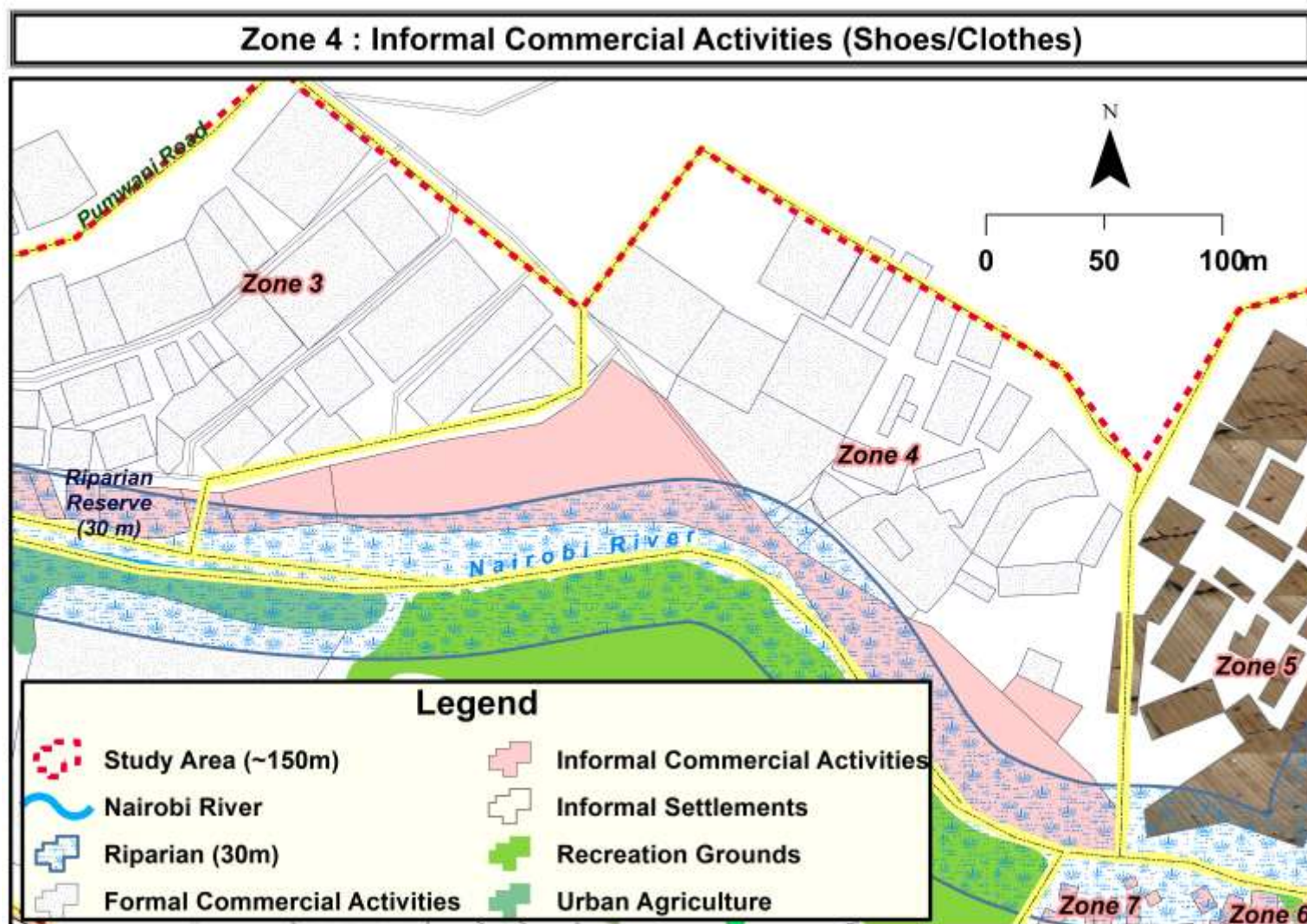
Source: Adapted from Google Earth, 2014

Map 4.6: Map of the Study Area showing Zones 1, 2, 3 and 4 on how the study was spatially conducted



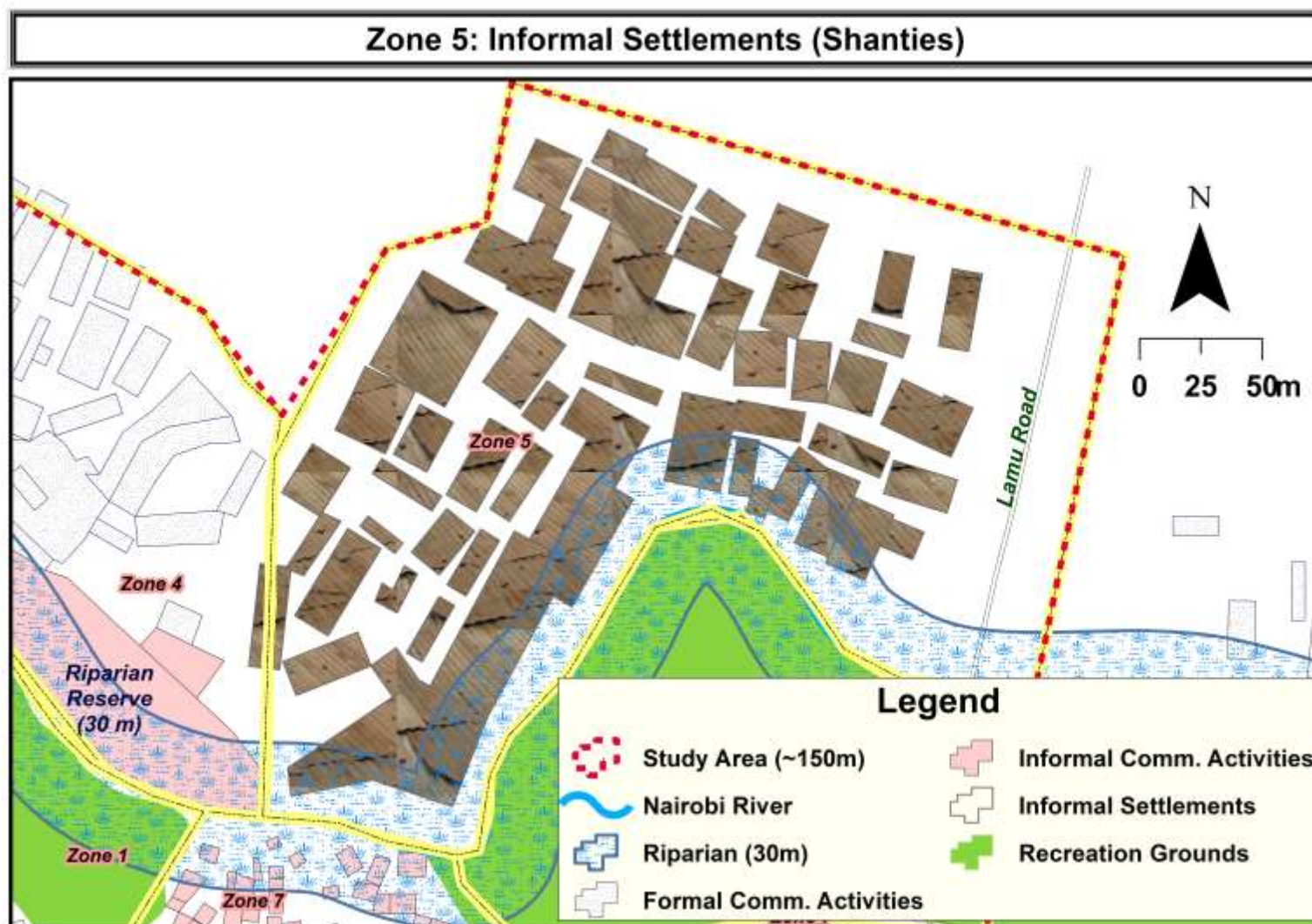
Source: Adapted from Google Earth, 2014

Map 4.7: Map of the Study Area showing Zones 3 and 4 on how the study was spatially conducted



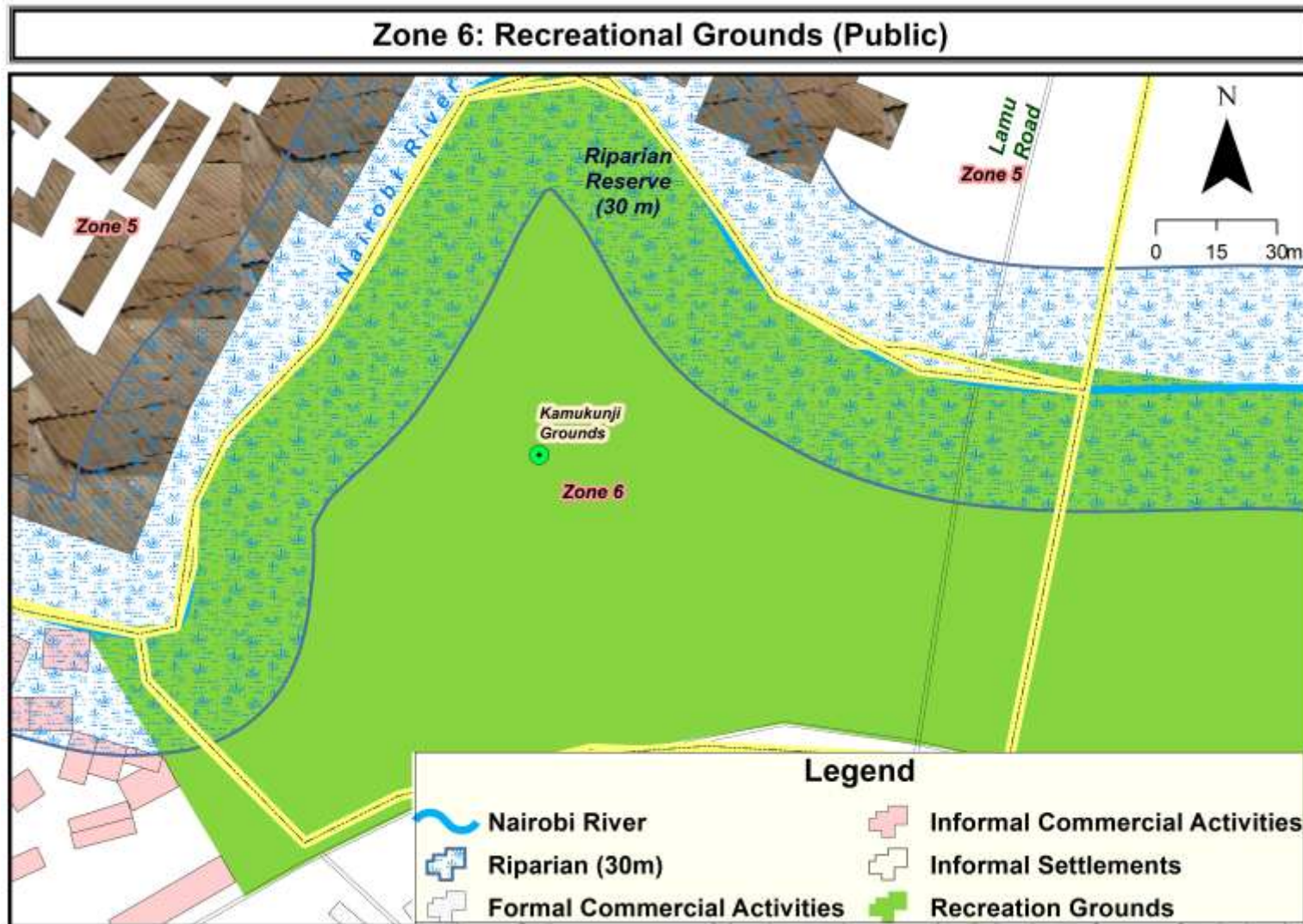
Source: Adapted from Google Earth, 2014

Map 4.8: Map of the Study Area showing Zone 5 on how the study was spatially conducted



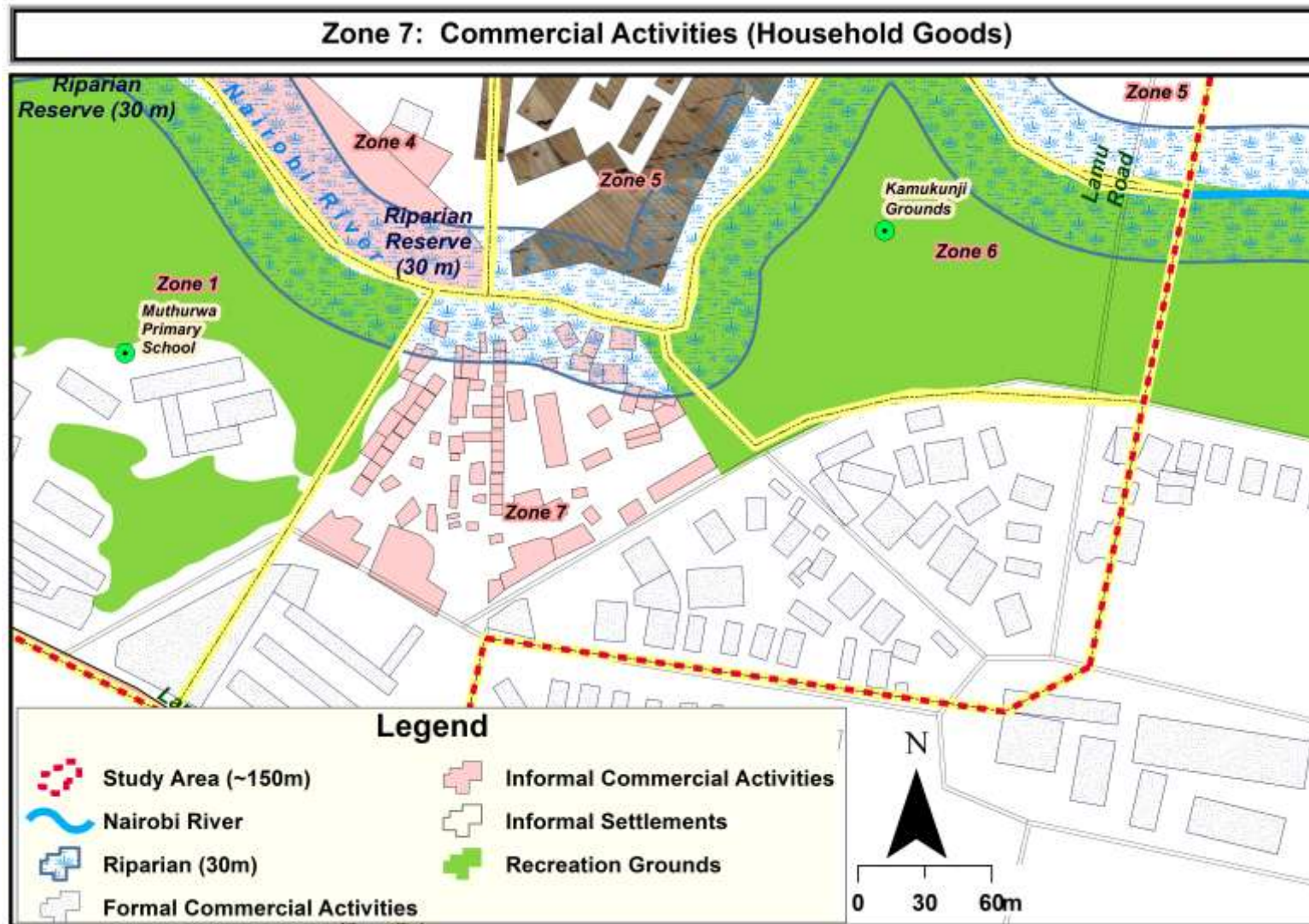
Source: Adapted from Google Earth, 2014

Map 4.9: Map of the Study Area showing Zone 6 on how the study was spatially conducted



Source: Adapted from Google Earth, 2014

Map 4.10: Map of the Study Area showing Zone 7 on how the study was spatially conducted



Source: Adapted from Google Earth, 2014

4.3 Sampling Plan/Design

4.3.1 Sample Frame

The sampling frame consisted of all the rivers traversing Nairobi City and their adjacent human population. However, the research zeroed down to the Nairobi River and its adjacent population due to limited time and resources as well as historical perspective of the said river, where the city derives its name from the river. Nairobi River corridor was thus purposively sampled to represent all the other river corridors that fall within the same brackets of degradation.

4.3.2 Sample Size

In determining the sample size, Mugenda O. and Mugenda A. (2003) provides the following two formulas:

$$a) n = \frac{Z^2 pq}{d^2} \text{ (Formula used if the Target population is more than 10,000)}$$

Where:

n = the desired sample size (if the target population is greater than 10,000)

Z = the standard normal deviate at the required confidence level

p = the proportion in the target population estimated to have characteristics being measured

$q = 1 - p$

d = the level of statistical significance set

$$b) n = \frac{n}{1 + (1+n)/N} \text{ (Formula used if the Target population is less than 10,000)}$$

Where:

n = the desired sample size (if the target population is less than 10,000)

n = the desired sample size (if the target population is more than 10,000)

N = the estimate of the population size.

In our case, we shall use the second formula $n = \frac{n}{1 + (1+n)/N}$ since our population is less than 10,000

However, we first need get the value of n using the first formula, where the standard normal deviate at the required confidence level is at 95% (standard value of 1.96), the standard deviation at 0.5 and margin of error at 7% (standard value of 0.07).

$$n = \frac{Z^2 pq}{d^2} = \frac{1.96^2 \times 0.5 (1-0.5)}{0.07^2} = \frac{3.8416 \times 0.25}{0.0049} = 196$$

Below now are the calculations for the sample size nf with target populations of 650 persons for informal group and 545 for formal group both of which are less than 10,000:

$$(i) \quad nf = \frac{n}{1 + (1+n)/N} = \frac{196}{1 + (1+196)/650} = \frac{196}{1 + (197)/650} = \frac{196}{1.30} = 150 \quad (\text{Informal Group})$$

$$(ii) \quad nf = \frac{n}{1 + (1+n)/N} = \frac{196}{1 + (1+196)/545} = \frac{196}{1 + (197)/545} = \frac{196}{1.36} = 144 \quad (\text{Formal Group})$$

With the population figure of 650 persons for the *informal group* and 545 persons for the *formal group*, the second formula gives a sample size of 150 and 144 respectively, as shown by the calculations above. However, it was difficult for the researcher to work with this sample size, as it was excessively large and would have necessitated more time and financial resources. In view of these factors, the researcher settled on a sample size of 56 for the informal and a further 54 for the formal group, being about 10% of the target population. This sample size was neither too small, nor too large, but rather optimum. The decision to reduce the sample size is supported by Kothari (2004), who orates that the size of a sample should neither be excessively large, nor too small. It should be optimum. He further states that an optimum sample size is one which fulfills the requirements of efficiency, representativeness, reliability and flexibility. Furthermore, Mugenda O. and A. Mugenda, (2003), assert that a sample size of 30 is good enough for a scientific research. Using these assertions as the basis of determining the sample size, then a sample of 110 was appropriate for this study. This figure also took care of non-response situations during the actual field study.

The researcher worked with a sample size of one hundred and ten (110) respondents drawn from *informal group* and *formal group*. In this regard, fifty six (56) respondents from *informal group* were selected for observation on assumption that they represented the characteristics of the others who were left out of the interview and observation. Furthermore, fifty four (54) respondents from *formal group* were selected from communities adjacent to the river corridor. These were considered as a representative sample of the entire formal groups in the study area.

Ten (10) key informants were also purposively chosen for interviews, on account that they possessed the required information with respect to the objectives of the study. These included:

- (i) Director of Environment, Ministry of Environment, Water and Natural Resources
- (ii) Director General, National Environmental Management Authority (NEMA)
- (iii) Director, Water Resources Management Authority (WRMA)
- (iv) Director, Tana and Athi River Development Authority (TARDA)
- (v) Director, Nairobi River Basin Projects (NRBP)
- (vi) Director of Environment, Nairobi City County
- (vii) Director of Physical Planning, Nairobi City County
- (viii) Director, Nairobi City Water and Sewerage Company (NCWSC) Ltd
- (ix) Director, Integrated Waste Management, Nairobi City County
- (x) Director, of Public Health, Nairobi City County.

4.3.3 Type of Sampling per Unit

(i) Purposive Sampling: This was employed in sampling of institutions that were stakeholders in the area of study. As such, all relevant institutions were purposively selected for interview in view of the fact that they were few in number and most importantly they were stakeholders in the subject of study. These institutions included: *Ministry of Environment, Water and Natural Resources (MEWNR); National Environmental Management Authority (NEMA); Water Resources Management Authority (WRMA); Tana and Athi River Development Authority (TARDA); Nairobi River Basin Projects (NRBP); Department of Environment, Nairobi City County; Department of Physical Planning, Nairobi City County; Nairobi City Water and Sewerage Company (NCWSC) Ltd; Department of Integrated Waste Management, Nairobi City County and Department of Public Health, Nairobi City County.*

(ii) Stratified Sampling: This was used in selection of samples from *informal group* owing to their large number, distribution and the fact that the population from which the sample was being drawn was not of a homogenous group. The technique involved dividing the population into seven (7) sub-populations in form of zones or strata/stratums that were individually more homogenous than the total population. The total population in this case was about 650 persons and the approximate population in each stratum was as follows; Zone 1= 90, Zone 2= 93, Zone 3= 98, Zone 4= 102, Zone 5= 89, Zone 6= 83, and Zone 7= 95. Eight (8) subjects (respondents) were then randomly selected from each of the seven (7) zones/stratums, using equal sample selection method to constitute the required sample. This yielded a sample size of fifty six (56) respondents. An equal sample selection method was applied in this case as opposed to

proportional allocation method because individual population across all the seven strata was almost equal and again according to Kothari (2004), it's the most efficient method in case one wants to compare the differences among strata, which was the researcher's intention.

(iii) Systematic Sampling: This was used to obtain samples from the *formal group*. This mainly comprised of some well-planned commercial shops adjacent to Nairobi River Corridor, totaling to about 545 entities/units. This method was therefore facilitated by somewhat planned nature of the area. The procedure entailed ascertaining the randomness of the entities and then determining the sampling interval and the unit/entity with which to start with. On the issue of randomness, the units were deemed to be randomized since they were not spatially arranged in any definite way. In deciding on the sampling interval, the researcher took the total population (545) and then divided it by the sample size (54). This gave a sampling interval of 10. The starting point was determined by taking the last digit of the first number that was randomly drawn from the table of randomly selected three digit numbers as recommended by Mugenda and Mugenda (2003). In our situation, the first random number selected was 294. The first or the last digit of this number constituted the starting point. In this view, we had an option of starting either with the 2nd or the 4th unit, being the first and the last digit of the selected random number respectively. For this case, the 4th unit was chosen as the starting point and the remaining entities/units were selected at fixed interval until the required sample size was achieved. To this end, every 10th enterprise was chosen until a sample size of 54 units was attained.

Table 4.4: Summary of Sampling Units, Methods and Sample Sizes for the Study

| Sampling Unit | | Type of Sampling | Sample Size | |
|---|--------|---------------------|-------------|-----------|
| 1.Study Area (Nairobi River Corridor) | | Purposive Sampling | 1 | |
| 2.Informal Group (Direct Users of the Nairobi River Corridor) | Zone 1 | Stratified Sampling | 8 | 56 |
| | Zone 2 | Stratified Sampling | 8 | |
| | Zone 3 | Stratified Sampling | 8 | |
| | Zone 4 | Stratified Sampling | 8 | |
| | Zone 5 | Stratified Sampling | 8 | |
| | Zone 6 | Stratified Sampling | 8 | |
| | Zone 7 | Stratified Sampling | 8 | |
| 3.Formal Group (Indirect Users of the Nairobi River Corridor) | | Systematic Sampling | 54 | |
| 4.Key Interview Informants (KIIs) | | Purposive Sampling | 10 | |
| Total | | | 121 | |

Source: Author, 2014

4.4 Data Needs and Sources

4.4.1 Data Needs

Data needs for the research comprised both primary and secondary data. Primary data entailed going to the field and subjecting respondents to an interview or a sample of predetermined questions, in form of a questionnaire. It also involved personal observation and assessment of the river corridor.

4.4.2 Data Sources

Primary data was sourced from the study area. Here the main sources of data included the physical environmental situation, infrastructural services and the socio-economic situation of the users of the Nairobi River Corridor. Secondary data on the other hand was obtained from libraries. It was extracted from published papers, journals, Acts of parliament, policy and strategy papers and such other documents that address the subject of conservation and utilization of urban river corridors. Useful in this case were documents from the National Government particularly from Government Printer, Nairobi City County Government, Nairobi River Basin Projects (NRBP) and National Environmental Management Authority (NEMA) among others.

4.5 Data Collection Methods and Instruments

Primary data was collected through survey of the study area. Instruments used in collection of primary data included: structured questionnaires, administered to both *formal* and *informal groups* along the river corridor, observation guides/checklist, a photography camera and maps. Planning for collection of primary data entailed the following:

- **Preparation of data collection instruments:** These included Questionnaires, Interview Schedules, and Observation Lists. Draft copies of these instruments were first developed or formulated in line with the objectives of the study in readiness for pilot testing. Question-sequence was taken into account in order to make the questionnaires and interview schedules effective and also ensure quality responses. In this case, sensitive questions were avoided as the opening questions and only those that arouse human interest were put as the opening questions.
- **Preparation of data collection methodology:** This involved field reconnaissance, identification of sample size & sampling technique, identification of key research informants and identification/hiring and training of research assistants. Adequate training was offered to all the research assistants to equip them with necessary skills of what they were to help establish or gather from the study area.

- **Pilot testing of data collection instruments:** This was done to test the research instruments and research assistants. The test was to assess the reliability and accuracy of the research instruments. This process was also able to identify weaknesses of the questionnaires through identifying ambiguous, vague, repetitive, unnecessary or extremely long questions. The pilot study/test also aimed at finding out if and how well the research assistants understood the process of data collection and administration of questionnaires. Each of the research assistants tested two questionnaires on the pilot testing day, which took place about one week prior to actual data collection day. This enabled the evaluation of the feasibility, time, and cost of carrying out the data collection.
- **Revision data collection instruments:** This was carried out immediately after the pilot testing to correct the shortcomings experienced/identified during the exercise. New questions were for instance added into the questionnaires/interview schedules as well as removal of irrelevant ones. Final copies of the same were then produced.
- **Data collection:** Administration of questionnaires was conducted by the researcher with the help of five (5) research assistants drawn from Environmental Conservation and Planning Disciplines since these fell within the brackets of what the researcher was studying. Before embarking on the exercise, adequate training was offered to the research assistants to equip them with necessary skills of what they were to help establish or gather from the ground/study area. Interview schedules were used by the researcher personally to obtain information from a number of key informants in institutions that play a direct or indirect role in the management of Nairobi River corridor including other stakeholders in the subject of study. Personal observation, assessment and documentation were the other methods that were employed in the collection of primary data.
- **Data editing/cleaning:** This involved examining the collected raw data to detect errors and omissions and to correct the same where possibility existed. It involved careful scrutiny of the completed questionnaires and schedules to ensure that the data is accurate, consistent with the facts gathered, uniformly entered, as completed as possible and have been well arranged to facilitate coding and tabulation.

Secondary data on the other hand, was majorly collected by the researcher personally through review of pertinent literature materials. Environmental conservation books, Magazines, newspapers and journals were of great importance in this case. Additional secondary data included layout plans showing the distribution of land uses adjacent to the river but within the Nairobi City.

4.6 Data Quality and Integrity

To permit quantitative analysis, data was first coded, representing attributes or measured variables. Data from both the informal and informal groups for instance first edited, coded and classified into classes or groups on the basis of the common characteristics of the responses as obtained from the questionnaires. Data from personal observation was also be first edited, coded and then cross-checked against other existing secondary data of the study area.

4.7 Data Inputting and Analysis

Quantitative data was input and analyzed using SPSS (Statistical Package for Social Sciences) and also Microsoft Excel programme. Qualitative data on the other hand was input in computers in form of maps, photographs, sketches, illustrations and plans. A pre-analysis of data was first done. This involved systematic organization of the raw data (from questionnaires, observation guides/checklists and interview schedules) into a manner that facilitated easy analysis. Both qualitative and quantitative techniques were used in the analysis of the obtained data.

4.8 Data Presentation

Maps and plans created through Geographic Information System (GIS) software or other relevant softwares and photographs were used to represent qualitative analysis of the physical conditions of the river and its corridor. On the other hand, tables, charts and descriptive reports were used to represent quantitative data of the respondents' (users') attitudes regarding the state and utilization of the river corridor.

4.9 Data Reliability and Validity

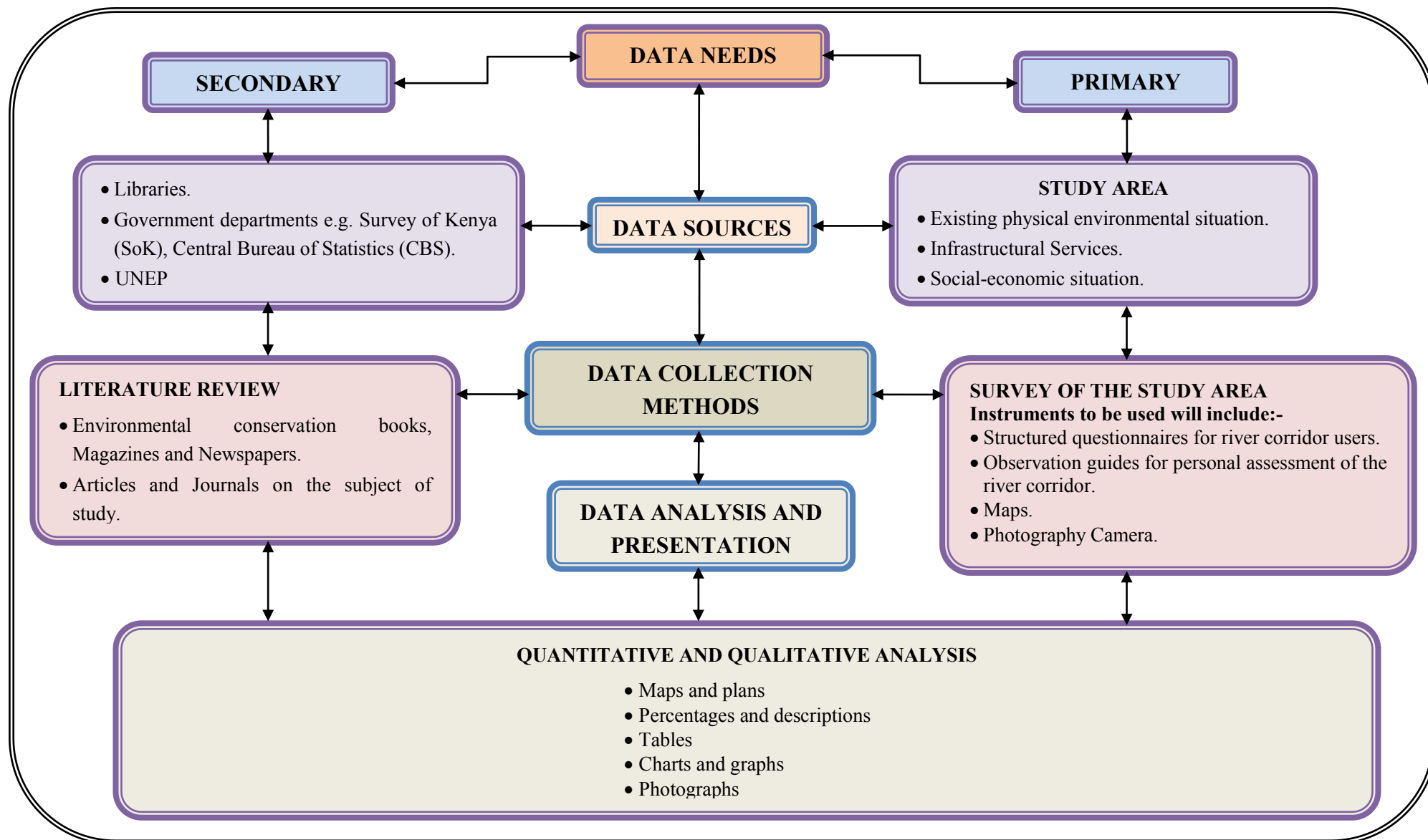
4.9.1 Data Reliability

Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials (Mugenda O. and Mugenda A., 2003). In our case, reliability was mainly concerned with consistency, that is, the probability of obtaining the same information if the study was to be conducted again. It was also meant to reduce random error. The research employed the *split-half technique* to ensure reliability of the data/information collected. This involved dividing the data/information collected into two and correlating one part of the data/information with the second part of the same. The reliability of data from the questionnaires was also enhanced by use of interactional checks through direct observation.

4.9.2 Data Validity

According to Mugenda O. and Mugenda A. (2003), validity is the accuracy and meaningfulness of inferences, which are based on research results. In our case, validity was concerned with checking the respondents' account with the situation on the ground. In this connection, validity of the data was enhanced through application of appropriate data collection methods as exemplified in the sampling methods, and also by use of photographs and observational guides. This data was then compared with that from the respondents.

Figure 4.8: Data Needs, Sources, Collection Methods and Analysis



Source: Author, 2014

Table .4.5: Data Needs Matrix

| Research Objectives | Data Needs | Sources of Data | Data Collection Methods | Data Analysis | Data Presentation |
|---|--|---|--|---|---|
| 1.To find out the utilization and conservation challenges facing the Nairobi River Corridor. | <ul style="list-style-type: none"> • Opinions and views from various stakeholders • Views/opinions from residents of Nairobi city/county • Views from the business community within the precincts of the river corridor | <ul style="list-style-type: none"> • Key informants • Nairobi County Government • MWNR • NEMA • UNEP- NRBP • Business Community around the river corridor | <ul style="list-style-type: none"> • Literature Review: books, articles, journals etc. • Round table discussions with key informants/resource persons • Open ended Questionnaires and Interview schedules to various respondents such as business | <ul style="list-style-type: none"> • Content Analysis • Qualitative and Quantitative Analysis • Use of spatial analysis tools (ArcGIS) | <ul style="list-style-type: none"> • Reports • Charts • Maps • Tables • Photos |
| 2.To examine the kind of river degradation occurring on the Nairobi River Corridor specifically on the section between Racecourse Road and Lamu Road. | <ul style="list-style-type: none"> • Level of degradation of the river corridor • Level of encroachment of human activities on the river corridor/riparian reserve. • Nature of activities taking place on the river corridor | <ul style="list-style-type: none"> • Key informants • Nairobi County Government • MWNR • NEMA • UNEP- NRBP • Users of the river corridor- flower nurseries, car washers, mechanics, vendors, picnickers • Business communities adjacent the river corridor | <ul style="list-style-type: none"> • Literature Review • Round table discussions with key informants/resource persons • Open ended Questionnaires and Interview schedules | <ul style="list-style-type: none"> • Content Analysis • Qualitative and Quantitative Analysis | <ul style="list-style-type: none"> • Reports • Charts • Maps • Tables • Photos |
| 3.To investigate the main causes of the observed degradation of Nairobi River Corridor on the | <ul style="list-style-type: none"> • Opinions and views from various stakeholders • Views/opinions from residents of Nairobi city/county | <ul style="list-style-type: none"> • Policy publications • Legislations • Key informants • Nairobi County | <ul style="list-style-type: none"> • Literature review on relevant library material, earlier research, the media and the Internet. | <ul style="list-style-type: none"> • Content Analysis • Qualitative and Quantitative Analysis | <ul style="list-style-type: none"> • Reports • Charts • Maps • Tables |

| | | | | | |
|---|--|--|--|---|---|
| section between Racecourse Road and Lamu Road. | <ul style="list-style-type: none"> Views from the business community within the precincts of the river corridor | <p>Government</p> <ul style="list-style-type: none"> MEWNR NEMA UNEP- NRBP | <ul style="list-style-type: none"> Round table discussions with key informants/resource persons Open ended Questionnaires and Interview schedules | | <ul style="list-style-type: none"> Photos |
| 4.To identify the policy, legislative and institutional measures in place for sustainable utilization and conservation of Nairobi River Corridor. | <ul style="list-style-type: none"> Opinions and views from various stakeholders View from various from various key informants. | <ul style="list-style-type: none"> Policy publications Legislations Business communities adjacent the river corridor Key informants | <ul style="list-style-type: none"> Literature Review Round table discussions with key informants/stakeholders Field Survey interviews | <ul style="list-style-type: none"> Content Analysis Qualitative and quantitative analysis using SPSS and MS-Excel | <ul style="list-style-type: none"> Reports Charts Maps Tables Photos |
| 5.To assess the available Political, Economic, Social, Technological, Environmental and Legal (P.E.S.T.E.L) options for sustainable utilization and conservation of Nairobi River Corridor and such others. | <ul style="list-style-type: none"> Opinions and views from various stakeholders Views/opinions from residents of Nairobi city/county Views from the business community within the precincts of the river corridor Views from various key informants. | <ul style="list-style-type: none"> Policy publications Legislations Business communities adjacent the river corridor Key informants Nairobi County Government | <ul style="list-style-type: none"> Literature Review Round table discussions with key informants/resource persons Open ended Questionnaires and Interview schedules | <ul style="list-style-type: none"> Content Analysis Qualitative and Quantitative Analysis | |

Source: Author, 2014

Table 4.6: Research Programme and Budget

| ACTIVITY NO: | NAME OF ACTIVITY | BUDGET (Per Month) | TIME / PERIOD | | | | | | | |
|--------------|--|--------------------|---------------|----------|----------|----------|----------|----------|-----------|-----------|
| | | | DEC 2013 | JAN 2014 | FEB 2014 | MAR 2014 | APR 2014 | MAY 2014 | JUN. 2014 | JUL. 2014 |
| 1 | Development of Research Proposal | Kshs. 1,000/- | | | | | | | | |
| 2 | Literature Review: Review and Analysis of secondary data | Kshs. 2,500/- | | | | | | | | |
| 3 | Preparation of Data Collection tools: Questionnaires, Interview Schedules, Observation Lists, Photography Camera, and Tape measures amongst others. | Kshs. 2,500/- | | | | | | | | |
| 4 | Preparation of data collection methodology: Field reconnaissance, identification of sample size & sampling technique, identification of key research informants and identification/hiring and training of research assistants. | Kshs. 1,500/- | | | | | | | | |
| 5 | Collection of Primary Data | Kshs. 10,000/- | | | | | | | | |
| 6 | Data entry, Analysis and Synthesis. | Kshs. 2,500/- | | | | | | | | |
| 7 | Preparation of proposals and recommendations. | | | | | | | | | |
| 8 | Preparation and presentation of the draft thesis | Kshs. 5,000/- | | | | | | | | |
| 9 | Incorporating comments from the presentation in activity No.8 above. | Kshs. 2,000/-- | | | | | | | | |
| 10 | Printing and Submission of final thesis | Kshs. 3,500/- | | | | | | | | |
| 11 | Thesis Defense | | | | | | | | | |

Source: Author, 2014

CHAPTER FIVE:
FINDINGS OF THE STUDY

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5.0 Introduction

This chapter presents the analysis of data and findings of the study on the planning approaches for sustainable utilization and conservation of urban river corridors in Kenya. The first section of the chapter presents the socio-demographic data of the respondents, while the second section presents data on utilization and conservation challenges facing the Nairobi River Corridor, the nature of river degradation occurring on this area and the main causes of the observed river corridor degradation. It further outlines the policy, legislative and institutional measures in place for sustainable utilization and conservation of the Nairobi River Corridor as well as the available Political, Economic, Social, Technological, Environmental and Legal (P.E.S.T.E.L) options for sustainable utilization and conservation of Nairobi River Corridor and such others.

5.1 Respondents' Socio-Demographic Data

The study first sought socio-demographic data of the respondents who were broadly categorized into two groups. The first category of respondents entailed a sample population of people working/operating or living on the riparian reserve (informal groups/users of river corridor) while the second category comprised of people working/operating or living along the river corridor but outside the riparian reserve and within a span of approximately 70m from the line of delineation (formal groups). The socio-demographic data sought from both categories entailed respondents' age, gender/sex, current marital status, education background, occupation, average income per month and their area of residence.

5.1.1 Socio-Demographic Data of Respondents from the Informal Group

5.1.1.1 Respondents' Age-Gender Distribution

Almost half of the respondents (50%) fell in age bracket of between 26 and 35 years. Of these, 27% were males while the rest 23%, were females. About 24% others were aged between 15-25 years, followed by those aged between 36-45 years (15%). A further 7% were aged between 46-55 years. Only 4% of the respondents fell in the age bracket of over 55 years. This indicates that the river is mostly used by the young age groups. From the survey, it also emerged that majority (55%) of the respondents interviewed were males with only 45% being females (See Table 5.1).

Table 5.1: Respondents' Age-Gender Distribution

| Age Bracket (Years) | Gender /Sex | | Total (%) |
|---------------------|-------------|-------------|------------|
| | Males (%) | Females (%) | |
| 15-25 | 14 | 10 | 24 |
| 26-35 | 27 | 23 | 50 |
| 36-45 | 8 | 7 | 15 |
| 46-55 | 4 | 3 | 7 |
| >55 | 2 | 2 | 4 |
| Total | 55 | 45 | 100 |

Source: Field survey, 2014

5.1.1.2 Respondents' Marital Status

The sample population consisted of married, single, widowed/widower and divorced or separated groups/categories. The study established that about 57% of the respondents' were married, with males taking up about 29% of this and females taking up 28%. The study also established that about 32% of the sample population was single, while the rest (11%) were either widows, widowers or separated.

Table 5.2: Respondents' Marital Status

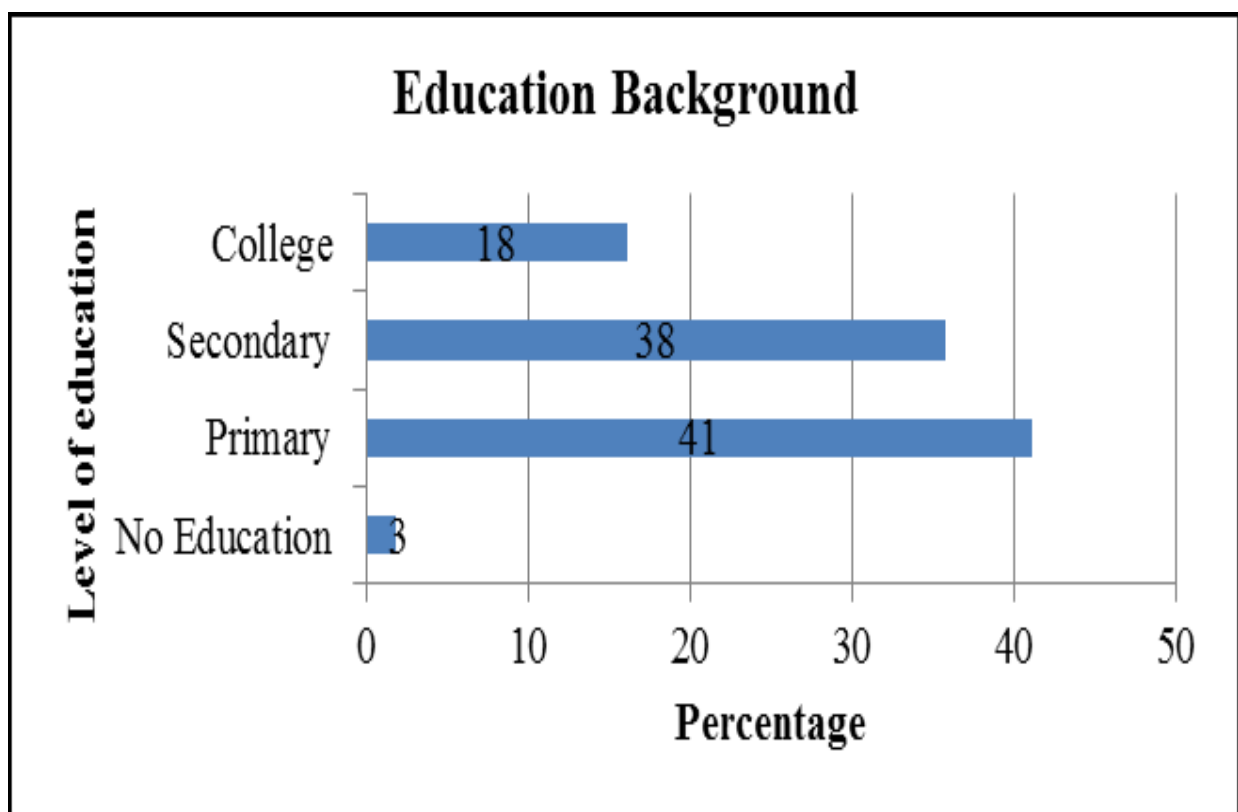
| Marital Status | Males % | Females % | Total % |
|--------------------|-----------|-----------|------------|
| Married | 29 | 28 | 57 |
| Single | 17 | 15 | 32 |
| Widow /Widower | 4 | 3 | 7 |
| Divorced/Separated | 2 | 2 | 4 |
| Total | 52 | 48 | 100 |

Source: Field survey, 2014

5.1.1.3 Respondents' Education Level

Approximately 41% of the sample population had received at least primary education, while secondary and tertiary levels recorded 38% and 18% respectively. A further, sample population of about 3% had not received any education at all. From the findings, it was clear that majority of the population had not attained tertiary education. This is probably why they are not absorbed in the formal sector of employment thus prompting them to engage in informal trade and live in informal settlements.

Chart 5.1: Respondents' Education Level

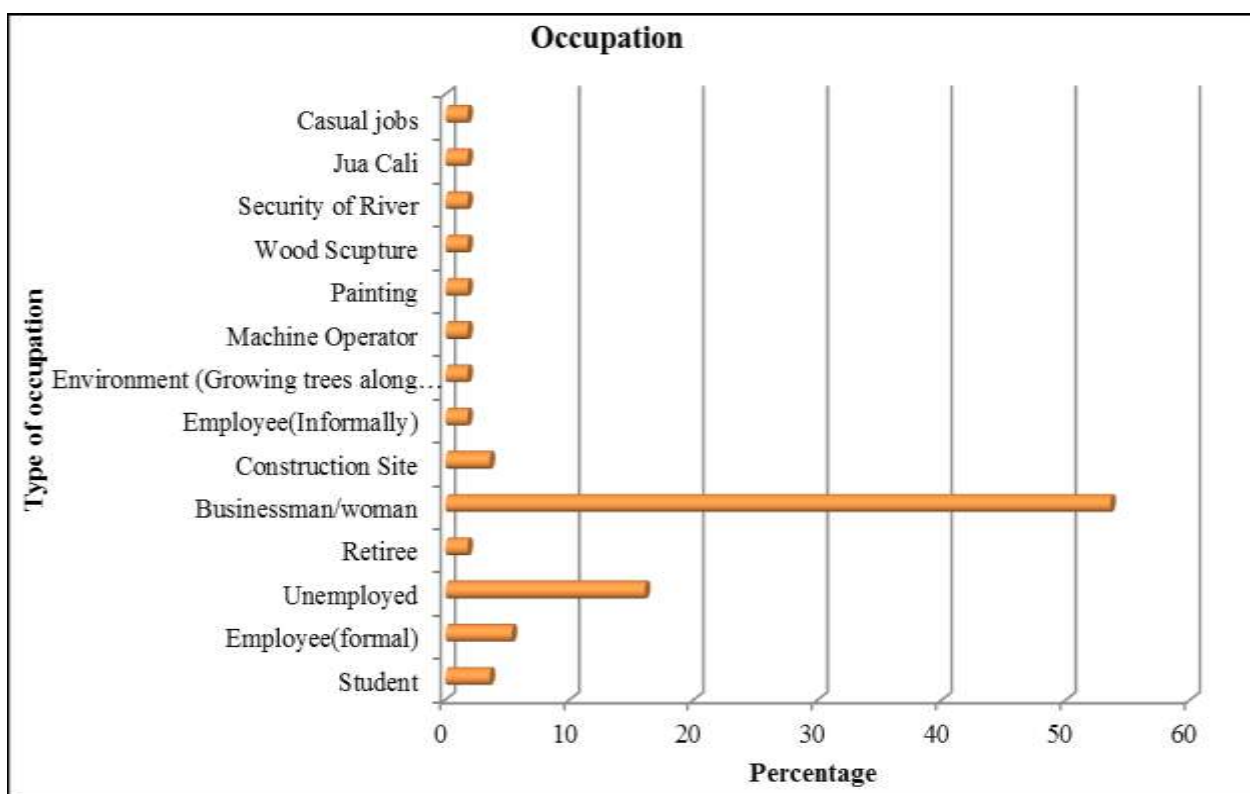


Source: Field survey, 2014

5.1.1.4 Respondents' Occupation

From field survey, it was established that majority of the respondents (54%) in the informal groups were self-employed, working either as businessmen or businesswomen. A considerable percentage of the sample population in the area (16%) is unemployed. Only about 5% of the sample population was formally employed as shown by the chart below. A further 1% of the sample population was neither employed formally nor informally but they did any casual job that came by. Such jobs included washing of cars, construction, loading and offloading of goods to and from goods vehicles and waste disposal among others. In view of the economic activities taking place along the river corridor, the study concludes that the major occupation in the area is entrepreneurship which mainly involves small scale informal businesses.

Chart 5.2: Respondents' Occupation

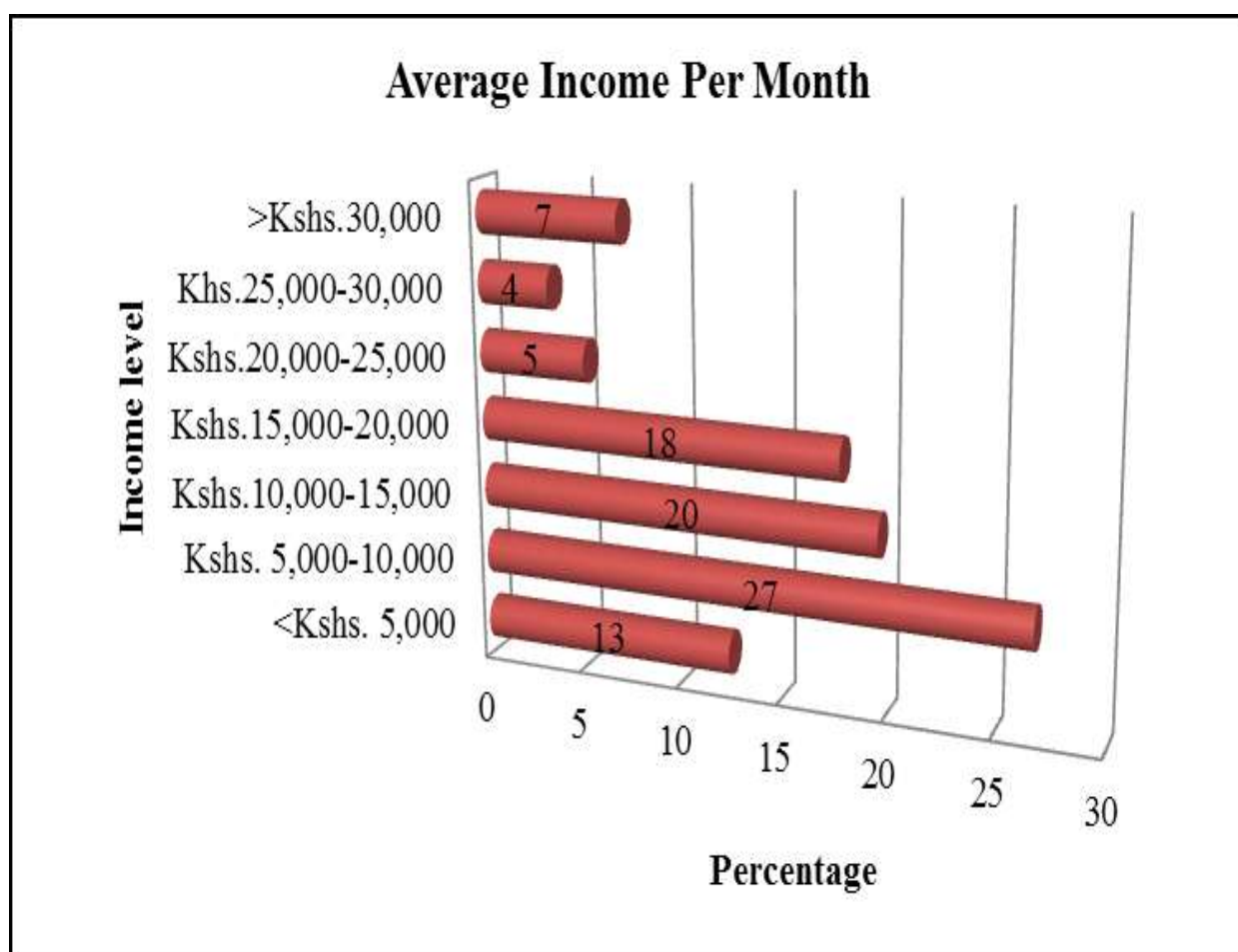


Source: Field survey, 2014

5.1.1.5 Respondents' Income Levels

Generally, income levels amongst the informal group in the study area are fairly spread out ranging between Kshs. 5,000/- to about Kshs. 30,000/-. Nearly a third of the sampled population (27%) earned between Kshs. 5,001/- and Kshs. 10,000/-per month. A further 20% of the sampled population earned between Kshs. 10,001/-and Kshs. 15,000/-. Only 7% of the sampled population fell in the income brackets of over Kshs. 30,000/- per month. To this end, it is apparent that majority of the respondents from the informal group (users of the river corridor) earn less than Ksh. 10,000/- a month.

Chart 5.3: Respondents' Income Levels



Source: Field survey, 2014

5.1.1.6 Respondents' Area of Residence

According to the study, almost 78% of the sampled respondents from informal groups (river corridor users) reside in various parts of the city, with majority of them either living in low income residential areas or informal settlements. About 30% of these lived in informal settlements located on or near the river corridor itself. Such areas include Gikomba, Kamukunji, Majengo estate, Muthurwa and Nairobi River. A considerable percentage (22%) of the respondents however lived outside the city and only visited the study area (river corridor) for work or other businesses. These came as far as from Githurai, Kajiado, Kangemi, Kiambu, Mwiki and Ngomongo. The major areas of sample respondents' residences are as listed in Table 5.3 below:

Table.5.3: Respondents' Area of Residence

| Respondents' Area of Residence | Percentage (%) | Respondents' Area of Residence | Percentage (%) |
|--------------------------------|----------------|--------------------------------|----------------|
| Dagoretti Corner | 2 | Kibera | 4 |
| Dandora | 5 | Kimendo | 2 |
| Eastleigh | 2 | Luckysummer | 2 |
| Embakassi | 4 | Majengo | 5 |
| Gikomba | 2 | Mathare | 2 |
| Githurai | 5 | Mukuru kwa Njenga | 5 |
| High-rise | 2 | Muthurwa | 3 |
| Huruma | 9 | Mwiki | 2 |
| Jericho | 2 | Nairobi River | 3 |
| Kajiado | 2 | Ngomongo | 2 |
| Kamukunji | 2 | N.Majengo | 2 |
| Kangemi | 2 | No permanent Residence | 2 |
| Kariokor | 4 | Shauri Moyo | 5 |
| Kayole | 5 | Taveta Majengo | 2 |
| Kiambiu | 2 | Ziwani | 2 |
| Kiambu | 7 | | |

Source: Field survey, 2014

5.1.2 Socio-Demographic Data of Respondents from the Formal Group

5.1.2.1 Respondents' Age-Gender Distribution

The sample population in the formal group category comprised of about 54% male respondents and 46% females. The greatest proportion of these (34%) fell in age bracket of between 26 and 35 years. Male respondents dominated this category, taking up 19% and females taking 15%. Furthermore, about 26% of the sampled population was aged between 15-25 years, while about 23% of the sampled population was in the age brackets of between 36-45 years. Almost 11% of the respondents fell in the age brackets of between 46-55 years and only about 6% of the sample respondents were 55 years and above as shown in Table 5.4 below.

Table 5.4: Respondents' Age-Gender Distribution

| Age Bracket(Years) | Gender/Sex | | Total |
|--------------------|--------------|--------------|--------------|
| | Males (%) | Females (%) | |
| 15-25 | 13.84 | 12.3 | 26.14 |
| 26-35 | 18.46 | 15.38 | 33.84 |
| 36-45 | 12.3 | 10.77 | 23.07 |
| 46-55 | 6.15 | 4.62 | 10.77 |
| >55 | 3.07 | 3.07 | 6.14 |
| Total | 53.82 | 46.14 | 99.96 |

Source: Field survey, 2014

5.1.2.2 Respondents' Marital Status

Respondents from the formal group comprised of about 52% married persons, 41% single persons and 5%, widows/widowers. The rest (4%) were divorced/separated groups. From the study, it was further established that there were more married males than females and the same scenario was replicated in the single person's category (See Table 5.5 below).

Table 5.5: Respondents' Marital Status

| Marital Status | Males % | Females % | Total % |
|--------------------|-----------|-----------|------------|
| Married | 28 | 24 | 52 |
| Single | 24 | 17 | 41 |
| Widow /Widower | 3 | 2 | 5 |
| Divorced/Separated | - | 2 | 2 |
| Total | 55 | 45 | 100 |

Source: Field survey, 2014

5.1.2.3 Respondents' Education Level

From the study, it was established that about 2% of the sample population in the formal group had not received any education at all. However, around 43% of the sample population had attained primary school education, while nearly 35% of the same sample population had attained secondary school education. Those with tertiary level of education accounted for about 20%, meaning that majority of the respondents in the sample population had not attained tertiary level education.

Overall, approximately 55% of the sample respondents had attained post primary school education. Furthermore, males dominated all levels of education, save for the primary level of where the percentage of females was greater than that of males by about 3%, followed by those of secondary school level where their percentages were more or less the same as indicated in Table 5.6 below.

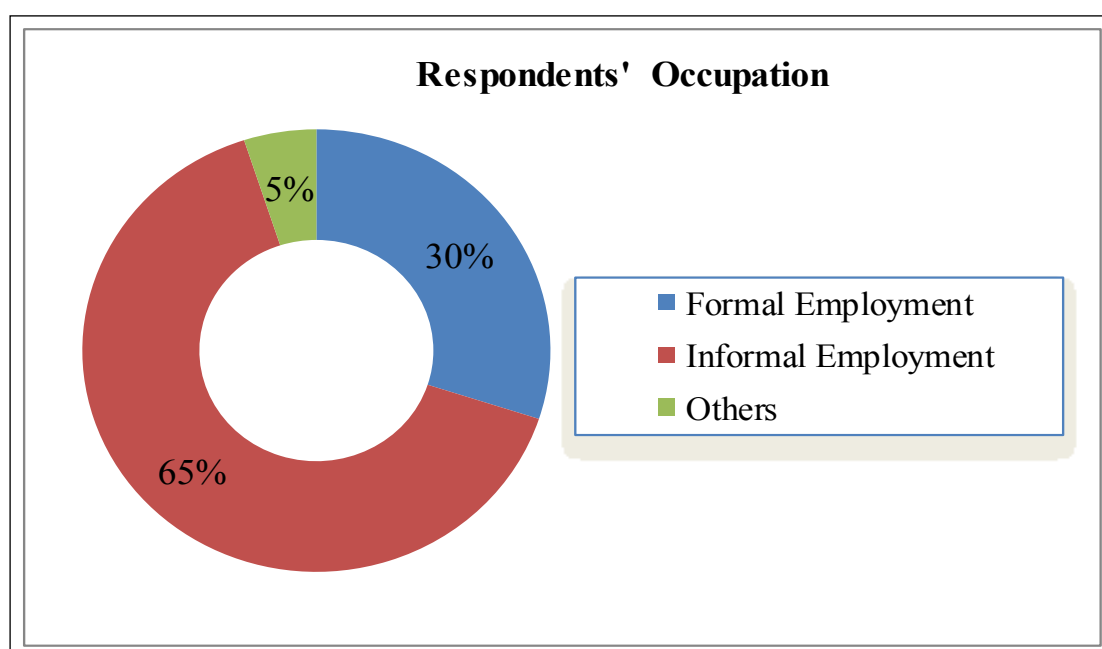
Table 5.6: Respondents' Education Level

| Respondents' Education Level | Gender/Sex | | Total |
|------------------------------|------------|-------------|------------|
| | Males (%) | Females (%) | |
| No Education | 1 | 1 | 2 |
| Primary Education | 20 | 23 | 43 |
| Secondary Education | 18 | 17 | 35 |
| Tertiary Education | 12 | 8 | 20 |
| Total | 51 | 49 | 100 |

Source: Field survey, 2014

5.1.2.4 Respondents' Occupation

From field survey, it was established that majority of the respondents (about 65%) were self-employed. Only 30% of the sample population was formally employed. A further 5% were neither employed formally nor informally but they did any job that came by e.g. loading and offloading of goods from trucks, construction, and waste disposal among others.

Chart 5.4: Respondents' Occupation

Source: Field survey, 2014

5.1.2.5 Respondents' Income Levels

Income levels in for this category of respondents (formal groups) ranged between Kshs. 5,000/- to about Kshs. 40,000/-. A majority of the respondents (25%) however earn between Kshs. 5,000/- to about Kshs. 10,000/-. About 20% of the sampled population earned between Kshs. 10,001/-and Kshs. 15,000/- .Furthermore, around 15% of the respondents earn an income of Kshs. 15,001/- to Kshs. 20,000/- per month while almost a similar percentage (14%) made an income of between Kshs. 20, 000/- to Kshs. 25,000/-. Further, about 11% of the sampled respondents earned between Kshs. 25,001/- and Kshs. 30,000/-. Only 7% fell on the income brackets of over Kshs. 30, 000/- per month. Some of the respondents were however reluctant to disclose their average income levels.

Table 5.7: Respondents' Income Levels

| Respondents' Average Monthly Income Brackets | Sex (Gender) | | Total (%) |
|--|--------------|------------|-----------|
| | Male (%) | Female (%) | |
| Below Ksh 5,000/- | - | 2 | 2 |
| Ksh.5001/- to 10,000/- | 11 | 14 | 25 |
| Ksh. 10,001/- to 15,000/- | 8 | 12 | 20 |
| Kshs. 15,001/- to 20,000/- | 9 | 6 | 15 |
| Kshs. 20,001/- to 25,000/- | 8 | 6 | 14 |
| Kshs. 25,001/- to 30,000/- | 6 | 4 | 10 |
| Above Kshs. 30,000/- | 5 | 2 | 7 |
| Total | 47 | 46 | 93 |

Source: Field survey, 2014

5.1.2.6 Respondents' Area of Residence

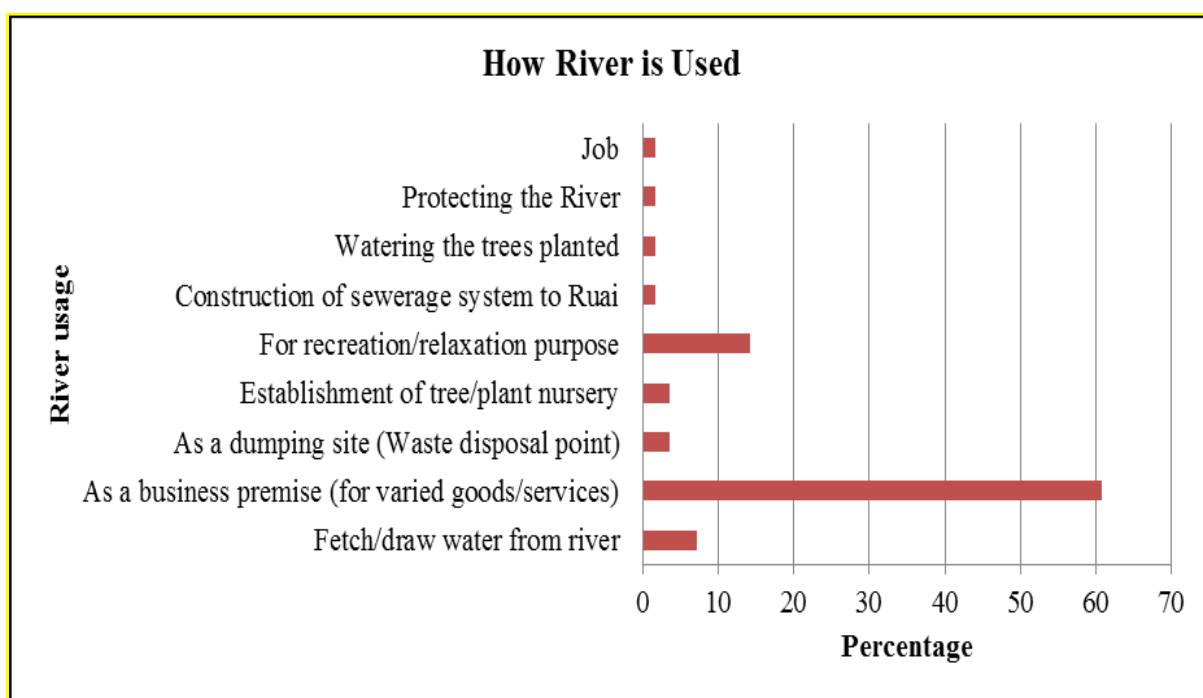
The study established that most of the people working/operating businesses along the river corridor reside in various parts of the city and report to work in the morning, with majority of them living in the neighbourhood of their work place. Of these, about 20% of the sampled population lived near or on the river corridor, which also happens to be their work place.

5.2 Utilization Patterns of the Nairobi River Corridor

5.2.1 Uses of the River Corridor by the Informal Group

From the field survey, it was observed that the river corridor is mainly dominated by informal socio-economic activities notably informal settlements and informal commercial activities. The greatest percentage (61%) of the sample respondents uses the river for business purposes- to sell a variety of goods and services. Most of these activities take place in make-shift or temporary structures on the river corridor. Other uses include visits to the area for recreation and relaxation purposes (14%), car washing and repair, hawking, shoe polishing etc. The river corridor is also a home of numerous less fortunate urban communities, including street families.

Chart 5.5: How Informal Group Uses of the Nairobi River Corridor

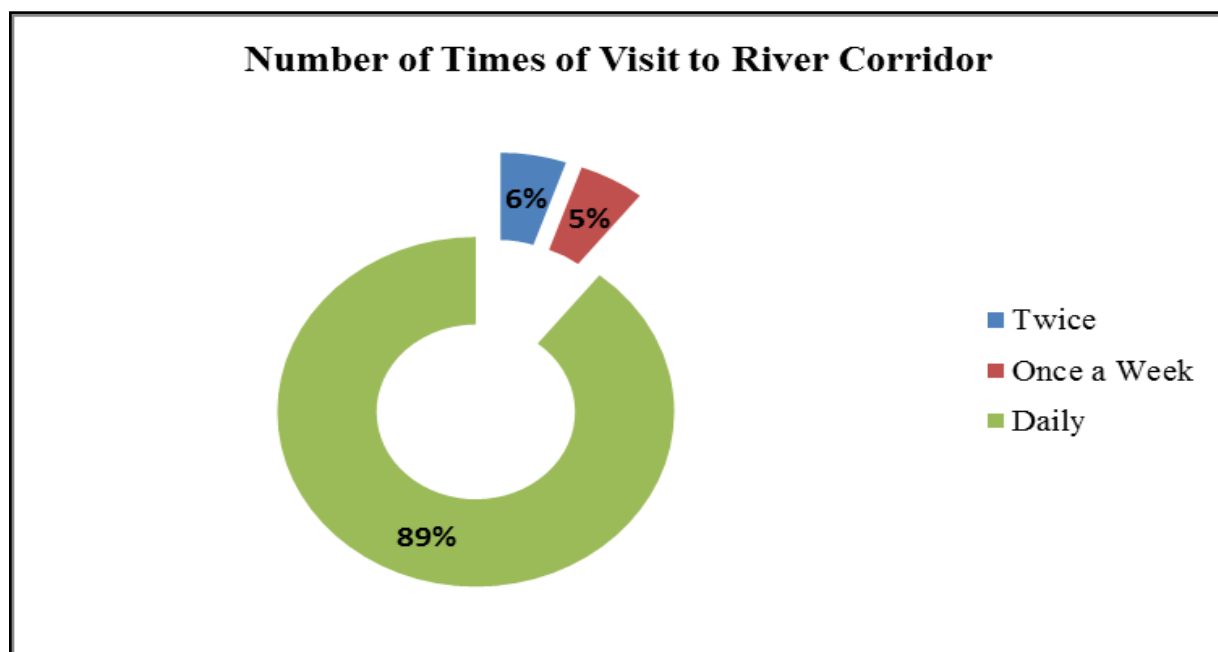


Source: Field survey, 2014

5.2.2 Frequency of Use of the River Corridor

The study established that the river corridor is used throughout the week, with 89% of the sample population using it on daily basis. About 6% of the respondents used the river twice a week. The remaining respondents (5%) disclosed that they used the river corridor at least once a week as shown in chart 5.6 below.

Chart 5.6: Frequency of use of the River Corridor



Source: Field survey, 2014

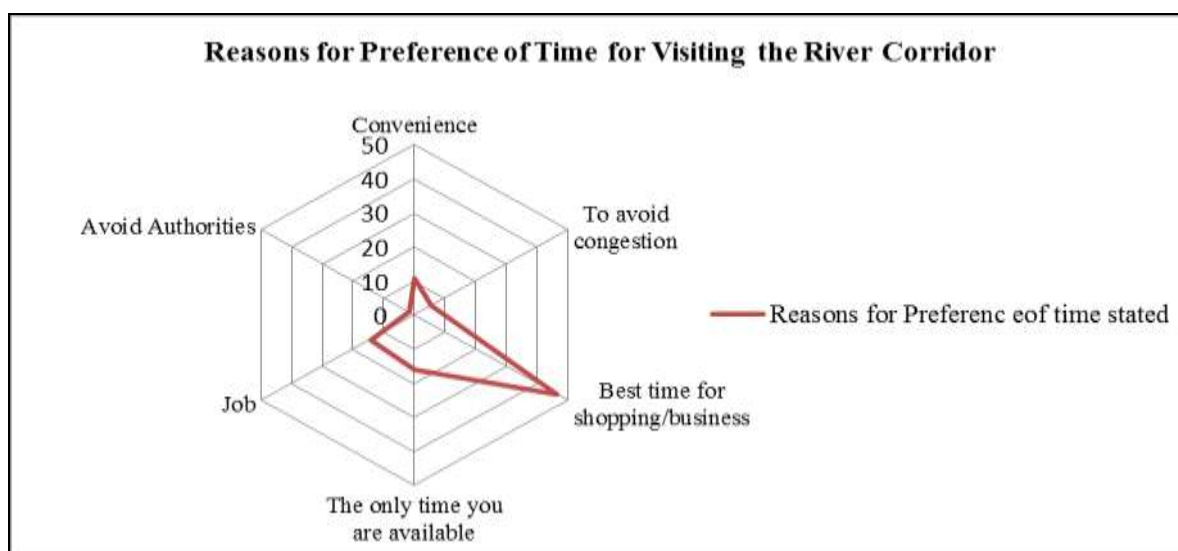
It was further established that the river corridor is mostly used during the day time, with peak hours being early morning hours as the respondents report to their work stations; and from noon time to around 3.00 pm (See Table 5.8) as they flock to purchase cheap food from food vendors operating on the river corridor. As for the food vendors, they visit the place as early as 6.00 am, in order to start their preparations. Majority of those who visit the river corridor in the evening argued that they just go to visit business friends and buy a few items to take home since that's the only time they are available.

On the other hand, some parts of the river corridor are used round the clock. They are used during the day for commercial and other related activities. At night they are used for residential purposes, as exemplified by the informal settlements especially at the lower section of the study area (Majengo slums), opposite Kamukunji recreational grounds.

Table 5.8: River Corridor's Utilization Pattern (Frequency of Use)

| TIME OF VISIT | | Users of the River Corridor | | Total (%) |
|----------------------|-----------------------|-----------------------------|-------------|-----------|
| | | Males (%) | Females (%) | |
| Morning Hours | 6.00 AM to 9.00 AM | 15 | 11 | 26 |
| | 9.00 AM to 12.00 Noon | 12 | 8 | 20 |
| Lunch/Afternoon Time | 12.00 Noon to 3.00 PM | 10 | 9 | 19 |
| | 3.00 PM to 6.00 PM | 9 | 7 | 16 |
| Evening/ Other Time | 6.00 PM to 9.00 PM | 6 | 5 | 11 |
| | 9.00 PM to 6.00 AM | 5 | 3 | 8 |

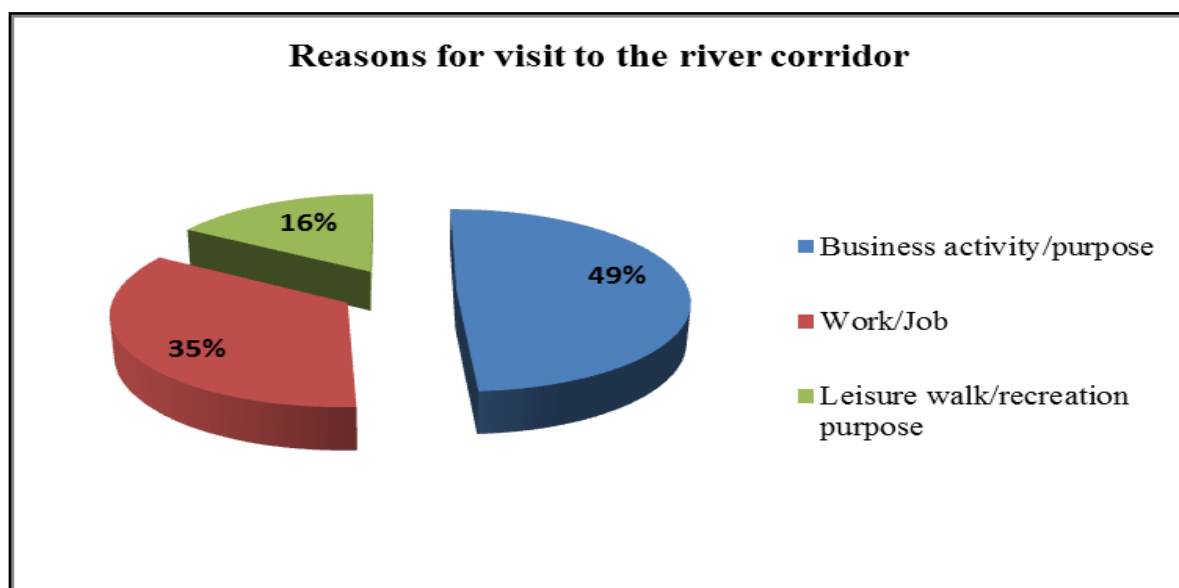
Source: Field survey, 2014

Chart 5.7: Reasons for Preference of Time for Visiting the Nairobi River Corridor

Source: Field survey, 2014

5.2.3 Reasons for Visiting the River Corridor

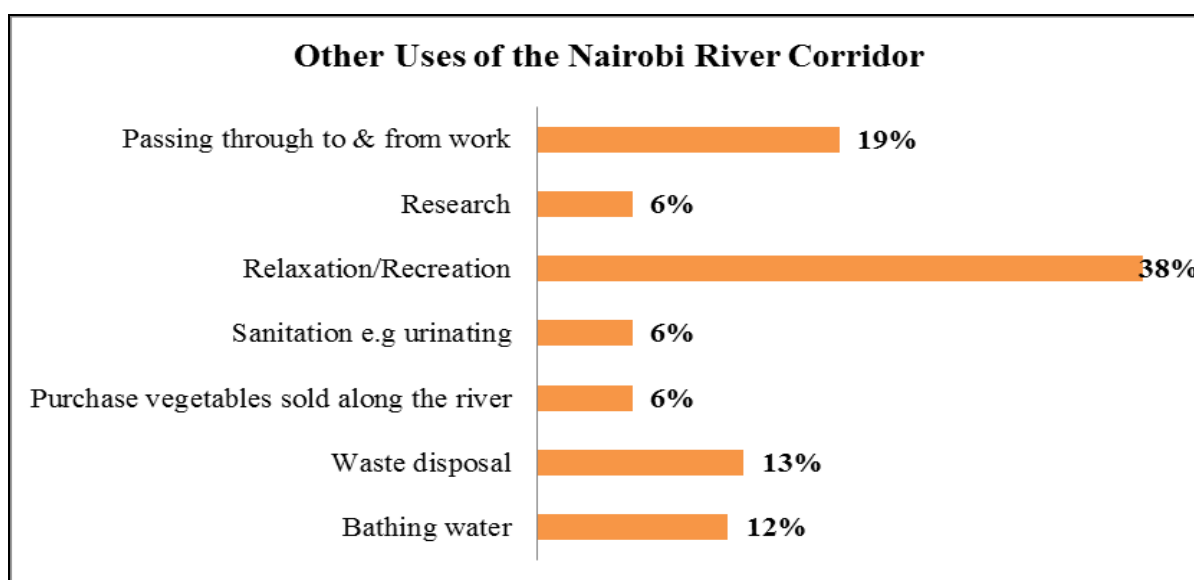
According to the field survey, 49% of the sample population visits the river corridor to run their own informal business activities. A considerable percentage of the sample population (35%) however visits the place for work or job, where they earn their living as employees in the formal or informal sector. Moreover, about 16% of the respondents visit the river corridor for leisure or recreational purposes, which make the lowest percentage as shown in Chart 5.8 below. Most of these recreation/relaxation activities mainly take place on the section of the river corridor abutting Kamukunji Recreational Grounds.

Chart 5.8: Reasons for Visiting the River Corridor

Source: Field survey, 2014

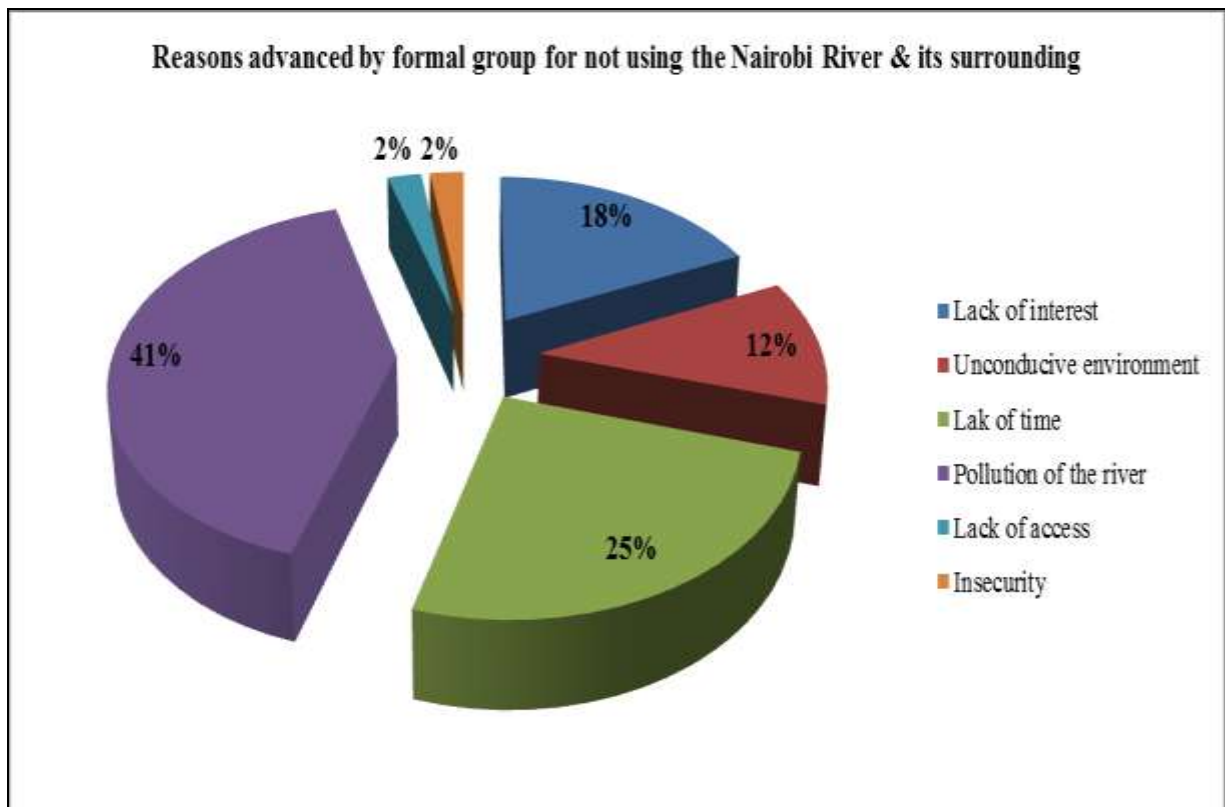
5.2.4 Uses of the Nairobi River Corridor by Formal Group

About 75% of the respondents from the formal group indicated that they had in one way or the other used the river corridor, while 25% had not used the river at all. Approximately 38% of the respondents in this category used the river and its surrounding for recreation purposes and 19% passed through the river and its surroundings on their way to and from work. Other uses of the river are as indicated in the chart 5.9 below.

Chart.5.9: How Formal Group Uses of the Nairobi River Corridor

Source: Field survey, 2014

Chart .5.10: Why the Formal Group has not been using the Nairobi River and its Surrounding



Source: Field survey, 2014

Plate 5.1: Some of the Uses of the River Corridor (Searching for scrap metals)



Source: Field survey, 2014

5.3 State of the Nairobi River Corridor

Both the occupants of the river corridor and the adjacent business community were of the view that the river corridor is in a degraded state. They however concurred that there were some positive improvements on the state of the river corridor owing to ongoing clean up exercise/initiative dubbed the Nairobi River Basin Rehabilitation and Restoration Programme.

5.3.1 Physical State of the Nairobi River Corridor

5.3.1.1 Physical State of the Nairobi River Corridor according to the Informal Group

From the analysis of the findings, it emerged from the users (occupants) of the river corridor that the Nairobi River Corridor is in a very bad state (22%), bad state (43%) and fair state (31%). Only 4% indicated that the river is in a fairly good state. When a comparison of current and past physical state of the river corridor was sought, the sample population indicated that the river corridor in the past was in very bad state (67%) while 18% said it was in a bad state. Only 4% and 6% said it was in a good and very good state respectively. The variation of the present and past status of the river was due to the recent efforts of cleaning the river done by the Nairobi city county government and other stakeholders under the Nairobi River Basin Rehabilitation and Restoration Programme.

Table 5.9: Physical State of the Nairobi River Corridor according to the Informal Group

| Informal Group's Views on Physical State of the River Corridor | | |
|--|-------------------|----------------|
| State/Condition | Present State (%) | Past State (%) |
| Very good | - | 6 |
| Good | 4 | 4 |
| Fair | 31 | 3 |
| Bad | 43 | 18 |
| Very bad | 22 | 67 |
| Other (Worse) | - | 2 |

Source: Field survey, 2014

5.3.1.2 Physical State of the Nairobi River Corridor according to the Formal Group

When the sample respondents of the business community (Formal group) in the study area were asked to rate the physical environment, about 35% rated it as very bad, some 22% bad and about 33% fair. Only about 10% rated it as good as shown in Table 5.10.

When asked to rate the previous or past physical state of the river corridor when the respondents (business operators) first moved to the study area, 63% indicated that it was very bad back then, while only 2% indicated that it had become worse. This indicates that, there has been an improvement in the surroundings of the Nairobi River corridor. This improvement can be attributed to the recent conservation efforts by NEMA and other stakeholders to clean the river by removing garbage that had accumulated on the river corridor and also greening the riparian reserve by plant assorted trees and shrubs. There have also been efforts by the same stakeholders, specifically by TARDA to free the river of sewage menace by construction of sewer line along the river corridor.

Table 5.10: Physical State of the Nairobi River Corridor according to the Formal Group

| Formal Group's Views on Physical State of the River Corridor | | |
|--|-------------------|----------------|
| State/Condition | Present State (%) | Past State (%) |
| Very good | - | 0 |
| Good | 10 | 0 |
| Fair | 33 | 6 |
| Bad | 22 | 29 |
| Very bad | 35 | 63 |
| Other (Worse) | - | 2 |

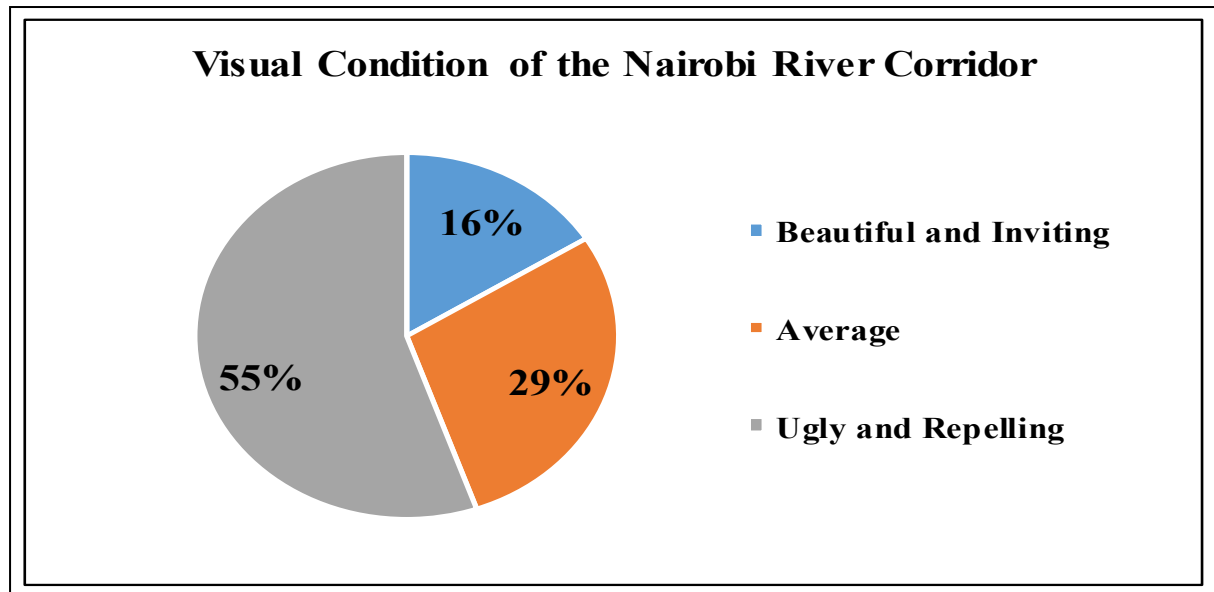
Source: Field survey, 2014

5.3.2 Visual Condition of the Nairobi River Corridor

5.3.2.1 Visual Condition of the Nairobi River Corridor according to the Informal Group

The large proportion of river corridor users (informal group) stated that the river was in ugly and repelling state (55%) while others said it was average (29%). Only 16% of the respondents indicated that the river was somehow beautiful and inviting. This category of respondents was however basing their views in comparison to the past condition of the river, which they described as terrible.

Chart 5.11: Visual Condition of the Nairobi River Corridor according to the informal group



Source: Field survey, 2014

5.3.2.2 Visual Condition of the Nairobi River Corridor according to the Formal Group

For the business operators, when asked to describe the visual condition of the Nairobi River Corridor, about 62% of the respondents indicated that it was ugly and repelling while 21% said it was average. Only 17% of the respondents indicated that it was beautiful and inviting.

Plate 5.2 a & b: Visual State of the River Corridor at different areas along the Nairobi River corridor



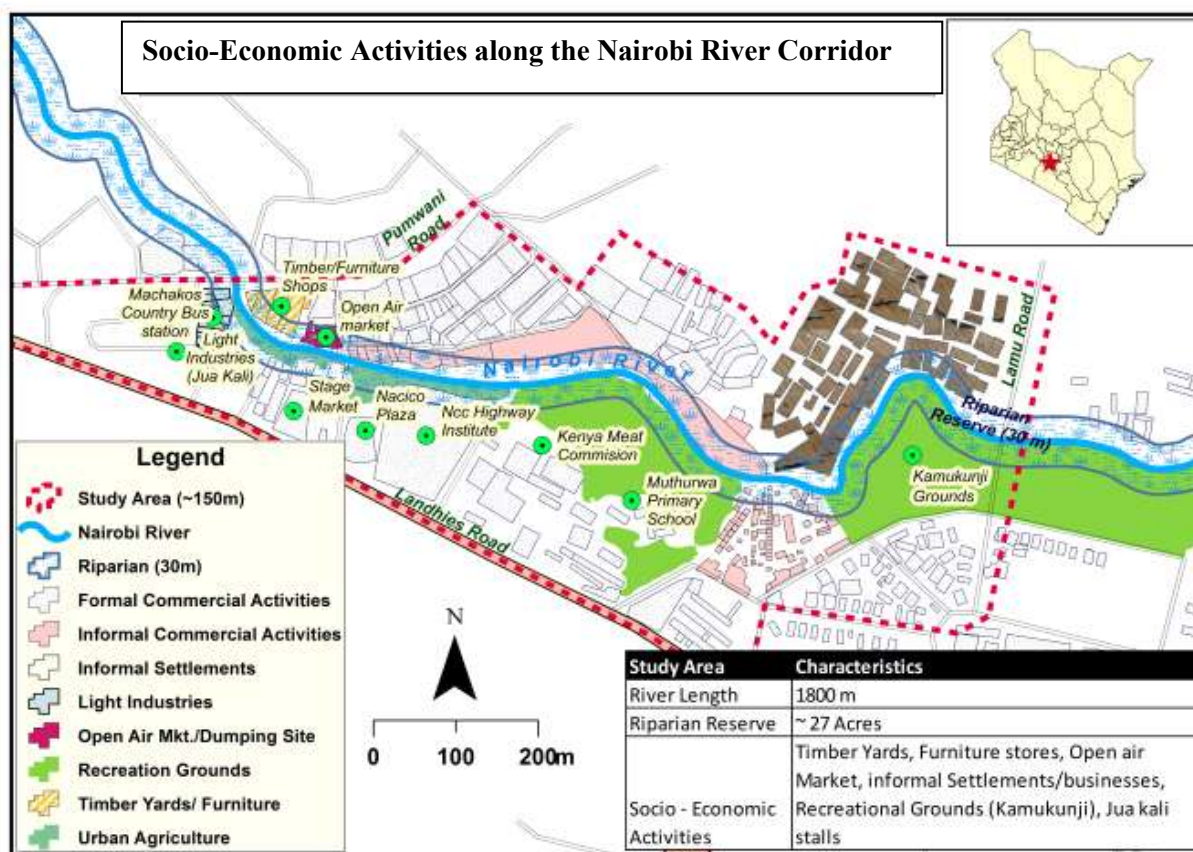
Source: Field survey, 2014

5.4 Utilization/Conservation Challenges Facing the Nairobi River Corridor

5.4.1 Nature of Utilization of the Nairobi River Corridor

From the field survey, it emerged that the river corridor is actually a small city in itself, hosting a number of socio-activities. These activities included social, commercial and agricultural activities. The river corridor is also used for residential purposes as reflected by the Majengo informal settlements around Lamu Road (Refer to Map 5.1, below). The main commercial activities include, food vending, car washing and repair, clothes selling, hawking and shoe polishing among others. Adjacent business activities include, sale of both new and used auto spares. On the other hand, the river corridor is used as a dumping site for commercial and domestic waste (See Plate 5.3, Page 121).

Map 5.1: Utilization of the Nairobi River Corridor (Socio-economic Activities)



Source: Adapted from Google Earth, 2014

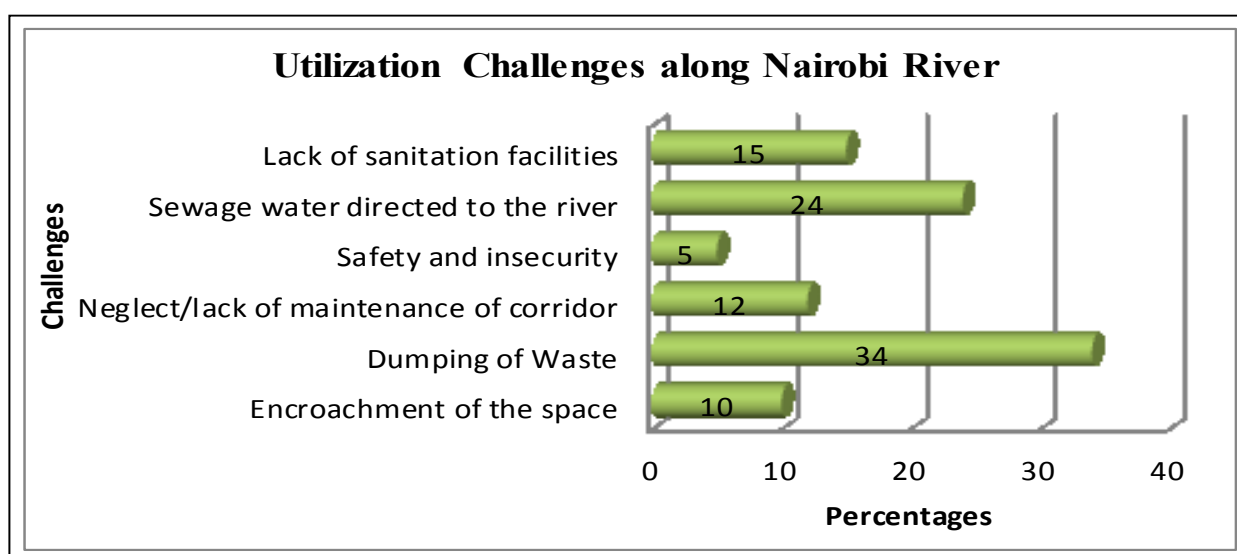
Plate 5.3: Negative Utilization of the Nairobi River Corridor

Source: Field survey, 2014

5.4.2 Utilization Challenges Facing the Nairobi River Corridor

The major challenge of utilization of the river corridor was noted to be dumping of waste (34%) followed by direction of sewerage water into the river (24%) and lack of sanitation facilities (15%). Neglect/ lack of maintenance (12%) and encroachment of space (10%) were other challenges that hindered utilization of the river corridor. Interestingly, safety/security was described to contribute insignificantly to river utilization. The reason advanced for this was that the users/residents are familiar with each other as well as their environment; hence security and safety weren't a major issue to them.

Chart 5.12: Challenges of Utilizing the Nairobi River Corridor

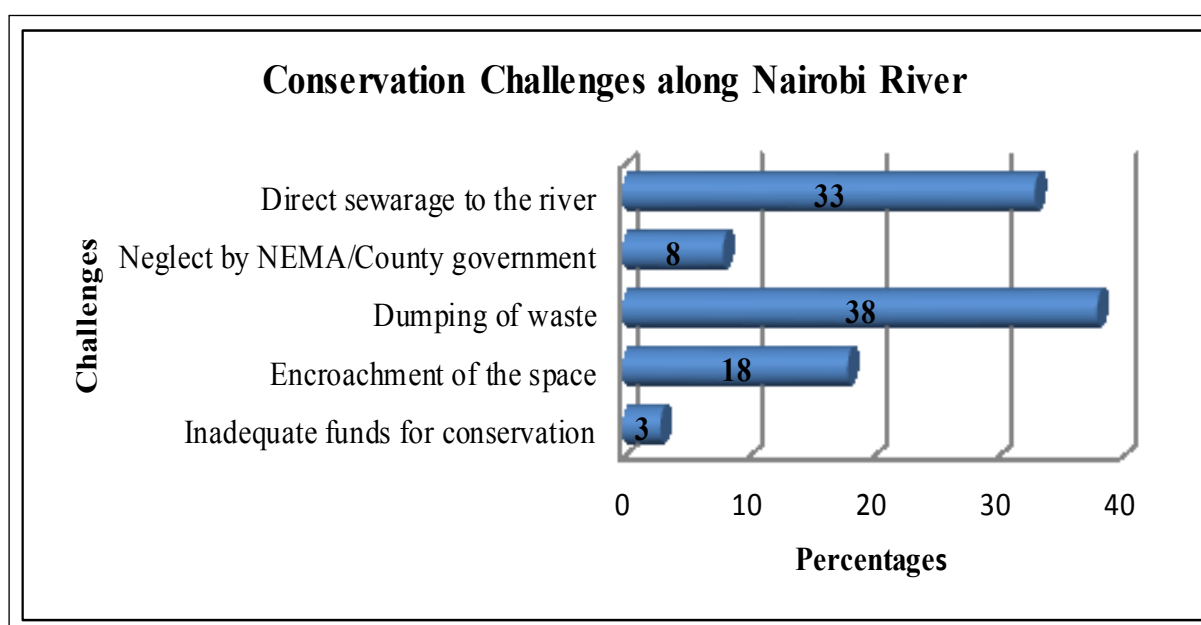


Source: Field survey, 2014

5.4.3 Conservation Challenges Facing the Nairobi River Corridor

According to the direct users of the river corridor (informal group), dumping of waste to the river (38%) was the major challenge to the conservation of the river corridor just like in the utilization. Direct discharge of raw sewerage into the river followed closely at 33%. Encroachment of the space (18%) was another key factor that has posed a challenge to conservation of the river corridor. Neglect by NEMA/County government (8%) and inadequate funds for conservation (3%) are other factors that pose a challenge to conservation of the river corridor albeit their contribution is insignificant comparing with other key challenges.

Chart 5.13: Challenges of Conserving Nairobi River Corridor

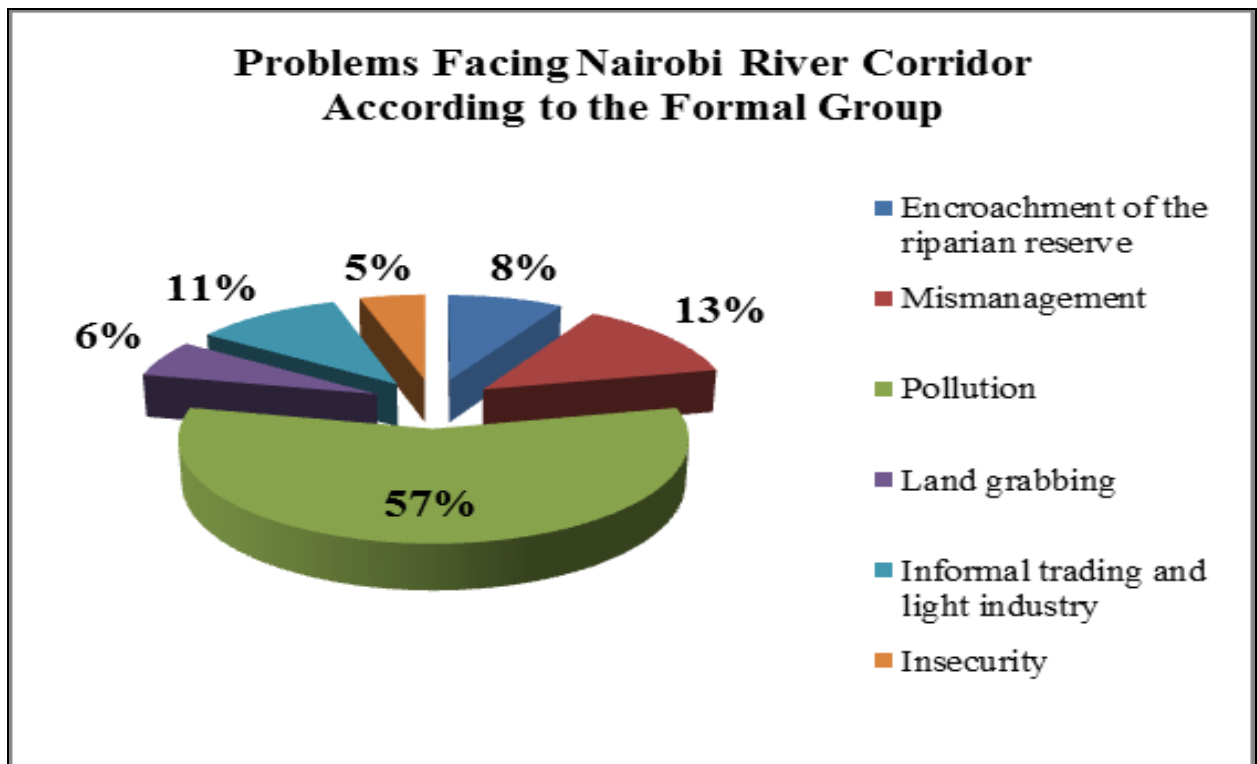


Source: Field survey, 2014

5.4.4 Problems facing Nairobi River Corridor

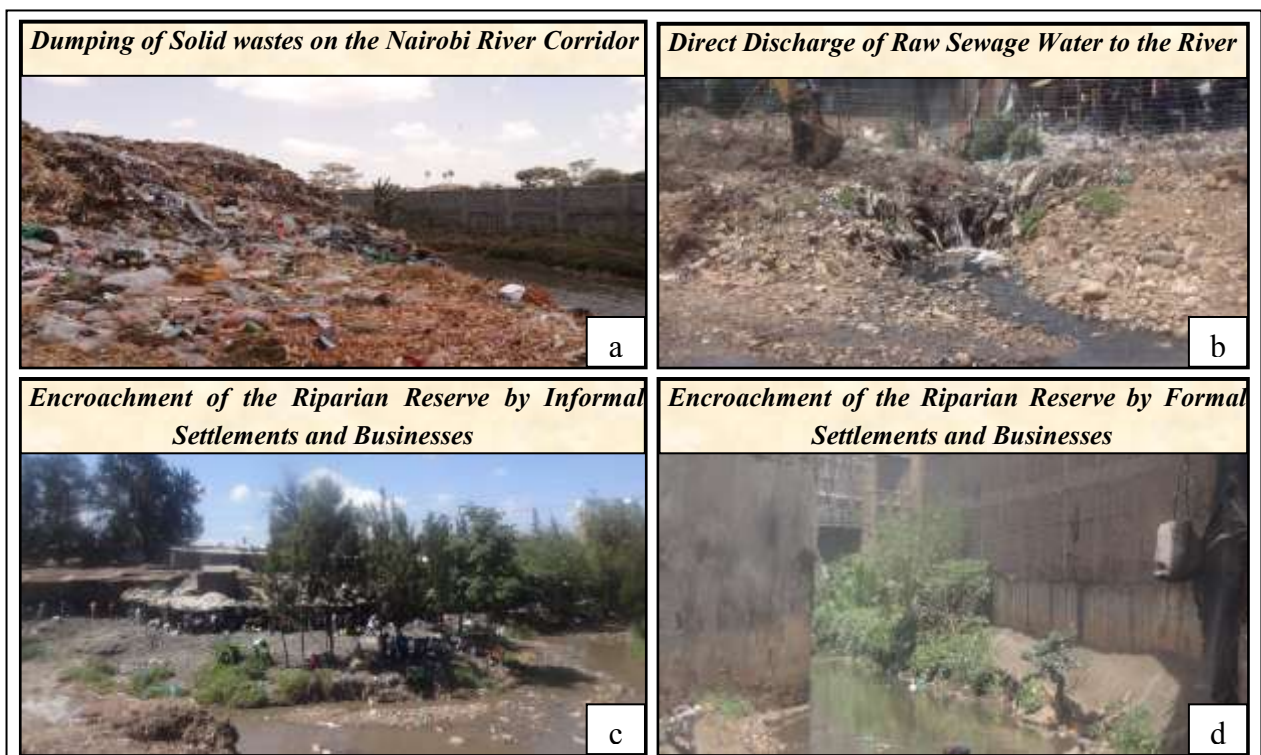
The major challenge facing the Nairobi River corridor according to the indirect users of the river corridor (formal group) is pollution at 57%. The lack of sanitation facilities along the river corridor and dumping of waste are some of the factors that have led to the pollution of the Nairobi River corridor. Other problems facing the Nairobi river corridor are as shown in the chart below:

Chart 5.14: Problems Facing the Nairobi River Corridor according to the Formal Group



Source: Field survey, 2014

Plate 5.4 a, b, c & d: Key Challenges of Utilizing and Conserving the Nairobi River Corridor



Source: Field survey, 2014

5.5 Nature of Degradation on the Nairobi River Corridor (Study Area)

5.5.1 Nature of Degradation of the Nairobi River Corridor

According to the field survey, the degradation of Nairobi River Corridor manifests itself in pollution of various types, erosion of its banks, declining levels of the river's water, encroachment of the riparian reserve, channelization of the river's natural channel and loss of its riverine vegetation. Pollution, however, emerged as the main form of the river's degradation. It manifests itself in both solid and liquid form.

Solid pollutants consisted of both bio-degradable and non-biodegradable wastes, with non – biodegradable waste taking the lead. Solid wastes include domestic refuse, fresh goods waste sawdust, old clothes, tyres, wrappings (polythene bags), and human waste (See Plate 5.5).

Liquid pollutants include waste water from car washing, oil spillage from garages, domestic waste water (grey water) from informal settlements along the river corridor and other residential areas within the study area. It also includes direct sewer and storm water discharges from the adjacent commercial and residential areas (See Plate 5.6, below).

Plate 5.6: Dumping of Solid Wastes on the River Corridor



Plate 5.5: Direct Discharge of Raw Sewerage into the River



Source: Field survey, 2014

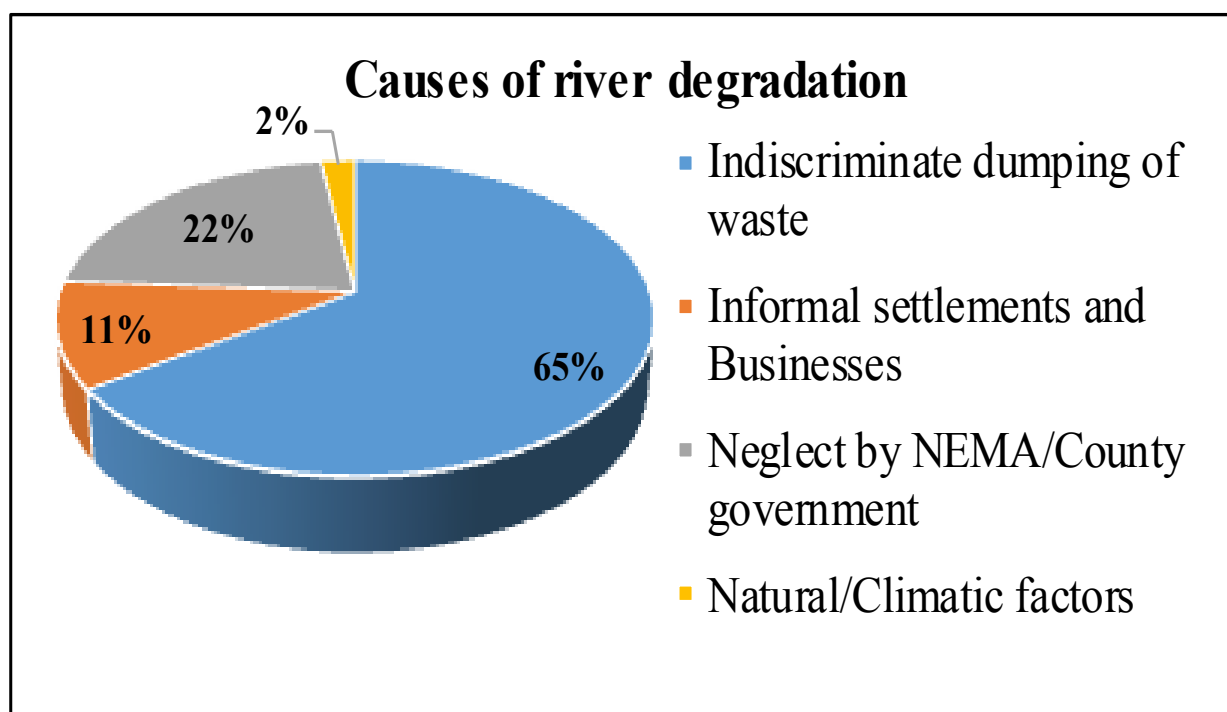
5.6 Main Causes /Sources of Degradation on the Nairobi River Corridor

5.6.1 Causes of Degradation of the Nairobi River Corridor

From the field survey, it emerged that there are many causes of degradation of Nairobi River Corridor. However, the main cause was indiscriminate dumping of both solid and liquid wastes into the river (65%). Other causes included neglect by NEMA/County government (22%) followed by informal settlements (11%) along the river corridor. Natural/climatic (2%) factors appeared to contribute insignificantly towards degradation of the river corridor. Other activities that were noted in the area that contribute to degradation of the river include:

- Grey water and liquid waste drained into the water
- Washing and dyeing of clothes
- Encroachment by informal business activities and informal settlements
- Oil spillage from garages
- River bank erosion
- Riparian agriculture.

Chart 5.15: Causes of the Nairobi River Degradation



Source: Field survey, 2014

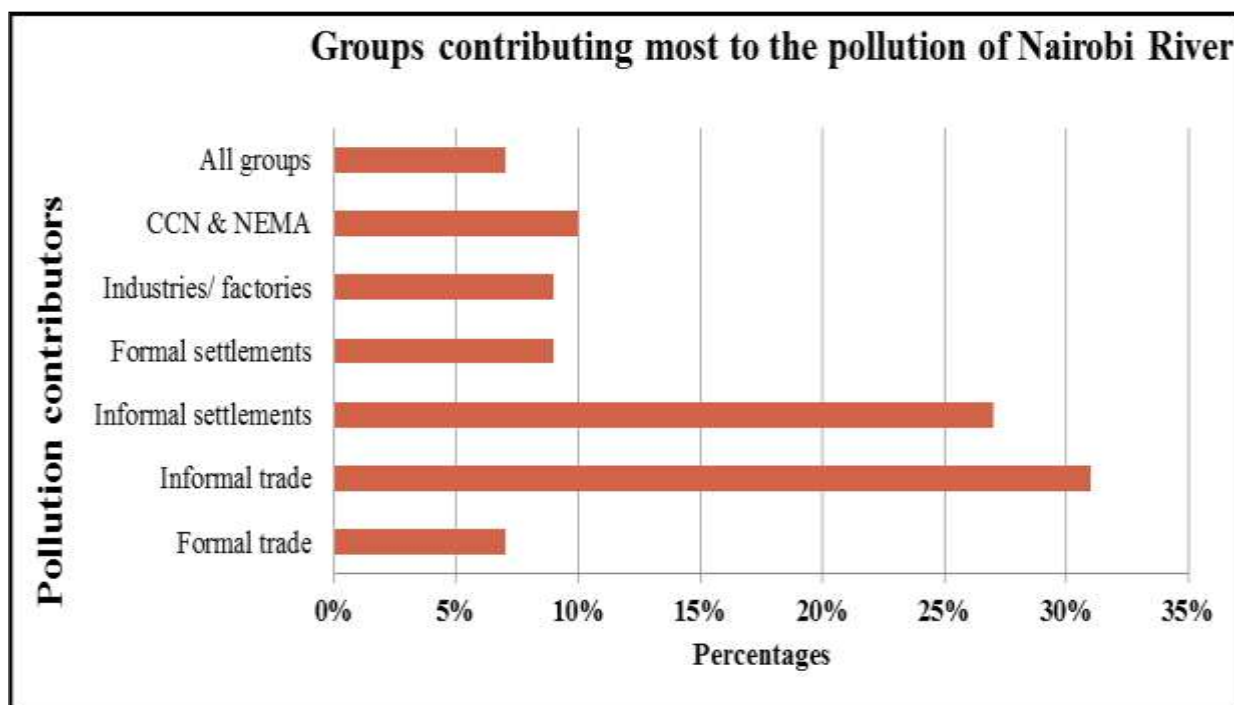
Plate 5.7: Causes of River Degradation (Neglect)



Source: Field survey, 2014

5.6.2 Contributors to Pollution

Based on the respondents' feedback, informal trade is the group that contributed most to the pollution of the river at 31%, followed by the informal settlements along the river at 27%. This is because these groups did not have access to proper solid and liquid waste disposal methods. The city county of Nairobi (CCN) and NEMA, at 10% also contributes to the pollution of the Nairobi River (See Chart 5.16). This is due to neglect of the river by the concerned authorities especially due to their failure to collect garbage along the river corridor in time and protect it from prolonged pollution. Respondents also cited that the burst sewer lines of the county government drain raw sewer into the river, contrary to their mandates of protecting the same from pollution. This was also observed near Pumwani Road during the field survey (See plate 5.7 above).

Chart 5.16: Contributors to Pollution

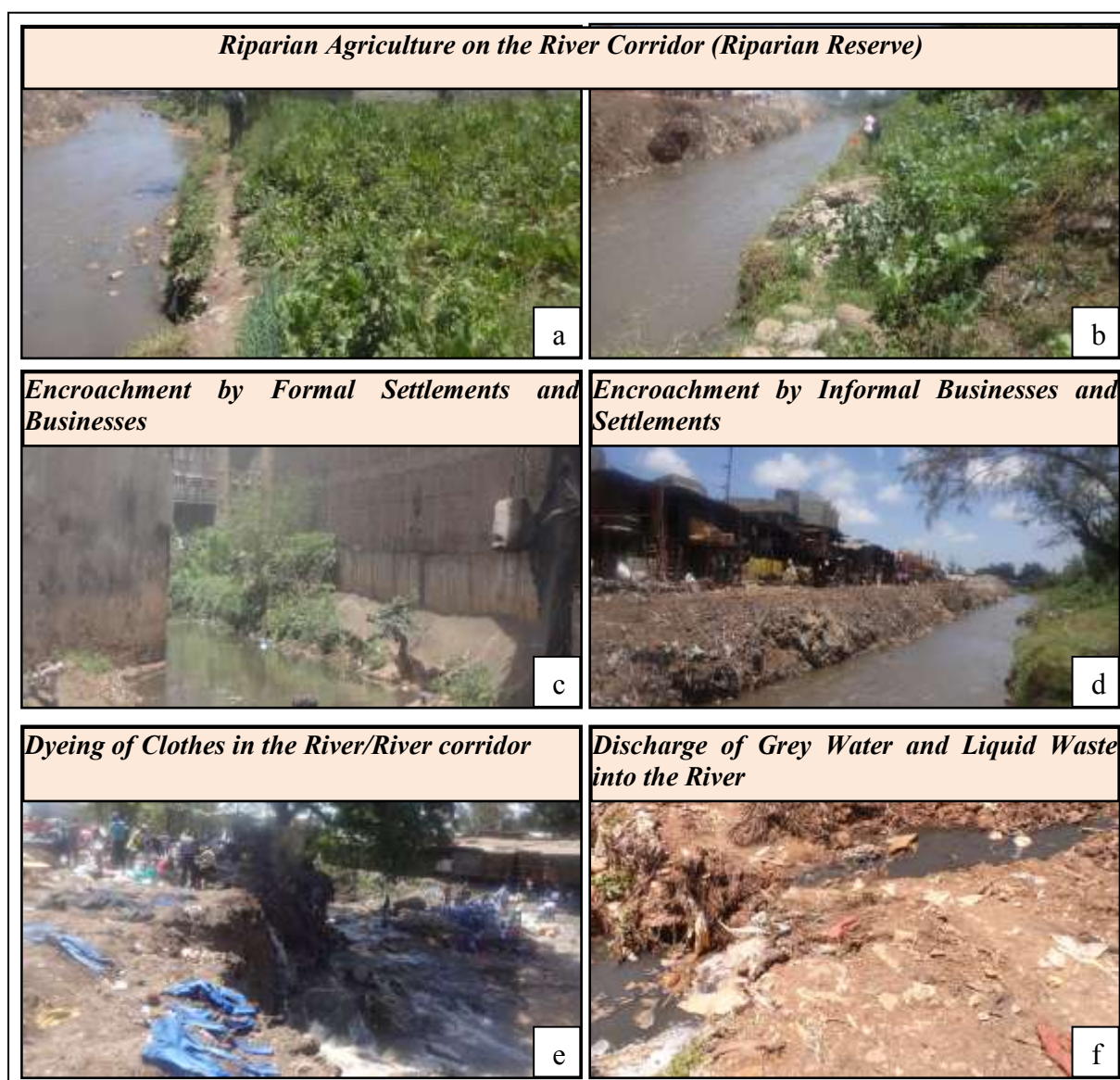
Source: Field survey, 2014

The other cause of river degradation is the bad attitude from the public. Members of the public seem not to pay any attention to the conservation measures that are put in place to counter the effects of pollution. This was exemplified by a group of individuals who were seen disposing their municipal waste in the river while workers from Nairobi River Basin Programme were busy cleaning up the place. Lack of awareness on the benefits of river corridor conservation is another issue.

5.6.3 Sources of Degradation of the Nairobi River Corridor

Results from the field survey revealed that there were a number of sources of pollutants that contribute to degradation of the river corridor. These, among others include commercial, domestic and agricultural activities in the urban areas. It also emerged that the greatest content of river corridor's pollutants comes from commercial and residential activities adjacent the river corridor. Most of these pollutants are either from a point or from a non-point (diffuse) source. Point sources included outright dumping, and also storm and sewage discharges that are directly connected to the river channel. These drain their content to the river thereby degrading its quality and rendering it unfit for both consumptive and non-consumptive uses.

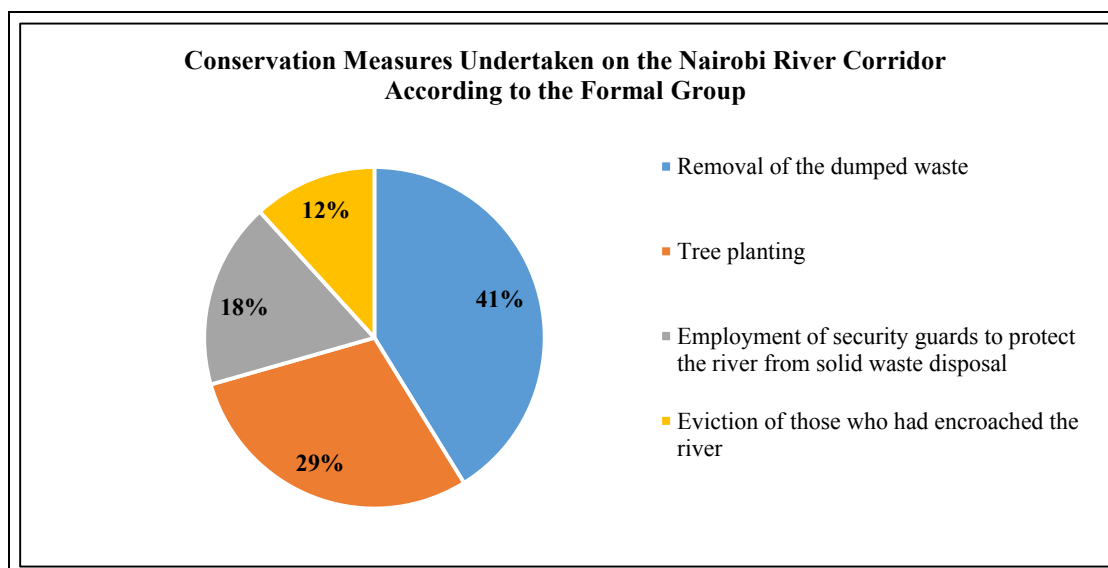
Plate 5.8: Other Key Contributors of the Nairobi River Corridor Degradation



Source: Field survey, 2014

5.7 Adequacy of Nairobi River Conservation

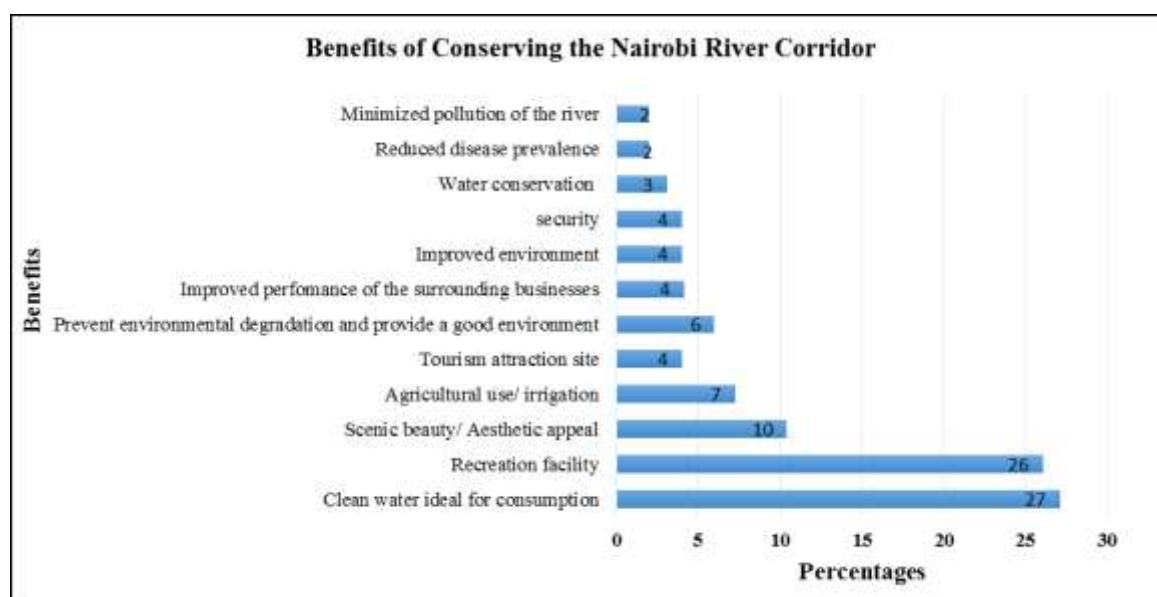
On the question of the view of the respondents on the adequacy of the river corridor conservation, 85% said the river is not adequately conserved while 15% said it was adequately conserved. The conservation measures noted by the business operators within the river corridor were removal of dumping waste (41%), tree planting (29%), employment of security guards to protect the river from solid waste disposal and eviction of those who had encroached the river (12%) as shown in the chart 5.17 below.

Chart 5.17: Conservation Measures undertaken on the Nairobi River Corridor

Source: Field survey, 2014

5.8 Benefit of Nairobi River Conservation

The large proportion (97%) of respondents from both the informal and formal group indicated that there are benefits of conserving Nairobi River Corridor while only 3% indicated that there no benefits. The top most benefit of Nairobi river corridor conservation was clean water ideal for consumption (27%) followed by benefit of the area being used as a recreation facility (26%) as shown in the chart 5.18 below.

Chart 5.18: Benefits of Conserving the Nairobi River Corridor

Source: Field survey, 2014

Table.5.11: Respondents' Recommendations for Sustainable Conservation the Nairobi River Corridor

| Recommendations | Frequency |
|---|------------------|
| Planting more trees, shrubs, groundcovers and grass to stabilize riverbanks | 20 |
| Good management/ maintenance systems | 15 |
| Proper solid waste management by surrounding businesses and residents | 13 |
| People to take responsibility of the river | 10 |
| Security especially at night to prevent waste disposal | 9 |
| Eviction of informal traders and settlements on riparian reserve | 7 |
| Purification/cleaning of the Nairobi river | 6 |
| Blocking of sewer lines that drain into the river | 6 |
| Enforce rules and regulations to govern surrounding land uses and violators | 5 |
| Fencing of the river and riparian reserve | 4 |
| Increased conservation measure on the riparian reserve | 4 |
| Provision of proper roads and pavements | 3 |
| Consistency in time for cleaning of the river | 3 |
| Creation of Recreation facility along the river corridor | 3 |
| Provision of sanitation facilities e.g. toilets | 2 |
| Provision of seats for resting for the users | 2 |
| Creation of job opportunities for the youth e.g. cleaning the river | 2 |
| Beautification/landscaping of the area | 1 |
| Efficiency in fund utilization for conserving the river | 1 |
| Holistic environmental conservation in the city | 1 |
| Public awareness on the importance of aesthetics | 1 |
| Relocation of informal settlements | 1 |
| Improvement of sewerage systems | 1 |

Source: Field survey, 2014

5.9 Policy, Legislative and Institutional Measures in Place for Sustainable Utilization and Conservation of Nairobi River Corridor

Table.5.12: Policy, Legislative and Institutional Measures in place for sustainable utilization and conservation of Nairobi River Corridor

| Institution | Role in conservation and utilization of Nairobi river | Achievement in accomplishing the mentioned roles | Most contributors to river degradation | Challenges your institution face to utilize and conserve the river | Annual allocation for Nairobi river corridor conservation | Relevant staff to oversee utilization and conservation of the river | Any initiated implementation of regulations regarding utilization and conservation of Nairobi river | Policies in place to guide the institution to utilize and conserve the river. |
|-------------|---|--|--|---|---|--|--|---|
| NEMA | <ul style="list-style-type: none"> -Tree planting and protection of indigenous vegetation along the river bank -Solid waste management along selected river stretches -Checking pollution from non-point source -Community sensitization and awareness creation | <ul style="list-style-type: none"> -Improved water quality in Nairobi -Fencing and tree planting in sections of Nairobi river -Removal / clean- up of a section of the river especially solid waste | <ul style="list-style-type: none"> -Encroachment of river banks by unplanned settlements that dispose solid waste and discharge of raw effluent into the river -Informal land use activities along Nairobi river –car wash and garages | <ul style="list-style-type: none"> -Encroachment of river banks by unplanned settlements - Accumulation of solid waste and discharge of raw effluent into the river system -Lack of clear implementation modalities -Inadequate technical and financial resources, -poor institutional coordination - | - | <ul style="list-style-type: none"> - Security officers/ field agents- protection of river corridor and monitoring of pollution | <ul style="list-style-type: none"> -Fencing of riparian reserve -Solid waste removal along the river banks in selected stretch | - |

| | | | | | | | | |
|-------|---|--|--|--|--|---|--|--|
| TARDA | -Making appropriate measures that ensure the disposal of waste water safely into the river by sewerage services | -In the process of implementing sewer line laying in high and low income areas such as Zimmerman and parklands -Toilets in informal settlements connection to reticulation sewers | -Informal settlements that disposal liquid and solid waste into the river corridor -Lack of planning that has led to growth of urban areas without management of formal and informal settlements -Low coverage in sewer and liquid waste find way to the river | -Way leave acquisition -People settling on top of sewer lines -Costly when there is resettlement | -First phase KShs. 4.5 billion for the construction of trunk and sewer reticulations | -Engineers -Environmental experts -Sociologists -Accountants | -Planting trees as buffer zone to protect way leaves and river -Construction of sewer lines for waste liquid disposal | |
|-------|---|--|--|--|--|---|--|--|

| | | | | | | | | |
|-----------------------------|--|---|--|--|----------------------------------|--|--|--|
| WRMA | Management of river corridors | Riparian conservation of the river on the stretch from Museum to river road | -Encroachment by land owners -Pollution from industries | -Law enforcement on the major polluters -Multiplicity of legislation | None at the moment | They are about 60 in number -water specialists, - water conservation officers - hydrologists | -water resource management rules 2007, to cater for all water resources management | 6 catchment management strategies-under them there are sub-catchment management plans at the local level-urban or rural The policies are adequate |
| INTEGRATED WASTE MANAGEMENT | -Solid waste collection -Law enforcement-arrest illegal dumpers and take them to county court for prosecution -Identification of illegal dumpsites along the river | Managed to clear illegally dumped waste from Museum hill bridge to Dandora Komarock road bridge | -Illegal dumping from informal settlements along the corridor-Kitui slums, motherland slums, Mathare slums, Korogocho slums etc. | -Lack of awareness from the residents since most of them practice illegal dumping -Uncontrolled developments e.g. slums | No budget for the year 2013/2014 | 30 officers working along the river between Museum hill to Kimathi bridge in Eastleigh Their duty includes tree planting among others | Local Government Act which has since been replaced by the County Government Act to prosecute the offenders | County Government Act |

| | | | | | | | | |
|---|---|--|---|--|----------------------------|--|-------------------------------|---|
| NAIROBI RIVER BASIN PROGRAMME (NRBP) | -To restore the Nairobi river to its original state -Rehabilitation and Maintenance | Accomplished the objective about 40% | -Encroachment by informal settlements -Lack of adequate sewer infrastructure -Improper solid waste management | | 25 million Not adequate | 3 technical staff Forester Natural resource scientist Administrator | Formulating other policies | In process of formulating environmental policies |
|---|---|--|---|--|----------------------------|--|-------------------------------|---|

Source: Field survey, 2014

Table 5.13: Suggestions for sustainable utilization & conservation of urban river corridors in Kenya

| Institution | | Proposed utilization measures | Proposed conservation measures |
|-------------|---|---|---|
| 1 | MEWNR | <ul style="list-style-type: none"> - Planning for infrastructure both in formal / informal settlements - Enforce the 30m riparian reserve - Identification of sources of pollution/ source of effluents along the river | |
| 2 | NEMA | <ul style="list-style-type: none"> - River riparian reserve to be designated as part of the green open space for recreational parks under clear management. - Fencing and waste management along Nairobi river corridor - Policies and regulation to control point source pollution into the river | |
| 3 | WRMA | <ul style="list-style-type: none"> - Involvement of county government in drawing up adequate utilization plans | <ul style="list-style-type: none"> - Stakeholder involvement in policing of the resource |
| 4 | TARDA | <ul style="list-style-type: none"> - Planning for infrastructure both in formal / informal settlements - Promotion of decentralized systems to manage liquid waste - Enforce the 30m riparian reserve - Efficient solid waste management - Expansion of sewer network coverage | |
| 5 | NRBP | <ul style="list-style-type: none"> - Sewer infrastructure to be addressed - Provision for well solid waste management - Address the issue of encroachment | <ul style="list-style-type: none"> - Making riparian reserve a recreation area - Introduce sports activities and swimming - Formulating holistic policies on river conservation - |
| 6 | DEPARTMENT OF ENVIRONMENT NAIROBI COUNTY | <ul style="list-style-type: none"> - Promoting water-based sporting activities - Use of the river for recreation and amenity | <ul style="list-style-type: none"> - Enforcement of Policies and regulation to control of the river |
| 7 | DEPARTMENT OF PHYSICAL PLANNING NAIROBI COUNTY | <ul style="list-style-type: none"> - Planning for infrastructure both in formal / informal settlements - Planting trees as buffer zone to prevent encroachment | <ul style="list-style-type: none"> - Enforcement of Policies and regulation to control of the river - Community sensitization and awareness creation |
| 8 | NAIROBI CITY WATER AND SEWERAGE COMPANY (NCWSC) LTD | <ul style="list-style-type: none"> - Stakeholder involvement in policing of the resource - Enhanced law enforcement especially those touching on pollution control - Community sensitization and awareness creation - Planting trees as buffer zone to prevent encroachment | |
| 9 | INTEGRATED WASTE MANAGEMENT | <ul style="list-style-type: none"> - Proper planning of the city - Awareness forums to the residents to prevent illegal dumping - Enhanced law enforcement | <ul style="list-style-type: none"> - Tree planting - Removal of dumped waste along the corridor - Identification of sources of pollution/ source of effluents along the river |
| 10 | DEPARTMENT OF PUBLIC HEALTH; NAIROBI COUNTY | <ul style="list-style-type: none"> - Awareness forums to the residents to prevent illegal dumping - Community sensitization and awareness creation | <ul style="list-style-type: none"> - Awareness forums to the residents to prevent illegal dumping - Proper waste management |

Source: Field Study, 2014

CHAPTER SIX:
SYNTHESIS OF THE RESEARCH FINDINGS

CHAPTER SIX: SYNTHESIS OF THE RESEARCH FINDINGS

6.0 Introduction

This chapter entails implications of the research findings with reference to the objectives of the research. It gives a summary of the research findings as per the objectives of the study.

6.1 Key Research Findings

6.1.1 Nature of Utilization of Nairobi River Corridor

A personal assessment of river corridor established that almost two thirds of its setting has been put into commercial, agricultural, social and residential use. Commercial activities in the area include, foodstuff vending, car washing/repair, clothes selling, hawking, etc. Adjacent business activities include, sale of construction materials, furniture making and petrol stations among others. Other than these uses, the river corridor is also used as a dumping site for commercial and domestic waste.

6.1.2 Perception of Key Informants on the State of Nairobi River Corridor

There was a general consensus between the respondents, the key informants and other stakeholders that the river corridor is in a degraded state. They viewed the state of the river corridor as ugly and repelling. They further described the river as dead. This was also noted during the field survey though efforts are being made by NEMA in conjunction with Nairobi River Basin and Restoration Programme to clean it. According to their sources, they have so far managed to free the river corridor of about 9,000 tons of waste.

6.1.3 Nature of Degradation of Nairobi River Corridor

Through observation, the study revealed that the degradation of Nairobi River Corridor manifests itself in pollution of various types, erosion of its banks, declining levels of the river's water, encroachment of its riparian reserve, channelization of the river's natural channel and loss of its riverine vegetation. Pollution from both solid and liquid waste, however, emerged as the key form of the river's degradation. These pollutants are both bio-degradable and non-biodegradable. These pollutants have greatly affected the commercial, agricultural, industrial, recreational and domestic use of the river's water. Worse still, the river corridor has also lost its natural character and its vital biodiversities. An effort is being made by the forestry department to replant the river with a variety of trees such as *Gravellea robusta* and *croton megalocarpus* among others, though majority of these trees are not naturally adapted to riparian environment.

6.1.4 Causes of Degradation of Nairobi River Corridor

6.1.4.1 Lack of Infrastructural and Sanitation Facilities

Results from the field survey indicated that lack of infrastructural facilities in the study area; especially in the slums was the main cause of degradation of Nairobi River and its corridor. Such facilities include toilets, dumping sites, etc.

6.1.4.2 Lack of Proper Management of the River Corridor

The Nairobi river corridor is not well maintained in terms of clear demarcation of the riparian reserve. The involved institutions have not been efficient to maintain the corridor hence leading to the direct solid and liquid waste disposal and encroachment. This has resulted to severe pollution and degradation of the corridor especially dirty water flowing in it which cannot be used whether for domestic or industrial purposes. Presence of huge heaps of solid wastes dumped on the corridor is a clear testimony that river corridor lacks proper maintenance; meaning conservation efforts being employed are inadequate.

6.1.4.3 Improper Solid and Liquid Waste Disposal

There is no proper solid and liquid waste management system in the area hence the surrounding land activities dump their waste into the river rendering it very polluted. The low income settlement of Majengo to the south of the study area has no sanitation system hence waste is directed to the river contributing to the pollution. On the other hand, direct discharge of waste water and sewage from the adjacent commercial and residential areas were also a major factor in degradation of the river corridor.

6.1.4.4 Influx of Encroachers in to Riparian Reserve

Different activities were observed to be operated within the river corridor making it difficult to promote conservation measures in the study area. This was particularly common on the lower part of the study area, near Lamu Road, where make-shift structures inform of residential units are found. It was therefore hard to sell conservation ideas to the occupants of these areas. According to them, it was not clear how they would benefit from conservation of the river corridor. In fact majority of them argued that conservation of river corridor would only displace them and deny them their daily bread. Hence, they were of the feeling that the river corridor be left alone as it is.

6.1.4.5 Poor Planning

Location of building too close to the riparian reserve in disregard of the minimum widths for riparian reserve has resulted into further encroachment of the riparian reserve and uncontrolled dumping of both solid and liquid waste into the river and its corridor.

6.2 Summary of Study Findings

After analysis of the research findings, issues that materialized can be summarized by the study's objectives as below:

- The river corridor is mainly dominated by informal socio-economic activities notably informal settlements and informal commercial activities. These activities have led to construction of temporary structures and also largely contribute to solid waste dumping into the river. They further lead to degradation of the river state.
- The river is in ugly and repelling state due to bad smell and has lost its natural colour. It is mainly composed of raw sewage, used engine oil, and other polluting effluents from the socio-economic activities in the area. It has therefore ceased from being a free flowing crystal clear liquid and is now a slow flowing murk. As such, this water has lost its amenity and recreational value and can also not be used for commercial, agricultural, domestic or industrial purposes.
- The major challenge of utilization of the river corridor was noted to be dumping of solid waste, direction sewerage water into the river, lack of sanitation facilities, lack of maintenance, encroachment of space. These challenges have led to the current state of the river.
- The major challenges to the conservation of the river corridor are direct discharge of raw sewerage into the river, encroachment of the space, neglect by NEMA/County government and inadequate funds for conservation.
- The degradation of Nairobi River Corridor was manifested in pollution of various types, erosion of its banks, declining levels of the river's water, encroachment of the riparian reserve, channelization of the river's natural channel and loss of riverine vegetation.
- The main liquid pollutants include waste water from car washing, oil spillage from garages, domestic waste water (grey water) from informal settlements along the river corridor and other residential areas within the study area. It also includes direct sewer and storm water discharges from the adjacent commercial and residential areas.

CHAPTER SEVEN:
CONCLUSION AND RECOMMENDATIONS

CHAPTER SEVEN: CONCLUSION AND RECOMMENDATIONS

7.0 Introduction

This chapter being the last chapter of the study draws conclusion from the findings of the study and then gives recommendations for sustainable conservation of urban river corridors. It also gives suggestions for further research.

7.1 Conclusion

This study recognizes that rivers and their corridors play a very important role in the welfare of the society. In the urban setting rivers are used for commercial, domestic as well as industrial purposes. They have also provided adequate recreation and amenity opportunities since early times of civilization. As such, their conservation is of paramount importance. This understanding therefore outlines need for conservation of the Nairobi River and its corridor. From the field survey it emerged that, Nairobi River, despite its high level of degradation, has some potential of recovery. This conclusion was reached after a field visit conducted on the upper parts of the river, just a few meters away from the study area.

To this end, Nairobi River if well protected can still be used for healthy socio-economic activities in the city. It can be used for commercial, industrial and agricultural purposes. It can also be used for amenity and recreation activities such as boating, canoeing, angling and many other water-based recreation activities. This is now where a Planner chips in to ensure that the proposed new use of the river and its corridor does not lead to its further degradation. This also requires total co-operation between the National government, Nairobi City County Government, the Business community, the users of the river corridor and various other stakeholders.

7.2 Recommendations

The study has come up with a number of recommendations that are critical in addressing some of the main problems that are currently bedeviling the Nairobi River corridor. These recommendations are based on the analysis of the study as per the objectives of the study. It is hoped that these recommendations will be the basis on which future planning for sustainable utilization and conservation of Nairobi River corridor and other rivers that fall within the same brackets of degradation will be founded.

7.2.1 Recommendations based on the Utilization/Conservation Challenges Facing the Nairobi River Corridor

From the study, it was clear that Nairobi River corridor is faced with a variety of utilization and conservation challenges. These included lack of proper river management and professionals to effectively handle these challenges.

a) Enhancement of Ownership and Management of the River Corridor

According to the study, both ownership and management of Nairobi River Corridor rests principally in the hands of the, National Government and City County Government. These have in past not been able to manage it effectively. Consequently, the river corridor has been left as no man's land, hence subjecting it to the tragedy of the commons in which any willing city dweller has asserted his or her rights to occupy it. This has in turn transformed the corridor into a conglomeration of various socio-economic activities, which have not only deprived wildlife of their natural habitat, but has also caused severe degradation of the river corridor.

In view of the aforementioned, ownership of the river corridor should not rest in the hands of the National and City County Government alone. Rather, it should be a joint ownership between the public and the private sector. This research therefore calls for a public- private partnership between the National and City County Government and the representatives of business communities and residents. They should work hand in hand to ensure that the river corridor regains its lost glory.

b) Involvement of Relevant Professionals in Planning for Utilization and Conservation of the River Corridor

The findings of the research revealed that though conservation efforts have been employed, not much has been achieved because most of the persons engaged lack the requisite professional training to effectively handle such kind of task. In view of this, this research recommends involvement of relevant professionals such as Landscape Architects and planners in both the planning and implementation of the conservation scheme. These professionals should ensure that any new development in the area does not lead to further degradation of the river corridor. As such, they should be able to use their professional skills and advice the partnership on possible self-sustaining river conservation schemes which are of less detriment to the river corridor.

c) Planning for the Socio-Economic Activities along the River Corridor

Planning has a key role to play in managing growth in urban areas. It should focus more on generating sustainable livelihood opportunities for urban dwellers, while maintaining order, and managing the various conflicting rationalities between different actors in urban space. Planning approach in managing and conserving river corridors must be holistic in approach.

Plate 7.1: Current State of the Riparian Reserve (Socio-Economic Activities)



Source: Field Survey, 2014

Figure 7.1: Proposed State of the Riparian Reserve (Planning for Socio-Economic Activities)



Source: Author, 2014

7.2.2 Recommendations based on the Nature of Degradation occurring on the Nairobi River Corridor

The study revealed various forms of degradation occurring on the Nairobi River corridor. These included pollution, bank erosion and encroachment among others.

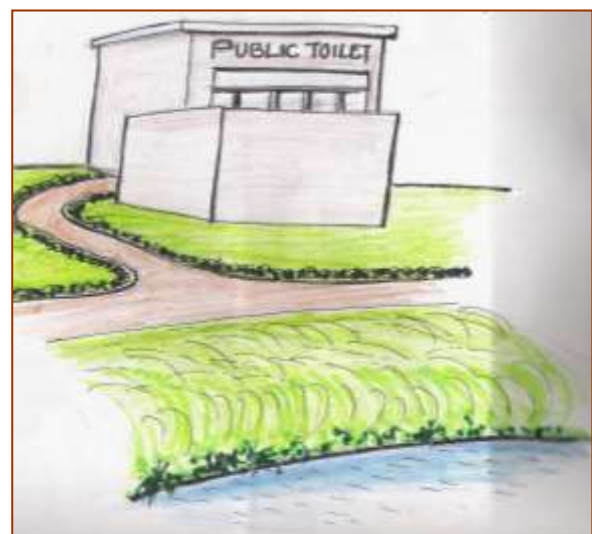
a. Pollution Control: On the issue of pollution, this study proposes that a comprehensive survey be conducted on whole river corridor to map out all forms of degradation in order to plan for the necessary conservation measure. This survey should include identifying the sources and the polluters of the river corridor. Stern action should also be taken against the polluters of the corridor. This should include forcing them to clean up contaminated sites along the river corridor. Since the Nairobi River corridor falls within the jurisdiction of the City County Government, it is therefore their role to eliminate or relocate the current dumping sites away from the river corridor. They should also involve the community in the clean-up and management of the said river corridor. This is the idea of promoting public awareness as well as creating a sense of ownership among the users of the river corridor and the other business community.

Other pollution control measures entail introduction of waste bins at required areas e.g. near food booth/outlets and other social places such as picnic areas to minimize indiscriminate dumping of waste on the river corridor (See Figure 7.2). Sanitary facilities such as public toilets should also be introduced along the river corridor. They should however be constructed away from the river channel to eliminate river degradation by human waste (See Figure 7.3).

Figure 7.2: Proposed Waste Bin



Figure 7.3: Proposed Public Toilet

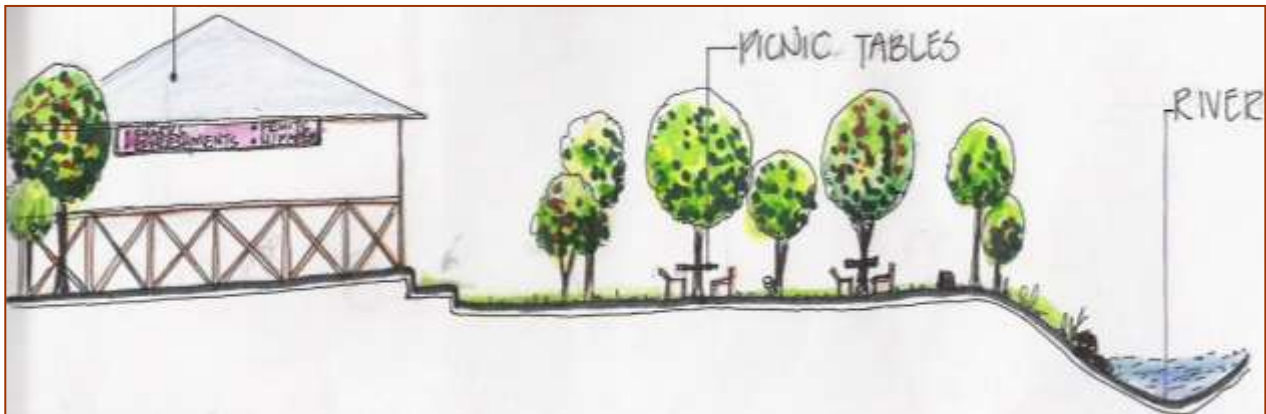


Source: Author, 2014

b. Relocation of the Socio-Economic Activities away from the River Corridor

Various socio-economic activities located on the riparian reserve were found to be the main causes of degradation of the river corridor (See Figure 7.4). To counter this, these activities should be relocated away from the river corridor, and if possible outside the riparian reserve (See Figure 7.5).

Figure 7.4: Relocation of Various Socio-Economic Activities away from the River Corridor



Source: Field Survey, 2014

Figure 7.5: Introduction of Designated Selling Points along the River Corridor



Source: Author, 2014

c. Replanting of the Riparian Reserve

The study recommends replanting of the river corridor with riparian adapted tree/pant species in order to stabilize its river banks and as well control the speed of storm water.

Figure 7.6: Plant Trees on the River Valley to Reduce Soil Erosion and River Degradation



Source: Author, 2014

Figure 7.7: Plant River-Based Trees of on the Riparian Reserve



Source: Author, 2014

7.2.3 Recommendations based on the Main Causes of Degradation occurring on the Nairobi River Corridor

a) Surveillance of the River Corridor

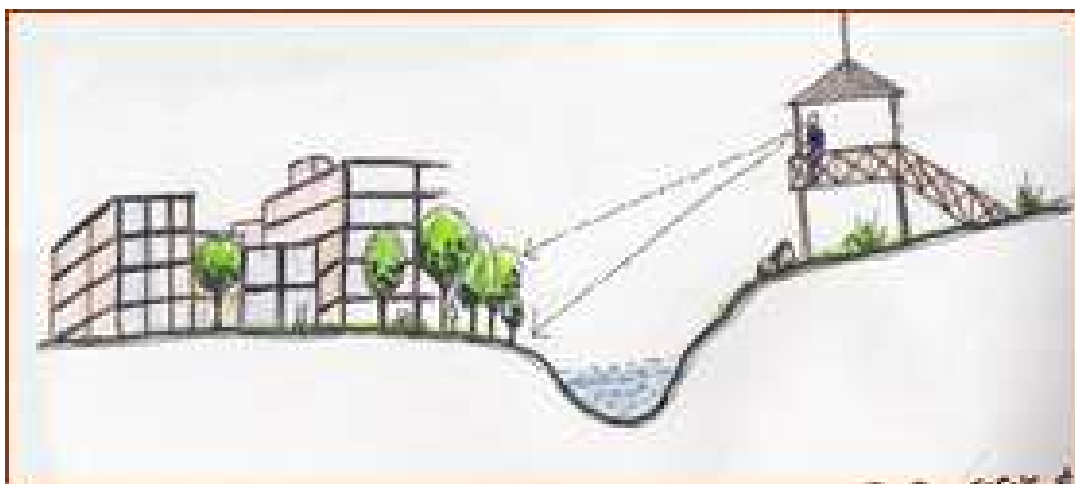
From the field survey, it emerged that most of the dumping on the river corridor is done when there isn't any person keeping watch. This is particularly common at night when there are few or no persons on the river corridor. To this effect, the study recommends an increase day and night surveillance of the river corridor e.g. by use of watch towers to monitor what is going on along the river corridor. The same could be used as a viewing deck by river users

Figure 7.8: Use of Watch Towers to Monitor Activities on the River Corridor



Source: Author, 2014

Figure 7.9: Use of Watch Towers to monitor the River Corridor



Source: Author, 2014

b) Orientation of all the Buildings along the River Corridor towards the same to guard against illegal dumping of waste

Research has shown that properties that face water bodies such as oceans, seas, lakes and rivers are more valuable than those that face opposite direction. This is particularly so in countries where such water bodies are free of pollution and other forms of degradation. In fact, such water bodies are mostly used for recreation and amenity purposes especially in developed countries.

Research has also shown that orientation of buildings towards water bodies help minimize cases of water pollution as there is enhanced surveillance. A case in point is the Hotel Boulevard located along Nairobi River, near Museums of Kenya whose rear elevation has balconies facing the river. Due to this, there is minimal river pollution in this section of the river corridor. This is in total contrast with other sections of the river with their backs facing the river, where there is little surveillance, hence higher chances of river water pollution. In view of the foregoing, the research recommends that all the buildings along the river corridor be oriented towards the river itself (See Figure 7.10).

Figure 7.10: Orientation of all the Buildings towards the River Corridor

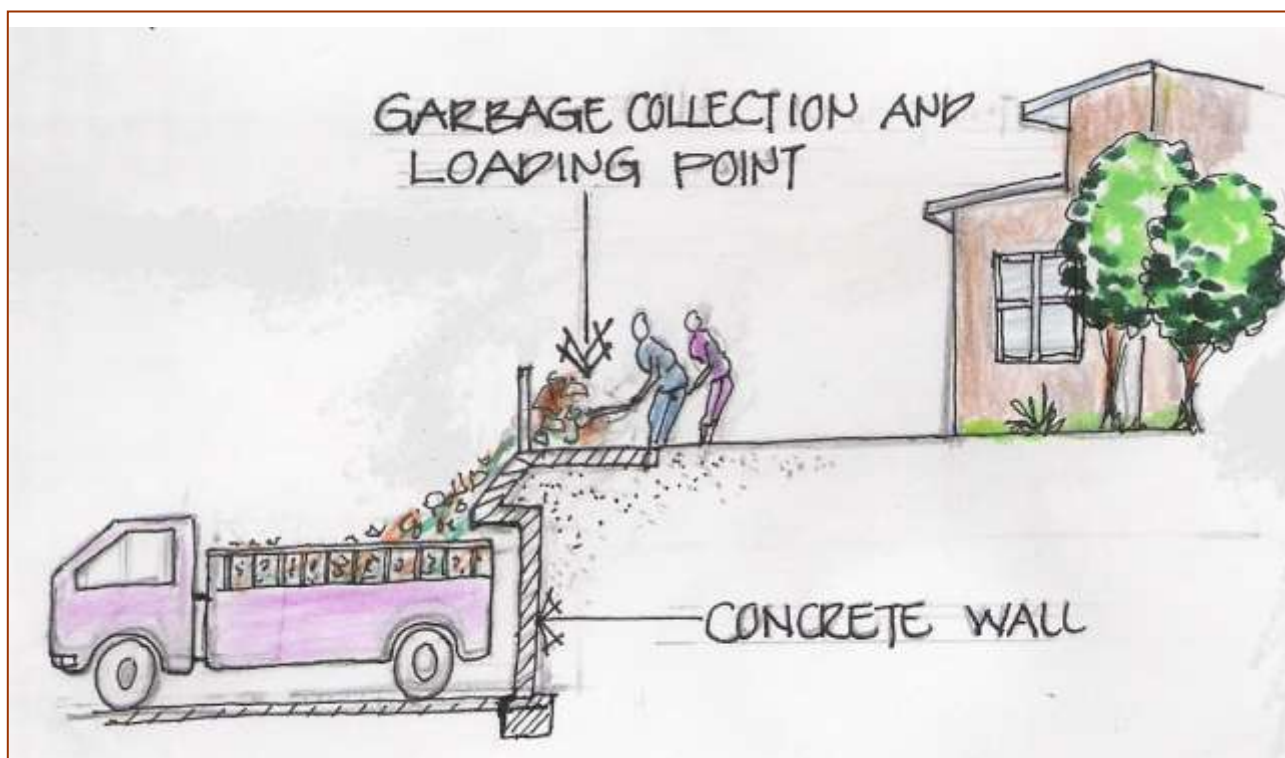


Source: Author, 2014

c) Establishment of Specific Garbage Collection Point for Easier Management of the same

Currently, waste generated in the study area is disposed of in various points without specific collection point. To address this problem, the study recommends designation of specific waste/garbage collection point accessible by garbage collection trucks.

Figure 7.11: Centralized Garbage Collection Point for Easier Management of Waste



Source: Author, 2014

7.2.4 Recommendations based on Policy, Legislative and Institutional Measures in

Place for Sustainable Utilization and Conservation of the Nairobi River Corridor

From the research findings it emerged that the current policy, legislative and institution measures in place for conservation of urban river corridors are inadequate and are at times conflicting. This was clear especially on the minimum recommended riparian reserve for rivers, streams and lakes, where the Physical planning Act, the Agriculture Act and the Survey Act give varied widths or dimensions. There are also various overlaps and gaps on the mandates of various institutions tasked with overseeing proper environmental conservation. In view of this, the study recommends as follows:

a) Placing Management of the River Corridor Under one Body or Institution

This research recommends that a private or an independent entity be given the mandate to manage the river corridor and control pollution. It should also be left to regulate and monitor the activities that take place on the river corridor e.g. clean up. On the other hand, other stakeholders such as NEMA and the City County Government should endeavour to provide the necessary support to enable those mandated to manage the river to do so effectively.

b) Enactment of Up-to-Date Policies and Guidelines on River Corridor Conservation

The government should formulate workable policies and by laws that will govern conservation and management of the river corridor. These should include: **Polluter Pays Principle** – The county government should also develop enforcement strategies for illegal dumping, in which those polluting the river corridor will be required by law to pay for the damages they will have caused to the river. These laws can then be enforced by the recommended partner e.g. NEMA.

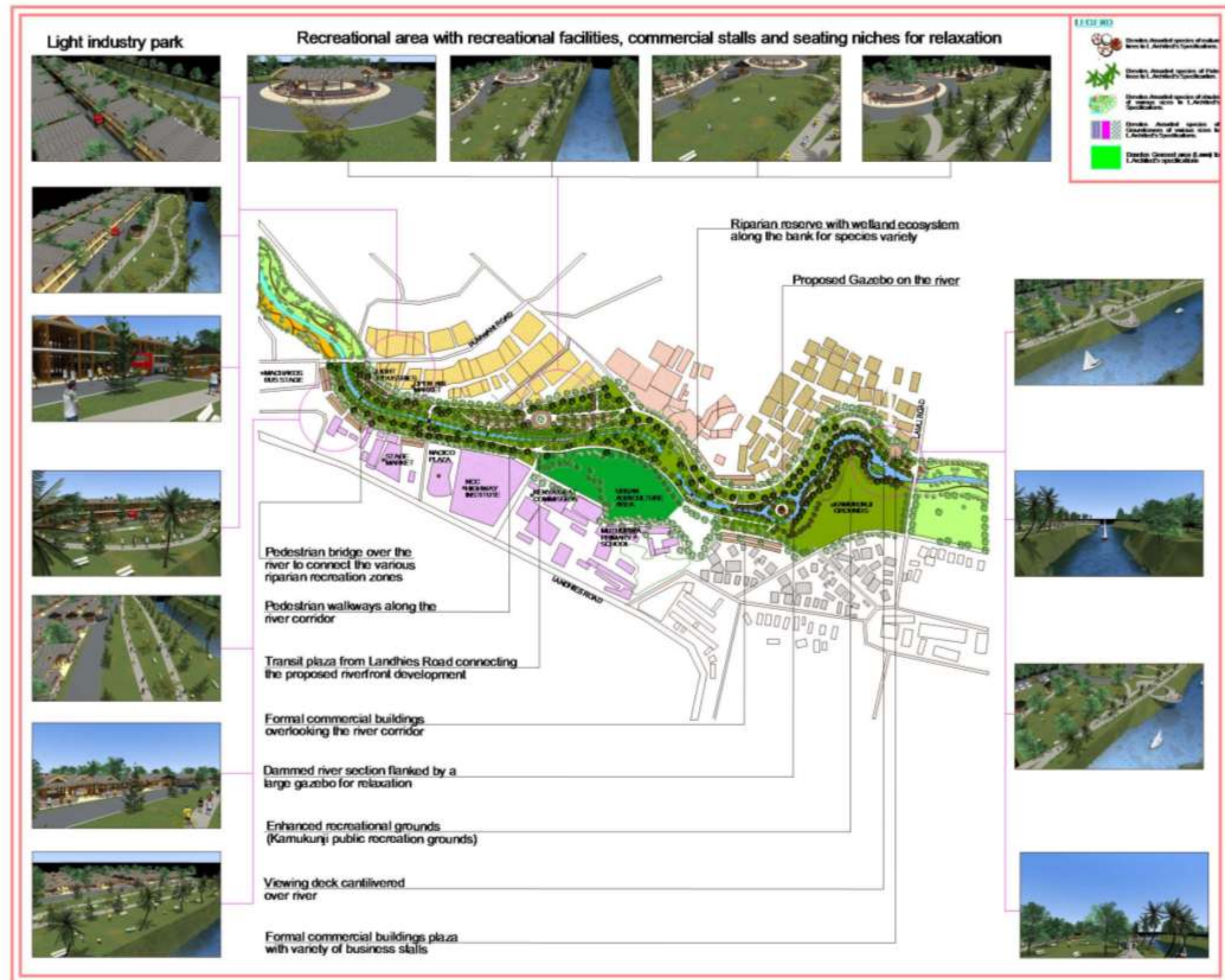
c) Zoning of Riparian Reserve- The government should incorporate policy guidelines on the development of any riparian reserve. This should include zoning of the riparian land, in which specific distances are to be left before any development can take place. They should take advantage of the recently harmonized document on riparian set back which has clear description of the extent or size of riparian reserves.

Planning has a key role to play in managing growth in urban areas. Planning should focus more on generating sustainable livelihood opportunities for urban dwellers, while maintaining order, and managing the various conflicting rationalities between different actors in urban space. Planning approach in managing and conserving river corridors must be holistic in approach. Spatial policies have to be implemented hand in hand with other regional development policies, employment and poverty reduction policies as well as urban management policies.

7.3 Proposed Riverfront Development on the Nairobi River Corridor

In order to sustainably utilize and conserve the Nairobi River corridor, the researcher has proposed that the river corridor be converted into a riverfront development with various socio-economic activities as shown in Figure 7.12 (Page 149). These include light industry park, recreational park and commercial stalls to take care of the current users of the river corridor who would otherwise be displaced in an effort to conserve the river corridor.

Figure 7.12: Proposed Riverfront Design for the Nairobi River Corridor



Source: Author, 2014

7.4 Areas for further Research

This research has essentially dealt with the role of socio-economic activities in the degradation of the Nairobi River Corridor. As such it has looked at only one side of the coin. Conversely, it is also vital to look at the role of the socio-economic activities in the utilization and conservation of urban river corridors. This should therefore form the next step in the subsequent utilization and conservation measures.

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APPENDICES

APPENDICES

Appendix I: Sample Questionnaire 1



UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

SCHOOL OF THE BUILT ENVIRONMENT

THESIS

ON

PLANNING FOR SUSTAINABLE UTILIZATION AND CONSERVATION OF URBAN RIVER CORRIDORS IN KENYA: A CASE STUDY OF THE NAIROBI RIVER

(By: John Gikundi)

(Supervised by: Dr. Fridah W. Mugo)

DATA COLLECTION QUESTIONNAIRE I

TARGET GROUP: *Direct users of the Nairobi River Corridor/Riparian Reserve (Informal Group)*

NAME OF INTERVIEWER: **TEL. NO.:**

NAME OF RESPONDENT (Optional): **TEL. NO.:**

DATE OF INTERVIEW: **TIME: Start..... End.....**

PLACE OF INTERVIEW: **QUESTIONNAIRE NO.:**

DECLARATION: *The information obtained via this questionnaire is confidential and it will be used purely for academic purpose(s).*

INSTRUCTIONS TO RESPONDENTS: *Please; *Respond to all the questions*

**Provide answers to all the questions as honestly and precisely as possible*

**Tick in the square brackets as shown [√]; where appropriate or fill in the required information on the spaces provided below the questions*

SECTION A: RESPONDENTS' SOCIO-DEMOGRAPHIC DETAILS

| | |
|--|---|
| <p>Q1. Age (In Years)</p> <p>(1) 15-25 []</p> <p>(2) 26-35 []</p> <p>(3) 36-45 []</p> <p>(4) 46-55 []</p> <p>(5) 55 and above []</p> | <p>Q4. Education Background</p> <p>(1) No education []</p> <p>(2) Primary []</p> <p>(3) Secondary []</p> <p>(4) College []</p> <p>(5) University []</p> |
| <p>Q2. Gender/Sex</p> <p>(1) Male []</p> <p>(2) Female []</p> | <p>Q5. Occupation</p> <p>(1) Student []</p> <p>(2) Employee (formal) []</p> <p>(3) Unemployed []</p> <p>(4) Retiree []</p> <p>(5) Businessman/woman []</p> <p>(6) Any other (specify) _____</p> |
| <p>Q3. Current Marital Status</p> <p>(1) Married []</p> <p>(2) Single []</p> <p>(3) Widow []</p> <p>(4) Widower []</p> <p>(5) Other (specify) _____</p> | <p>Q6. Average Income per Month</p> <p>(1) Below Kshs. 5,000/- []</p> <p>(2) Kshs. 5,001-10,000/- []</p> <p>(3) Kshs. 10,001-15,000/- []</p> <p>(4) Kshs. 15,001-20,000/- []</p> <p>(5) Kshs. 20,001-25,000/- []</p> <p>(6) Kshs. 25,001-30,000/- []</p> <p>(7) Above Kshs. 30,000/- []</p> |
| <p>Q7. Which part of Nairobi City/County do you reside? _____</p> | |

SECTION B: UTILIZATION PATTERNS OF THE NAIROBI RIVER CORRIDOR

Q8. (i) For the last one month, how many times have you visited this section of river corridor?

- (1) Once []
- (2) Twice []
- (3) Once a week []
- (4) Daily []
- (5) Rarely []

(ii) State the reason(s) for your visit(s) in Q8 (i) above.

- (1) Business activity/purpose []
- (2) Work/job []
- (3) Leisure walk/recreation purpose []
- (4) Research work []
- (5) Any other (specify) _____

Q9. (i) At what time of the day do you prefer visiting this section of river corridor?

- (1) 6.00 am - 9.00 am []
- (2) 9.00 am - 12.00 noon []
- (3) 12.00 noon - 3.00 pm []
- (4) 3.00 pm - 6.00 pm []
- (5) Any time of the day []
- (6) Any other time (specify) _____

(ii) State why you prefer the time you have mentioned 9(i) above.

- (1) Convenience []
- (2) To avoid congestion []
- (3) Best time for shopping/business []
- (4) The only time you are available []
- (5) Any other (specify) _____

Q10. How do you make use of this river corridor?

- (1) Fetch/draw water from the river []
- (2) As a business premise (for varied goods/services) []
- (3) As a dumping site (waste disposal point) []
- (4) As a home/settlement/dwelling place []
- (5) For agricultural purpose(s) []
- (6) Establishment of tree/plant nursery []
- (7) For recreation/relaxation purpose []
- (8) Any other (specify) _____

SECTION C: STATE OF THE NAIROBI RIVER CORRIDOR

Q11. How would you describe the physical state of the Nairobi River Corridor?

- (1) Good []
- (2) Fair []
- (3) Bad []
- (4) Very bad []

Q12. What was the state of the Nairobi River Corridor and the surrounding when you first moved to this area?

- (1) Very good []
- (2) Good []
- (3) Fair []
- (4) Bad []
- (5) Very bad []

Q13. How would you describe the visual condition of the Nairobi River Corridor?

- (1) Beautiful & Inviting []
- (2) Average []
- (3) Ugly & Repelling []

Q14. (i) What utilization challenges is the Nairobi River Corridor facing?

- (1) Encroachment of the space []
- (2) Dumping of wastes []
- (3) Neglect/lack of maintenance of corridor []
- (4) Safety and insecurity []
- (5) Any other (specify) _____

(ii) What conservation challenges is the Nairobi River Corridor facing?

- (1) Inadequate funds for conservation []
- (2) Encroachment of the space []
- (3) Dumping of wastes []
- (4) Neglect by NEMA/ County government []
- (5) Any other (specify) _____

Q15. If you are of the view that the Nairobi River Corridor is in a degraded state, what has contributed to this problem?

- (1) Indiscriminate dumping of wastes []
- (2) Informal settlements and businesses []
- (3) Neglect by NEMA/ County government []
- (4) Natural/climatic factors []
- (5) Any other (specify) _____

Q16. What suggestions would you like to make towards sustainable management of Nairobi River Corridor?

1. _____
2. _____
3. _____
4. _____
5. _____

Thank you for your time

Appendix II: Sample Questionnaire 2



UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

SCHOOL OF THE BUILT ENVIRONMENT

THESIS

ON

PLANNING FOR SUSTAINABLE UTILIZATION AND CONSERVATION OF URBAN RIVER CORRIDORS IN KENYA: A CASE STUDY OF THE NAIROBI RIVER

(By: John Gikundi)

(Supervised by: Dr. Fridah W. Mugo)

DATA COLLECTION QUESTIONNAIRE II

TARGET GROUP: *Communities Living or operating along the Nairobi River Corridor but outside the Riparian Reserve/Indirect users of the river corridor (Formal Group)*

NAME OF INTERVIEWER: **TEL. NO.:**

NAME OF RESPONDENT (Optional): **TEL. NO.:**

DATE OF INTERVIEW: **TIME: Start..... End.....**

PLACE OF INTERVIEW: **QUESTIONNAIRE NO.:**

DECLARATION: *The information obtained via this questionnaire is confidential and it will be used purely for academic purpose(s).*

INSTRUCTIONS TO RESPONDENTS: *Please; *Respond to all the questions*

**Provide answers to all the questions as honestly and precisely as possible*

**Tick in the square brackets as shown [√]; where appropriate or fill in the required information on the spaces provided below the questions*

SECTION A: RESPONDENTS' SOCIO-DEMOGRAPHIC DETAILS

| | |
|--|---|
| <p>Q1. Age (In Years)</p> <p>(1) 15-25 []</p> <p>(2) 26-35 []</p> <p>(3) 36-45 []</p> <p>(4) 46-55 []</p> <p>(5) 55 and above []</p> | <p>Q4. Education Background</p> <p>(1) No education []</p> <p>(2) Primary []</p> <p>(3) Secondary []</p> <p>(4) College []</p> <p>(5) University []</p> |
| <p>Q2. Gender/Sex</p> <p>(1) Male []</p> <p>(2) Female []</p> | <p>Q5. Occupation</p> <p>(1) Student []</p> <p>(2) Employee (formal) []</p> <p>(3) Unemployed []</p> <p>(4) Retiree []</p> <p>(5) Businessman/woman []</p> <p>(6) Any other (specify) _____</p> |
| <p>Q3. Current Marital Status</p> <p>(1) Married []</p> <p>(2) Single []</p> <p>(3) Widow []</p> <p>(4) Widower []</p> <p>(5) Other (specify) _____</p> | <p>Q6. Average Income per Month</p> <p>(1) Below Kshs. 5,000/- []</p> <p>(2) Kshs. 5,001-10,000/- []</p> <p>(3) Kshs. 10,001-15,000/- []</p> <p>(4) Kshs. 15,001-20,000/- []</p> <p>(5) Kshs. 20,001-25,000/- []</p> <p>(6) Kshs. 25,001-30,000/- []</p> <p>(7) Above Kshs. 30,000/- []</p> |
| <p>Q7. Which part of Nairobi City/County do you reside? _____</p> | |

SECTION B: UTILIZATION PATTERNS OF THE NAIROBI RIVER CORRIDOR

Q7. How long have you worked or lived in this place?

- (1) <1 year []
- (2) 1-5 years []
- (3) 6-10 years []
- (4) >11years []

Q8. Have you been using the Nairobi River or its immediate surrounding?

- (1) Yes []
- (2) No []

(i) If yes in Q8 above, for what purpose?

- (1) Drinking water []
- (2) Bathing water /Swimming[]
- (3) Relaxation/Recreation []
- (4) Angling/Fishing []
- (5) Any other (specify) _____

(ii) If no in Q8 above, please give your honest reasons

- (1) Lack of interest []
- (2) Unconducive environment []
- (3) Lack of time []
- (4) Pollution of the river []
- (5) Any other (specify) _____

Q9. If the state of the river was to be improved, would you start using the river or its immediate surrounding?

- (1) Yes []
- (2) No []

(i) If yes in Q9 above, for what purpose?

- (1) Drinking water []
- (2) Bathing water /Swimming[]
- (3) Relaxation/Recreation []
- (4) Angling/Fishing []
- (5) Any other (specify) _____

(ii) If no in Q9 above, please give your honest reasons

- (1) Lack of interest []
- (2) Lack of time []
- (3) Any other (specify) _____

SECTION C: STATE OF THE NAIROBI RIVER CORRIDOR

Q10. How would you describe the physical state of Nairobi River Corridor?

- (1) Very good []
- (2) Good []
- (3) Fair []
- (4) Bad []
- (5) Very bad []

Q11. What was the state of the Nairobi River Corridor and the surrounding when you first moved to this area?

- (1) Very good []
- (2) Good []
- (3) Fair []
- (4) Bad []
- (5) Very bad []

Q12. How would you describe the visual condition of the Nairobi River Corridor?

- (1) Beautiful & Inviting []
- (2) Average []
- (3) Ugly & Repelling []

Q13. What problem(s) is Nairobi River Corridor facing?

- (1) Encroachment to the riparian reserve []
- (2) Mismanagement []
- (3) Pollution []
- (4) Land grabbing []
- (5) Informal trading and light industry []
- (6) Any other specify_____

Q14. In your opinion, which group contributes most to the pollution of the Nairobi River?

- (1) Formal traders []
- (2) Informal trade []
- (3) Informal settlements []
- (4) Formal settlements []
- (5) Motorists []
- (6) Industries/factories []
- (7) Any other (specify) _____

Q15. (i) Do you think there are any benefits of conserving the Nairobi River Corridor?

- (1) Yes []
- (2) No []

(ii) If yes in Q15 (i) above, please list some of those benefits

- (1) _____
- (2) _____
- (3) _____
- (4) _____

(iii) If no in Q15 (i) above, please give reasons for your answer

- (1) _____
- (2) _____
- (3) _____
- (4) _____

Q16. (i) In your opinion, do you think the Nairobi River corridor is adequately conserved?

- (1) Yes []
- (2) No []

(ii) If yes in 16(i) above, list some of the conservation measures that have been undertaken.

- (1) _____
- (2) _____
- (3) _____
- (4) _____
- (5) _____

(iii) If no in Q16 (i) above, please suggest what should be done to improve the river corridor condition.

- (1) _____
- (2) _____
- (3) _____
- (4) _____
- (5) _____

Thank you for your time

Appendix III: Sample Interview Schedule 1



UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING
SCHOOL OF THE BUILT ENVIRONMENT

THESIS

ON

PLANNING FOR SUSTAINABLE UTILIZATION AND CONSERVATION OF URBAN RIVER CORRIDORS IN KENYA: A CASE STUDY OF THE NAIROBI RIVER

(By: John Gikundi)

(Supervised by: Dr. Fridah W. Mugo)

DATA COLLECTION INTERVIEW SCHEDULE I

KEY INTERVIEW INFORMANT: *Director of Environment, Ministry of Environment, Water and Natural Resources*

NAME OF INTERVIEWEE: **TEL. NO.:**

NAME OF INTERVIEWER: **TEL. NO.:**

DATE OF INTERVIEW: **TIME:**

DECLARATION: *The information obtained from this interview is confidential and it will be used purely for academic purpose(s).*

GUIDING QUESTIONS:

Q1. What are the roles of your Ministry in the utilization and conservation of urban river corridors in Kenya, particularly the Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q2. How far have you accomplished your roles as mentioned in (Q1) above?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q3. Nairobi River corridor is currently in a degraded state. In your view, what has mostly contributed to this?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q4. Which specific challenges is your Ministry facing with regard to utilization and conservation of urban river corridors in Kenya, particularly the Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q5. Does your Ministry have any budget for conservation of urban river corridors in Kenya? If so, what is your annual allocation (in Kshs.)? In your opinion, is that allocation enough to adequately run your operations? If no, how do you cope with the situation?

Q6. Does your Ministry have relevant staff (specialists) to oversee utilization and conservation of urban river corridors in Kenya? If yes, how many and what are their areas of specialization?

Q7. Has your Ministry initiated implementation of any regulations regarding conservation of urban river corridors in Kenya, especially on Nairobi River? If yes, which ones? If no, why?

Q8. What policies does your Ministry have in place to guide on utilization and conservation of urban river corridors in Kenya?

Q9. In your opinion, are the policies mentioned in (Q8) above effective? If yes, in what ways? If no, what are you doing to address this shortcoming?

Q10. What suggestions would you like to advance for sustainable utilization and conservation of urban river corridors in Kenya, particularly the Nairobi River corridor?

(i) Suggestions for sustainable utilization

- (a) _____
- (b) _____
- (c) _____
- (d) _____

(ii) Suggestions for sustainable conservation

- (a) _____
- (b) _____
- (c) _____
- (d) _____

Thank you for your time

Appendix IV: Sample Interview Schedule 2



UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING
SCHOOL OF THE BUILT ENVIRONMENT

THESIS

ON

**PLANNING FOR SUSTAINABLE UTILIZATION AND CONSERVATION OF URBAN
RIVER CORRIDORS IN KENYA: A CASE STUDY OF THE NAIROBI RIVER**

(By: John Gikundi)

(Supervised by: Dr. Fridah W. Mugo)

DATA COLLECTION INTERVIEW SCHEDULE II

KEY INTERVIEW INFORMANT: *Director General, National Environmental Management Authority (NEMA)*

NAME OF INTERVIEWEE: **TEL. NO.:**

NAME OF INTERVIEWER: **TEL. NO.:**

DATE OF INTERVIEW: **TIME:**

DECLARATION: *The information obtained from this interview is confidential and it will be used purely for academic purpose(s).*

GUIDING QUESTIONS:

1. What are the roles of your institution in the conservation and utilization of urban river corridors in Kenya, particularly the Nairobi River Corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q2. How far have you accomplished your roles as mentioned in (Q 1) above?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q3. Nairobi River corridor is currently in a degraded state. In your view, what has mostly contributed to this?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q4. Which specific challenges is your institution facing with regard to conservation of urban river corridors in Kenya, especially Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q5. Does your institution have any budget for conservation of urban river corridors in Kenya? If so, what is your allocation in Kshs. per year? In your opinion, is the allocation enough to run your operations? If no, how do you cope with the situation?

Q6. What type of staff has your institution employed to oversee conservation of urban river corridors in Kenya, particularly the Nairobi River corridor? Briefly comment on their qualifications and areas of specialization.

Q7. Has your institution initiated implementation of any regulations regarding conservation of urban river corridors in Kenya, especially on Nairobi River? If yes, which ones? If no, why?

Q8. What policies does your institution have in place to guide on utilization and conservation of urban river corridors in Kenya?

Q9. In your opinion, are the policies mentioned in (Q8) above effective? If yes, in what ways? If no, what is your institution doing to address this shortcoming?

Q10. What suggestions would you like to advance for sustainable utilization and conservation of urban river corridors in Kenya, particularly the Nairobi River corridor?

(i) Suggestions for sustainable utilization

- (a) _____
- (b) _____
- (c) _____
- (d) _____

(ii) Suggestions for sustainable conservation

- (a) _____
- (b) _____
- (c) _____
- (d) _____

Thank you for your time

Appendix V: Sample Interview Schedule 3



UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING
SCHOOL OF THE BUILT ENVIRONMENT

THESIS

ON

PLANNING FOR SUSTAINABLE UTILIZATION AND CONSERVATION OF URBAN RIVER CORRIDORS IN KENYA: A CASE STUDY OF THE NAIROBI RIVER

(By: John Gikundi)

(Supervised by: Dr. Fridah W. Mugo)

DATA COLLECTION INTERVIEW SCHEDULE III

KEY INTERVIEW INFORMANT: *Director, Water Resources Management Authority (WRMA)*

NAME OF INTERVIEWEE: **TEL. NO.:**

NAME OF INTERVIEWER: **TEL. NO.:**

DATE OF INTERVIEW: **TIME:**

DECLARATION: *The information obtained from this interview is confidential and it will be used purely for academic purpose(s).*

GUIDING QUESTIONS:

Q1. What are the roles of your institution in the utilization and conservation of urban river corridors in Kenya, particularly the Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q2. How far have you accomplished your roles as mentioned in (Q1) above?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q3. Nairobi River corridor is currently in a degraded state. In your view, what has mostly contributed to this?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q4. Which specific challenges is your institution facing with regard to utilization and conservation of urban river corridors in Kenya, especially the Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q5. Does your institution have any budget for conservation of urban river corridors in Kenya? If so, what is your annual allocation (in Kshs.)? In your opinion, is that allocation enough to adequately run your operations? If no, how do you cope with the situation?

Q6. Does your institution have relevant staff (specialists) to oversee utilization and conservation urban river corridors in Kenya, especially the Nairobi River corridor? If yes, how many and what are their areas of specialization?

Q7. Has your institution initiated implementation of any regulations regarding conservation of urban river corridors in Kenya, especially on Nairobi River? If yes, which ones? If no, why?

Q8. What policies does your institution have in place to guide on utilization and conservation of urban river corridors in Kenya, particularly the Nairobi River corridor?

Q9. In your opinion, are the policies mentioned in (Q8) above effective? If yes, in what ways? If no, what are you doing to address this shortcoming?

Q10. What suggestions would you like to advance for sustainable utilization and conservation of the Nairobi River corridor?

(i) Suggestions for sustainable utilization

(a) _____

(b) _____

(c) _____

(d) _____

(ii) Suggestions for sustainable conservation

(a) _____

(b) _____

(c) _____

(d) _____

Thank you for your time

Appendix VI: Sample Interview Schedule 4



UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING
SCHOOL OF THE BUILT ENVIRONMENT

THESIS

ON

PLANNING FOR SUSTAINABLE UTILIZATION AND CONSERVATION OF URBAN RIVER CORRIDORS IN KENYA: A CASE STUDY OF THE NAIROBI RIVER

(By: John Gikundi)

(Supervised by: Dr. Fridah W. Mugo)

DATA COLLECTION INTERVIEW SCHEDULE IV

KEY INTERVIEW INFORMANT: *Director, Tana and Athi River Development Authority (TARDA)*

NAME OF INTERVIEWEE: **TEL. NO.:**

NAME OF INTERVIEWER: **TEL. NO.:**

DATE OF INTERVIEW: **TIME:**

DECLARATION: *The information obtained from this interview is confidential and it will be used purely for academic purpose(s).*

GUIDING QUESTIONS:

Q1. What are the roles of your institution in the utilization and conservation of the Nairobi River corridor considering that Nairobi River is a tributary to Athi River?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q2. How far have you accomplished your roles as mentioned in (Q1) above?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q3. Nairobi River corridor is currently in a degraded state. In your view, what has mostly contributed to this?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q4. Which specific challenges is your institution facing with regard to utilization and conservation of Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q5. Does your institution have any budget for Nairobi River corridor conservation? If so, what is your annual allocation (in Kshs.)? In your opinion, is that allocation enough to adequately run your operations? If no, how do you cope with the situation?

Q6. Does your institution have relevant staff (specialists) to oversee utilization and conservation Nairobi River corridor? If yes, how many and what are their areas of specialization?

Q7. Has your institution initiated implementation of any regulation regarding utilization and conservation of Nairobi River corridor? If yes, which ones in particular? If no, why?

Q8. What policies does your institution have in place to guide on utilization and conservation of Nairobi River corridor?

Q9. In your opinion, are the policies mentioned in (Q8) above effective? If yes, in what ways? If no, what are you doing to address this shortcoming?

Q10. What suggestions would you like to advance for sustainable utilization and conservation of the Nairobi River corridor?

(i) Suggestions for sustainable utilization

- (a) _____
- (b) _____
- (c) _____
- (d) _____

(ii) Suggestions for sustainable conservation

- (a) _____
- (b) _____
- (c) _____
- (d) _____

Thank you for your time

Appendix VII: Sample Interview Schedule 5



UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING
SCHOOL OF THE BUILT ENVIRONMENT

THESIS
ON
PLANNING FOR SUSTAINABLE UTILIZATION AND CONSERVATION OF URBAN RIVER CORRIDORS IN KENYA: A CASE STUDY OF THE NAIROBI RIVER
(By: John Gikundi)
(Supervised by: Dr. Fridah W. Mugo)

DATA COLLECTION INTERVIEW SCHEDULE V

KEY INTERVIEW INFORMANT: *Director, Nairobi River Basin Projects (NRBP)*

NAME OF INTERVIEWEE: **TEL. NO.:**

NAME OF INTERVIEWER: **TEL. NO.:**

DATE OF INTERVIEW: **TIME:**

DECLARATION: *The information obtained from this interview is confidential and it will be used purely for academic purpose(s).*

GUIDING QUESTIONS:

Q1. What are the roles of your organization in the utilization and conservation of Nairobi river basins, particularly the Nairobi River?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q2. How far have you accomplished your role as mentioned in (Q 1) above?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q3. In your view, what has contributed to the degradation of Nairobi River Corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q4. Which specific challenges is your organization facing with regard to conservation of Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q5. Does your institution have any budget for Nairobi River corridor conservation? If so, what is your annual allocation (in Kshs.)? In your opinion, is that allocation enough to adequately run your operations? If no, how do you cope with the situation?

Q6. What type of staff has your organization employed to oversee utilization and conservation of Nairobi River corridor? How many are they and they sufficient?

Q7. Has your organization initiated implementation of any regulation regarding utilization and conservation of Nairobi River corridor? If yes, which ones in particular and how sustainable or successful are the initiatives? If no, why?

Q8. What policies does your organization have in place to guide on utilization and conservation of Nairobi River corridor?

Q9. In your opinion, are the policies mentioned in (Q8) above effective? If yes, in what ways? If no, what are you doing to address this shortcoming?

Q10. What suggestions would you like to advance for sustainable utilization and conservation of the Nairobi River corridor?

(i) Suggestions for sustainable utilization

(a) _____

(b) _____

(c) _____

(d) _____

(ii) Suggestions for sustainable conservation

(a) _____

(b) _____

(c) _____

(d) _____

Thank you for your time

Appendix VIII: Sample Interview Schedule 6



UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING
SCHOOL OF THE BUILT ENVIRONMENT

THESIS
ON
PLANNING FOR SUSTAINABLE UTILIZATION AND CONSERVATION OF URBAN RIVER CORRIDORS IN KENYA: A CASE STUDY OF THE NAIROBI RIVER
(By: John Gikundi)
(Supervised by: Dr. Fridah W. Mugo)

DATA COLLECTION INTERVIEW SCHEDULE VI

KEY INTERVIEW INFORMANT: *Director of Environment, Nairobi City County*

NAME OF INTERVIEWEE: **TEL. NO.:**

NAME OF INTERVIEWER: **TEL. NO.:**

DATE OF INTERVIEW: **TIME:**

DECLARATION: *The information obtained from this interview is confidential and it will be used purely for academic purpose(s).*

GUIDING QUESTIONS:

Q1. What are the roles of your office/department in the conservation of the Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q2. How far have you accomplished your roles as mentioned in (Q 1) above?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q3. Nairobi river corridor is in a degraded state, what has mostly contributed to this?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q4. Which specific challenges is your office/department facing with regard to conservation of the Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q5. Does your office/department have any budget for Nairobi River corridor conservation? If so, what is your allocation in Kshs. per year? In your opinion, is the allocation enough to run your operations? If no, how do you cope with the situation?

Q6. Briefly comment on your staffing for conservation of Nairobi River corridor; type of staff, their adequacy and qualifications.

Q7. Has your office/department initiated implementation of any regulation regarding protection of Nairobi River corridor? If yes, which ones in particular and how sustainable or successful are the initiatives? If no. why?

Q8. What policies does your office/department have in place to guide utilization and conservation of the Nairobi River corridor?

Q9. In your opinion, are the policies mentioned in (Q8) above effective? If yes, in what ways? If no, what are you doing to address this shortcoming?

Q10. What suggestions would you like to advance for sustainable utilization and conservation of urban river corridors, particularly the Nairobi River corridor?

(i) Suggestions for sustainable utilization

- (a) _____
- (b) _____
- (c) _____
- (d) _____

(ii) Suggestions for sustainable conservation

- (a) _____
- (b) _____
- (c) _____
- (d) _____

Thank you for your time

Appendix IX: Sample Interview Schedule 7



UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING
SCHOOL OF THE BUILT ENVIRONMENT

THESIS

ON

PLANNING FOR SUSTAINABLE UTILIZATION AND CONSERVATION OF URBAN RIVER CORRIDORS IN KENYA: A CASE STUDY OF THE NAIROBI RIVER

(By: John Gikundi)

(Supervised by: Dr. Fridah W. Mugo)

DATA COLLECTION INTERVIEW SCHEDULE VII

KEY INTERVIEW INFORMANT: *Director of Physical Planning, Nairobi City County*

NAME OF INTERVIEWEE: **TEL. NO.:**

NAME OF INTERVIEWER: **TEL. NO.:**

DATE OF INTERVIEW: **TIME:**

DECLARATION: *The information obtained from this interview is confidential and it will be used purely for academic purpose(s).*

GUIDING QUESTIONS:

Q1. What planning roles does your office/department play towards safeguarding city river corridors (particularly the Nairobi River corridor) against negative effects of various developments in the city?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q2. How far have you accomplished your roles as mentioned in (Q1) above?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q3. Nairobi River corridor is currently in a degraded state. In your view, what has mostly contributed to this?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q4. Which specific challenges is your office/department facing with regard to protection of the Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q5. Does your office/department have any budget for protection of Nairobi River corridor? If so, what is your annual allocation (in Kshs.)? In your opinion, is that allocation enough to adequately run your operations? If no, how do you cope with the situation?

Q6. Does your office/department have relevant staff (specialists) to monitor various development activities in the city especially those along Nairobi River corridor? If yes, how many and what are their areas of specialization?

Q7. Has your office/department initiated implementation of any regulation regarding protection of Nairobi River corridor? If yes, which ones in particular and how sustainable or successful are the initiatives? If no, why?

Q8. What policies does your office/department have in place to guide on protection of the Nairobi River corridor?

Q9. In your opinion, are the policies mentioned in (Q8) above effective? If yes, in what ways? If no, what are you doing to address this shortcoming?

Q10. What suggestions would you like to advance for sustainable utilization and conservation of the Nairobi River corridor?

(i) Suggestions for sustainable utilization

- (a) _____
- (b) _____
- (c) _____
- (d) _____

(ii) Suggestions for sustainable conservation

- (a) _____
- (b) _____
- (c) _____
- (d) _____

Thank you for your time

Appendix X: Sample Interview Schedule 8



UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING
SCHOOL OF THE BUILT ENVIRONMENT

THESIS

ON

PLANNING FOR SUSTAINABLE UTILIZATION AND CONSERVATION OF URBAN RIVER CORRIDORS IN KENYA: A CASE STUDY OF THE NAIROBI RIVER

(By: John Gikundi)

(Supervised by: Dr. Fridah W. Mugo)

DATA COLLECTION INTERVIEW SCHEDULE VIII

KEY INTERVIEW INFORMANT: *Director, Nairobi City Water and Sewerage Company (NCWSC) Ltd*

NAME OF INTERVIEWEE: **TEL. NO.:**

NAME OF INTERVIEWER: **TEL. NO.:**

DATE OF INTERVIEW: **TIME:**

DECLARATION: *The information obtained from this interview is confidential and it will be used purely for academic purpose(s).*

GUIDING QUESTIONS:

Q1. What are the roles of your company in the utilization and conservation of the Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q2. How far have you accomplished your roles as mentioned in (Q1) above?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q3. Nairobi River corridor is currently in a degraded state. In your view, what has mostly contributed to this?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q4. Which specific challenges is your company facing with regard to utilization and conservation of Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q5. Does your company have any budget for Nairobi River corridor conservation? If so, what is your annual allocation (in Kshs.)? In your opinion, is that allocation enough to adequately run your operations? If no, how do you cope with the situation?

Q6. Does your company have relevant staff (specialists) to oversee utilization and conservation Nairobi River corridor? If yes, how many and what are their areas of specialization?

Q7. Has your company initiated implementation of any regulation regarding utilization and conservation of Nairobi River corridor? If yes, which ones in particular and how sustainable or successful are the initiatives? If no, why?

Q8. What policies does your company have in place to guide on utilization and conservation of the Nairobi River corridor?

Q9. In your opinion, are the policies mentioned in (Q8) above effective? If yes, in what ways? If no, what are you doing to address this shortcoming?

Q10. What suggestions would you like to advance for sustainable utilization and conservation of the Nairobi River corridor?

(i) Suggestions for sustainable utilization

- (a) _____
- (b) _____
- (c) _____
- (d) _____

(ii) Suggestions for sustainable conservation

- (a) _____
- (b) _____
- (c) _____
- (d) _____

Thank you for your time

Appendix XI: Sample Interview Schedule 9



UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING
SCHOOL OF THE BUILT ENVIRONMENT

THESIS

ON

PLANNING FOR SUSTAINABLE UTILIZATION AND CONSERVATION OF URBAN RIVER CORRIDORS IN KENYA: A CASE STUDY OF THE NAIROBI RIVER

(By: John Gikundi)

(Supervised by: Dr. Fridah W. Mugo)

DATA COLLECTION INTERVIEW SCHEDULE IX

KEY INTERVIEW INFORMANT: *Director of Integrated Waste Management, Nairobi City County*

NAME OF INTERVIEWEE: **TEL. NO.:**

NAME OF INTERVIEWER: **TEL. NO.:**

DATE OF INTERVIEW: **TIME:**

DECLARATION: *The information obtained from this interview is confidential and it will be used purely for academic purpose(s).*

GUIDING QUESTIONS:

Q1. What planning roles does your office/department play towards protecting Nairobi city rivers especially the Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q2. How far have you accomplished your roles as mentioned in (Q1) above?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q3. Nairobi River corridor is currently in a degraded state. In your view, what has mostly contributed to this?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q4. Which specific challenges is your office/department facing with regard to protection of the Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q5. Does your office/department have any budget for protection of Nairobi River corridor? If so, what is your annual allocation (in Kshs.)? In your opinion, is that allocation enough to adequately run your operations? If no, how do you cope with the situation?

Q6. Does your office/department have relevant staff (specialists) to ensure protection of Nairobi River corridor? If yes, how many and what are their areas of specialization?

Q7. Has your office/department initiated implementation of any regulation regarding protection of Nairobi River corridor? If yes, which ones in particular and how sustainable or successful are the initiatives? If no, why?

Q8. What policies does your office/department have in place to guide on protection of the Nairobi River corridor?

Q9. In your opinion, are the policies mentioned in (Q8) above effective? If yes, in what ways? If no, what are you doing to address this shortcoming?

Q10. What suggestions would you like to advance for sustainable utilization and conservation of the Nairobi River corridor?

(i) Suggestions for sustainable utilization

(a) _____

(b) _____

(c) _____

(d) _____

(ii) Suggestions for sustainable conservation

(a) _____

(b) _____

(c) _____

(d) _____

Thank you for your time

Appendix XII: Sample Interview Schedule 10



UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING
SCHOOL OF THE BUILT ENVIRONMENT

THESIS
ON
PLANNING FOR SUSTAINABLE UTILIZATION AND CONSERVATION OF URBAN RIVER CORRIDORS IN KENYA: A CASE STUDY OF THE NAIROBI RIVER
(By: John Gikundi)
(Supervised by: Dr. Fridah W. Mugo)

DATA COLLECTION INTERVIEW SCHEDULE X

KEY INTERVIEW INFORMANT: *Director of Public Health, Nairobi City County*

NAME OF INTERVIEWEE: **TEL. NO.:**

NAME OF INTERVIEWER: **TEL. NO.:**

DATE OF INTERVIEW: **TIME:**

DECLARATION: *The information obtained from this interview is confidential and it will be used purely for academic purpose(s).*

GUIDING QUESTIONS:

Q1. What planning roles does your office/department play towards protecting Nairobi city rivers especially the Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q2. How far have you accomplished your roles as mentioned in (Q1) above?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q3. Nairobi River corridor is currently in a degraded state. In your view, what has mostly contributed to this?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q4. Which specific challenges is your office/department facing with regard to protection of the Nairobi River corridor?

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

Q5. Does your office/department have any budget for protection of Nairobi River corridor? If so, what is your annual allocation (in Kshs.)? In your opinion, is that allocation enough to adequately run your operations? If no, how do you cope with the situation?

Q6. Does your office/department have relevant staff (specialists) to ensure protection of Nairobi River corridor? If yes, how many and what are their areas of specialization?

Q7. Has your office/department initiated implementation of any regulation regarding protection of Nairobi River corridor? If yes, which ones in particular? If no, why?

Q8. What policies does your office/department have in place to guide on protection of the Nairobi River corridor?

Q9. In your opinion, are the policies mentioned in (Q8) above effective? If yes, in what ways? If no, what are you doing to address this shortcoming?

Q10. What suggestions would you like to advance for sustainable utilization and conservation of the Nairobi River corridor?

(i) Suggestions for sustainable utilization

(a) _____

(b) _____

(c) _____

(d) _____

(ii) Suggestions for sustainable conservation

(a) _____

(b) _____

(c) _____

(d) _____

Thank you for your time

Appendix XIII: Sample Observation List



UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

SCHOOL OF THE BUILT ENVIRONMENT

THESIS

ON

PLANNING FOR SUSTAINABLE UTILIZATION & CONSERVATION OF URBAN RIVER CORRIDORS IN KENYA: A Case Study of the Nairobi River

(By: John Gikundi)

(Supervised by: Dr. Fridah W. Mugo)

OBSERVATION LIST

GENERAL OBSERVATIONS AT THE STUDY AREA

Q1. Land uses along the river corridor (*Enumerate all the land uses along the river corridor*).

- | | |
|--------------|---------------|
| (i) _____ | (xi) _____ |
| (ii) _____ | (xii) _____ |
| (iii) _____ | (xiii) _____ |
| (iv) _____ | (xiv) _____ |
| (v) _____ | (xv) _____ |
| (vi) _____ | (xvi) _____ |
| (vii) _____ | (xvii) _____ |
| (viii) _____ | (xviii) _____ |
| (ix) _____ | (xix) _____ |
| (x) _____ | (xx) _____ |

Q2. The size of the river corridor at various point of the river channel in relation to various land uses along the river corridor (*Measure the distance of the river corridor to the nearest land use or business premise*)

Q3. The visual condition of the Nairobi River Corridor (*Use a photographic camera to capture the visual condition of the river corridor at measured points*).

Q4. The physical condition of the Nairobi River channel (*Use a photographic camera to capture the physical condition of the river corridor e.g. is the river channel natural or channelized or in its natural form*).

Q5. Kind of river degradation occurring on the Nairobi River Corridor (List down all visible forms of degradation)

| | |
|--------------|---------------|
| (i) _____ | (xi) _____ |
| (ii) _____ | (xii) _____ |
| (iii) _____ | (xiii) _____ |
| (iv) _____ | (xiv) _____ |
| (v) _____ | (xv) _____ |
| (vi) _____ | (xvi) _____ |
| (vii) _____ | (xvii) _____ |
| (viii) _____ | (xviii) _____ |
| (ix) _____ | (xix) _____ |
| (x) _____ | (xx) _____ |

Appendix XIV: Shared Vision..... Saving the Nairobi River

JOYTAI Y. ILAC
DAILY NATION
Tuesday July 1, 2014

TACKLING POLLUTION | Factories expected to adopt cleaner production strategies

20 firms join forces to save Nairobi River

Companies working with Nema in seeking ways of reducing disposal of effluent into basin

BY SAMUEL SIRINGI
ssiringi@ke.nationmedia.com

At least 20 companies have launched a multi-million-shilling programme to curb pollution in the Nairobi River Basin.

The firms are working with the National Environment Management Authority in seeking ways of reducing disposal of effluent into the crucial river source.

The agency, in collaboration with the Kenya National Cleaner Production Centre (KNCPC), has called a meeting today to spell out measures that will ensure the Promotion of Compliance Assistance for Enterprises in Nairobi River Basin Project leads to a cleaner water source.

It is expected to save the companies up to Sh430 million per year.

Reduce wastage

The firms include Athi River Mining, Kenya Meat Commission, Mombasa Cement, East African Portland Cement Company, British American Tobacco and East African Breweries Limited.

Bamburi Cement, Kenya Oil Refineries, Leather Industries of Kenya and Savanna Cement are also part of the programme.

KNCPC director Jane Nyakang'o said the initiative sought to reduce industrial pollution of Nairobi River, "which threatens to rise".

"We hope companies will end up adopting cleaner production

strategies. We also hope they will put in place measures that help them reduce wastage," Ms Nyakang'o said.

The project seeks to help targeted factories to comply with national environmental standards spelt out by Nema instead of waiting for the agency to crack down on them.

Experts are set to visit factories within the Nairobi River Basin to assess their contribution to pollution.

The teams will sample the effluent from the factories for analysis to establish the pollution levels.

Identify options

Assessments at individual firms will be conducted to identify options that can help minimise waste and ensure resource efficiency.

The project comes after a related one, the Nairobi River Basin Programme Phase III, revealed that no consistent environmental monitoring had taken place in all the rivers under the Nairobi River Basin between 1969 and 2008.

"Analysis of past work on the Nairobi River Basin shows that there is serious lack of documented information on the nature and ecological performance of biodiversity within the basin," says a report on the project.

The latest project is similar to the ongoing Sh92 million World Bank-funded programme that has reduced pollution in the Lake Victoria Basin.

It involves 40 companies on



PLAYERS

Institutions in programme

- Athi River Mining
- Kenya Meat Commission
- Atlas Copco Eastern Africa
- Blue Triangle Cement
- Mombasa Cement
- Savanna Cement
- Bamburi Cement
- East African Portland Cement Company
- London Distillery
- Kenya Oil Refineries
- East African Breweries Limited
- British American Tobacco
- Chandaria Industries
- Osho Chemicals
- Somochem (Kenya) Ltd
- Ecolab East Africa (K) Ltd

FILE PHOTO
The Nairobi River. A programme has been launched to reduce industrial pollution of the water source.

the Kenyan side of the Lake Victoria Basin. They have adopted a resource efficient and clean production programme.

They recycle their wastewater, leaving the environment clean.

Through these interventions, companies have reduced the consumption of resources — mainly raw materials, water and energy — by up to 50 per cent.


Appendix XV: Research Clearance Permit from National Commission for Science, Technology and Innovation

CONDITIONS

- 1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit**
- 2. Government Officers will not be interviewed without prior appointment.**
- 3. No questionnaire will be used unless it has been approved.**
- 4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.**
- 5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.**
- 6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice**

Thomas

REPUBLIC OF KENYA



National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A-1315

CONDITIONS: see back page


THIS IS TO CERTIFY THAT:

MR. JOHN GIKUNDI NDEGE
of UNIVERSITY OF NAIROBI, 25621-100 NAIROBI, has been permitted to conduct research in Nairobi County

on the topic: SUSTAINABLE UTILIZATION AND CONSERVATION OF URBAN RIVER CORRIDORS IN KENYA: A CASE OF THE NAIROBI RIVER

for the period ending: 30th July, 2014

Permit No : NACOSTI/P/14/8196/919
Date of Issue : 1st April, 2014
Fee Received :KSH 1,000.00



Thomas
Secretary
National Commission for Science, Technology & Innovation

Appendix XVI: Research Authorization from National Commission for Science, Technology and Innovation



NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No.

Date:

1st April, 2014

NACOSTI/P/14/8196/919

John Gikundi Ndege
University of Nairobi
P.O.Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on *“Sustainable utilization and conservation of urban river corridors in Kenya: A case of the Nairobi River,”* I am pleased to inform you that you have been authorized to undertake research in **Nairobi County** for a period ending **30th July, 2014**.

You are advised to report to **the County Commissioner and the County Director of Education, Nairobi County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

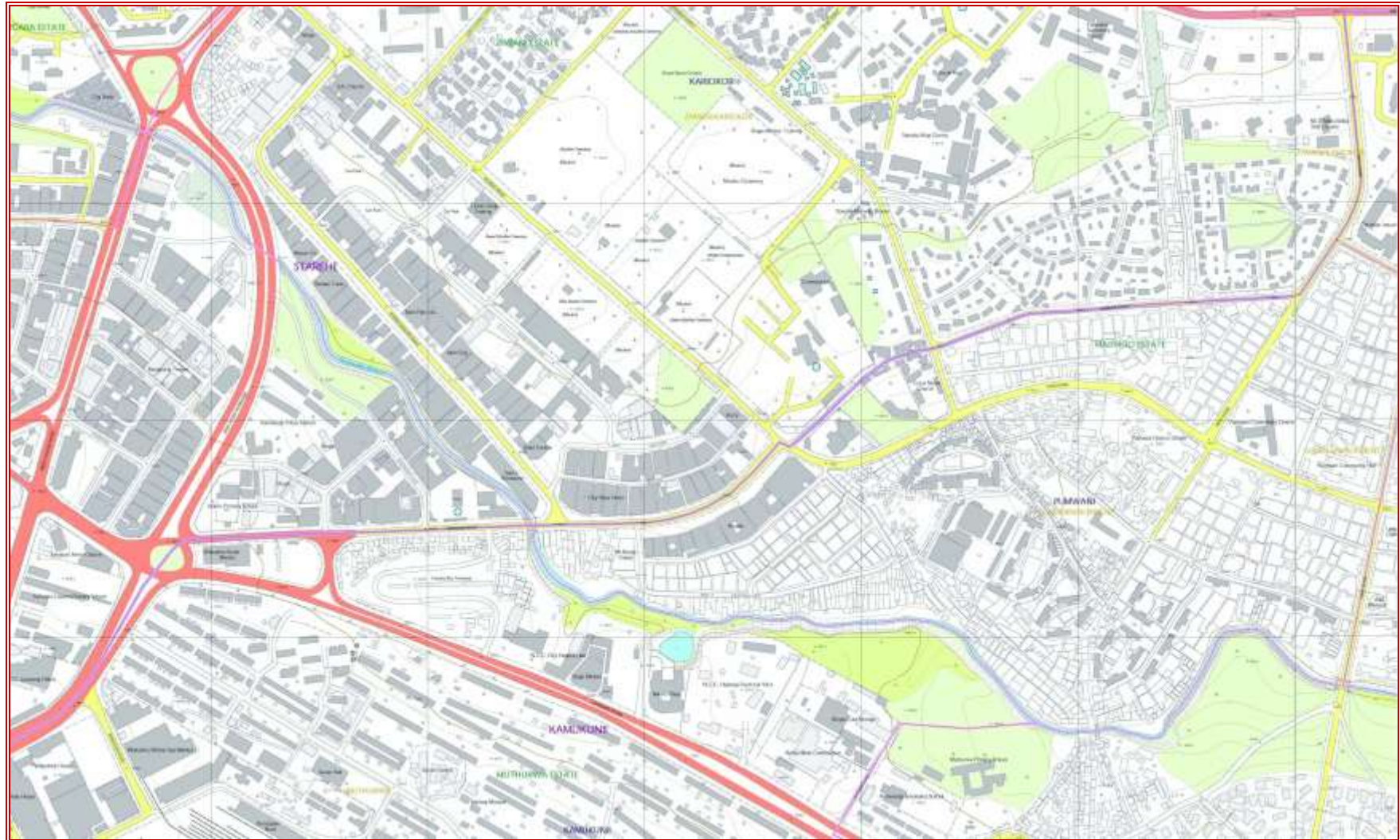
DR. M. K. RUGUTT, PhD, HSC.
FOR: SECRETARY/CEO

Copy to:

The County Commissioner
The County Director of Education
Nairobi County.



APPENDIX VII: Map of the Lower City of Nairobi Showing the Site Context



Source: Survey of Kenya, 2012