AN INVESTIGATION INTO CAUSES AND EFFECTS OF ENCROACHMENTS ON RIPARIAN RESERVES
A CASE STUDY OF RUAKA RIVER

By
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DECLARATION

This planning research project is my original work and has not been submitted for examination of a degree in any other university.

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DEDICATION

To my son, Koome Mureti.
ACKNOWLEDGEMENT

This study was certainly made complete by the knowledge and contributions of many. Their ideas, support critique and guidance have been my source of strength and direction. First of all, I direct my special thanks to the staff members of the Department of Urban and Regional Planning for availing all that I needed to ensure this research project is completed. Specific acknowledgement to my supervisor, Margaret Ng’ayu for having been a patient instructor, she carefully walked with me through my draft papers, commenting, editing and pushing me to deliver my best.

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Above all I thank God, without whose grace and provision, nothing can be accomplished.
ABSTRACT

This research is a contribution to the growing discourse on contemporary challenges of environmentally fragile areas and land use planning with regards to the use of riparian zones. It begins with giving an insight into the concept of the riparian reserve and discusses it within the context of land use planning within the Ruaka area of Kiambu County. Thereafter, key theoretical and conceptual issues of the main subject matter of encroachment are reviewed in the context of the riparian reserve in the River Ruaka.

The main data needs for the research include; major land use activities along the riparian belt of River Ruaka, in particular the section between Ruaka Bus Park and Gacharage Junction; the pull and push factors along the riparian belt; space standards and requirements for development; manifestation of encroachment; and, causes and effects of riparian reserve encroachment. Research questionnaires and interviews among other forms of primary methods of data collection were used to collect information from land users (where the study targeted 95 respondents), professionals and public officers in key government institutions while secondary data was mainly derived from library and internet sources. Detailed observation and mapping techniques using a variety of tools was also used to capture the degree of the causes and effects of encroachment within the riparian reserve of the study area. The process of data collection was conducted with reference to the objectives of this research which are highlighted as; the human activities encroaching the riparian belt of Ruaka river; main reasons driving the land users into the location hence encroachment; challenges of applying existing legal guidelines for riparian conservation; and the desire to recommend strategies to conserve the riparian reserve.

According to the data findings, the identified causes of riparian encroachment in the study area include; negative user perception and sub-optimal design of space; relatively high population against scarcity of land; limited awareness of space standards and requirements of land uses; the need to locate appropriately/competitively; low level awareness of environmental and land use standards and poor management and co-ordination of existing land use policy guidelines. The effects of encroachment include; establishment of incompatible land uses; congestion; relocation/displacement; conflicts, environmental degradation and pollution; soil erosion; insecurity and lost ecotourism opportunities.
These findings were followed by necessary measures which will serve as preventive and curative intervention to the ill of riparian encroachment. Recommendations includes capacity building to encourage ownership and responsibility in conservation and protection; delineation of an adaptable riparian reserve; securing, delineating and designing of the Ruaka water fall to accommodate recreation needs; promotion of green infrastructure along the entire riparian reserve; relocation and demolition where necessary and provision of utility and sanitary facilities.
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ABBREVIATIONS

CAAC Catchment Area Advisory Committee

CBD Central Business District

CGK County government of Kiambu

DEC District Environmental Committee

EMCA Environmental Management and Coordination Act

GIS Geographic Information System

NEMA National Environment Management Authority

NRBP Nairobi River Basin Programme

PPA Physical Planning Act

SPSS Statistical Package for the Social Sciences

UN United Nations

UNDP United Nations Development Programme

UNEP United Nations Environment Programme

UN-Habitat United Nations Human Settlements Programme

WRMA Water Resources Management Authority

WRUA Water Resource Users Association
A river seems a magic thing. A magic, moving, living part of the very earth itself.

- Laura Gilpin - From the Rio Grande, 1949

1.0 Introduction

Internationally, riparian reserves are classified and protected from encroachments under the Ramsar convention of 1971. Ramsar convention main mission is the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world. Under the Ramsar Convention, a wide variety of natural and human-made habitat types ranging from rivers to coral reefs can be classified as wetlands. Wetlands include swamps, marshes, billabongs, lakes, salt marshes, mudflats, mangroves, coral reefs, fens, peat bogs, or bodies of water - whether natural or artificial, permanent or temporary. Water within these areas can be static or flowing; fresh, brackish or saline; and can include inland rivers and coastal or marine water to a depth of six meters at low tide (Viney, 2013).
In Kenya, several institutional frameworks that are aimed at preservation and protection of wetlands exist. They include the National Environment Management Authority (NEMA) and Water Resources Management Authority (WARMA). Wetlands conservation and management draft policy is the latest instrument addressing the issues of wetlands in specific the national. It describes wetlands as areas of swamps, marshes, bogs, shallow lakes, ox bow lakes, dams, riverbanks, floodplains, fishponds, lakeshores and seashores. In Kenya, wetlands occupy about 3% to 4%, which is approximately 14,000 km2 of the land surface (UNEP, 2013).

Locally, County governments and local communities play a key role in filling the gaps in wetland protection because they have primary responsibility for local land use management. Local action is particularly critical in areas that do not have comprehensive wetland protection programs. Protecting wetlands using regulatory or voluntary measures provides a review of regulatory and non-regulatory options for local governments. Ideally, a combination of approaches has been used in riparian reserve management in local context. (MOE 2013).

Riparian buffer strips are vegetated areas adjacent to streams, rivers, lakes, and other waterways that protect aquatic environments from excessive sedimentation, surface runoff pollutants, and contaminants from the adjacent landscape (Karisa 2010). However, in Ruaka river, riparian buffer strip is facing major encroachment challenges and scientific support for using Ruaka river riparian buffer strip to mitigate changes in water resources is needed.

In traditional African culture, there is no demarcation or separation of people from nature since nature and people are viewed to be the same (Lelo et al. 2005). People in communal Africa have sustained their livelihoods for many years, practicing cultivation within riparian areas without posing a significant threat to the ecosystem (Derman 1998). Consequently, people visit and use riparian areas and streams on a daily basis (Mathooko 2001). However, with an increasing human population and increased intensity of adjacent land use due to increased commercial and agricultural activities, there is need to pay more attention to these areas to ensure that they are not overburdened through encroachments.

The Constitution of Kenya 2010 provides that “The State shall ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and ensure
the equitable sharing of the accruing benefits.”(2010 page 56) The riparian zone has significant ecological, social and economic functions. Well managed and preserved riparian reserve increase value of adjacent properties since represents nature, reduce property loss from excessive erosion and flooding, protect water quality, enhance wildlife habitat, contribute to the natural beauty of the land, dissipate noise from the reservoir traffic and nearby properties, provide privacy, screen unsightly views and enhance scenic view (Hawe, 2005).

1.1 Statement of the study problem
Buffer policies worldwide are significantly influenced by political acceptability rather than scientific data (Castelle et al., 1994), and the River Ruaka riparian reserve in Kiambu County is no exception. In Kenya, the 2002 Water Act describes riparian zones as land lying within a distance equal to the width of the watercourse, with a minimum of 2 m and a maximum of 30 m (Republic of Kenya 2002). This policy is being debated, as some Kenyan stakeholders feel it is too wide, while others express a need for a wider buffer strip (Shivoga et al. 2007). There is no scientific basis to support a 30 m or any other width of riparian buffer strip. Advocacy for a properly functioning riparian buffer strip is strong because River Ruaka is stressed by encroachments within its riparian (Maina et al. 2013).

The riparian area of Ruaka River provides resources to local communities and supports critical downstream water services. River Ruaka at the study section has a width of 4 to 8 meters water course and characterized by narrow strip of indigenous riparian vegetation averaging about 15–20 m. Some sections of this reserve have been completely cleared to provide access to the stream as well space for human activities (Magana and Bretschko 2003; Mathooko 2001). The riparian areas of Ruaka River are threatened by encroachments between (1) tribal norms, (2) communal regulatory mechanisms, and (3) government statutory enforcement mechanisms. The “free access” mentality has led to a decline in riparian services such as water quantity and water quality. The increased prevalence of downstream flooding during rainfall events due to increased runoff during the rainy season and decreased runoff during the dry season has been attributed to land use change (Baldyga et al. 2007; Lelo et al. 2005). Better quality stream water has been observed adjacent to intact riparian buffer strips compared to stream water adjacent to little or no vegetated riparian buffer strips (Shivoga et al. 2007).
To achieve sustainable management of the environment and in particular the riparian reserve of river Ruaka, there is need to develop a harmonized land use system that minimizes the negative impacts encroachments along the riparian reserves. However, the relationship between land uses and environmental management in the context of multiple uses and users with often encroaching objectives is not easily understood or resolved. For the case of a river Ruaka riparian reserve, there is a wide range of users of the river water and the riparian land alongside it. For example farmers in the upper catchments often over extract water from the river to irrigate their crops while the industrialists downstream often discharge effluent into the river. These agricultural activities, presence of residential uses, small scale enterprisers, small scale industrialists among others encroaches the riparian reserve of River Ruaka. The adjacent land users often use the water from the river and the riparian land in a way that degrades the river ecosystem. (Kiamba, 1986). The riparian reserves of river Ruaka no longer serve as effective buffer zones protecting the natural environment from human invasion. This is evident in the resultant encroachment and reduced riparian space along the river. Results of these encroachments are exposing the river banks and hilly areas of Ruaka River to soil erosion.

Encroaching activities especially in the most densely populated section along river Ruaka include car wash stations and informal commercial hubs (Kiithia 2012). As a consequence, increased river pollution and environmental degradation affect the sustainable use of this natural resource. River Ruaka is increasingly being polluted with garbage, industrial liquid effluence, agro-chemicals, and petro-chemicals among others. This situation has occasioned spread of water-borne diseases, loss of sustainable livelihoods, loss of biodiversity, reduced availability and access to safe potable water, and the insidious effects of toxic substances and heavy metal poisoning which affects human productivity (Kiambu development plan 2007-2012). A study conducted by Kithiia in (1992) revealed Malathion pesticide residues of 0.63mg l-1 River Ruaka waters. High pollution levels, cleared natural vegetation and several human activities encroaching on the riparian zone hinder the riparian reserves of River Ruaka from fulfilling its role as a buffer.
Several institution frameworks exist and are tasked with the protection and preservation of the riparian reserves including deterring encroachments. Institutions such as National Environment Management Authority (NEMA), Water Resources Management Authority (WRMA), Kiambu county government, Physical Planning Department, Department of Survey, Ministry of Agriculture and government line ministries are tasked with the cardinal duty of conserving the riparian zone. These multiple institutions however, often push for their specific interests and overlook integrated development of the riparian zone. (Kithiia, S.M & Khroda, G.O, 2011). Development control guidelines, definitions of riparian reserves and standards differ among existing legislations making a comprehensive protection of the river reserves inefficient. According to Kiambu County, department of lands, environment and natural recourses, inadequate enforcing staff and financial incapability of tasked offices has worsened the encroachment situations along the riparian reserves.

Management of riparian reserves has further been hindered by politicians who have managed to stir up revolts against the government so as to protect their own interests in the riparian reserve. Multiplicity of publics with different interests in the riparian zone has also caused scramble for temporary space, occupying fragile and suboptimal environments, leading to extreme environmental degradation and misuse of land resources. (Kiamba, 1986).

1.2 Research Purpose
The main purpose of the study therefore is Investigate land uses encroachment along the riparian reserve of river Ruaka.

1.3 Research Objectives
- To explore the human activities encroaching on the riparian reserves of Ruaka River.
- To investigate the reasons for this encroachments
- To assess the challenges of applying existing legal/ institution guidelines set for conservation of riparian reserves.
- To recommend for strategies to conserve the Ruaka river riparian reserve.
1.4 Justification of the Study

According to Kiambu County planning department, Ruaka Township has for the last five years experienced a boom in construction industry especially residential units. This trend is expected to continue and subsequent increase of population and human activities in the Ruaka area. Ruaka river terrain is gentle slopy and remains the only natural drains of the highly built up neighborhoods during rainy seasons. Encroached riparian reserves contribute to blocking of natural drains resulting to flash floods which adversely affect humans, settlements and property. Therefore it is certainly crucial for river Ruaka to be conserved to provide this crucial natural purpose.

According to Residents, Ruaka River has had a long cultural and social attachment with the Kikuyu community for ages. The entomology of Ruaka township is the river itself which literally means “Ruui Rwa aka” meaning the river of the women. During the traditional Kikuyu rituals, women undergoing initiation would bath in the river for cleansing and blessings on the morning before circumcision. Although the archaic practice is now illegal and uncommon among the residents, the river remains a historical and cultural monument to be preserved and protected. Natural river belts provide opportunity for recreation uses where people opt to spend their leisure time viewing the natural flow of water and enjoying natural ecosystem. If the riparian belts are conserved, the highly increasing population of Ruaka area can be accorded this opportunity since the Ruaka river reserves provides the most beautiful terrain for this purpose.

While the amount of water available in a drainage channel normally remains relatively static, the demand for water often rises with changing human activities. The latter include a wide spectrum from changes in the basic way of living to changes in the technology employed to exploit natural resources (Dunne & Leopold, 1978; Kithiia, 1992). River Ruaka water pollution levels are high and consequently low quality water supply as well major reduction in its quantity. Conservation of the river belts can lead to quality and quantity supply of water for use in Ruaka and communities downstream.

Therefore, it is most timely to examine land use encroachments along river Ruaka riparian reserve aiming to find a solution to the encroachment menace. The research findings will inform a multi-attribute evaluation models based on user-weighted criteria and user-rated strategies to
recommend best-compromise compactable land uses and further inform land use options for the management of the Ruaka river riparian reserve.

1.5 Basic Assumptions

The research will be carried out on the premise that there the riparian reserves of river Ruaka will continue to be encroached upon due to population increase. Further, the assumption that the un-coordination and ineffectiveness of institutional framework tasked with development control along river Ruaka reserve prevail.

1.6 Study Area

The Study will be carried on Ruaka River a tributary of Nairobi River, area herein referred to as the riparian reserve of Ruaka River within Kiambaa Sub County, Kiambu County,. The exact location is the section between Ruaka Bus Park and Gacharage shopping center. This is the increasingly densely populated location within Kiambaa Sub County. Gacharage area, the upper section of the study along River Ruaka is characterized by narrow, steep canyons. The bed of the river is covered with large boulders as the river passes through many rapids. As the River nears Ruaka Bus Park, the steepness of the river channel decreases. The width of Ruaka river is average 4 meters (ranging from about 3 to 8 meters). According to the physical planning hand book therefore, the riparian reserve of river Ruaka at the study area should be minimum 10m.

Map 1.1, Study location area. Source: Author 20
"In the course of history, there comes a time when humanity is called to shift to a new level of consciousness, to reach a higher moral ground, a time when we have to shed our fear and give hope to each other." - (Wangari Maathai’s Nobel Lecture, Oslo, December 2004.)

2.0 OVERVIEW

This chapter seeks to offer a comprehensive understanding of the subject matter of the research. It defines the various concepts of the study, digesting what has been done by other scholars in the same field of study and builds on the same while also identifying the theoretical and legislative framework that the research is anchored on. This therefore provides the broad context of the study and sets the existing scholarly and historical context of the research.

2.1 land use Planning

Land use planning is done to identify alternatives for land use and to select and adopt the best land use options. The main objective of land use planning is to allocate land uses to meet the economic and social needs of people while safeguarding future resources. Land use planning is
therefore a public policy exercise that designates and regulates the use of land in order to improve a community’s physical, economic, and social efficiency and well-being. By considering socioeconomic trends as well as physical and geographical features (such as topography and ecology), planning helps identify the preferred land uses that will support local development goals. The final outcome is allocation and zoning of land for specific uses, regulation of the intensity of use, and formulation of legal and administrative instruments that support the plan. A land use plan may be prepared for an urban area, a rural area, or a region encompassing both urban and rural areas.

2.2 The concept of Land use encroachment

Once upon a time, when humans existed by hunting and gathering and were themselves prey, there was a “natural” landscape. Since then the Earth’s surface, including the biota, topography, surface and groundwater, has been profoundly and irreversibly altered by the direct and indirect effects of human uses of the land (Sala et al.2000; Vitousek et al.1997; Wilson 1992). By some analyses, the transformation of the surface due to human activities approaches in magnitude the land cover transformations that have occurred during the transitions from glacial to interglacial climate (Meyer and Turner 1994; National Research Council 2001; Ramankutty and Foley 1999). A land-use encroachment therefore occurs when there are conflicting views on land-use policies, such as when an increasing population creates competitive demands for the use of the land, causing a negative impact on other land uses nearby.

Although we strive to avoid it, human beings and their activities are encroaching on conservation land uses moments after they open their eyes each morning. Human activities leading to encroachments occur automatically, sometimes subconsciously which comes into play as we go about life. Encroachment or competing for space with the right land use is a general term used but fairly vague in definition. However, Mary Louise Pratt in her work *Arts of the Contact Zone* expresses its use well, stating: “I use this term to refer to social spaces (also economic spaces as well) where cultures meet, clash, and grapple with each other, often in context of highly asymmetrical relations of power”. In brief, encroaching on space can be identified to be space where people or ideals collide resulting in the scramble for temporary available place for each player within the situation causing tension and friction among them. Encroaching on space can
vary from a very physical sense, to a completely mental state, affecting how we go about our daily operations. In this regard, land use encroachment is caused by competition of space and refers to the location on land where land uses compete for accommodation and struggle to gain control of the available space regarded has idle in and mostly in regard to economic benefits. Understanding the concept of land use encroachment needs a better understanding of the concepts of space conflicts and the realms under which they operate.

2.2.1 Theories of Land Use Conflict
Land use conflict theories are subset of conflict theories, a sociological perspective that focuses on structural antagonisms in society and their resolutions. Conflict theory is generally traced back to Marx, who first posited a sociological account of social conflict in his theses on class and capitalism. Conflict theory was subsequently taken up as an academic challenge to functionalist and positivist perspectives in the social sciences. Land conflict theory applies conflict theory premises to land disputes.

Land Conflict Theory
Land conflict theory addressed four dimensions of conflict: scarcity competition, structural inequality of access, war for land, and revolution precipitated by land conflicts. Scarcity competition happens when there is not enough land for everyone. Structural inequality is exemplified by the rich being able to buy land that the poor cannot afford. War for land might be for its arable qualities or its strategic value, and involves violent conflict between two nation-states. In Ruaka area the rich investors in real estate have owned a sizable portion of land in the area. Immigrants tenants definitely need support activities which are based on land. The poor in the pursuit of earning for living tend to provide the missing activities such as car wash services and as a result since they cannot afford appropriate land, they result in locating at the riparian reserve. Land conflict theory has shown revolution over land end up to civil conflict, even to the point of war, with the purpose of the revolutionaries being to seize state power as a precondition of land redistribution.
**Koler's Normative Quest**

A seminal work on land conflict as a subset of conflict theory is Avery Kolers' "Land Conflict, and Justice--A Political Theory of Territory" wherein Koler uses the Palestine-Israel conflict to study land conflict issues. His theory focuses on the attachment or particularity of a people with regard to their land claims, and on whether claims are based on status or achievement; and the theory seeks a normative understanding of territorial claims. In most cases, due to Africans attachment with land, land owners of land abutting the river profile claim ownership up to the river bed. (Witherick & Pinder, 1990).

**Akcali and the Core-Periphery Dynamic**

Emel Akçali, who grew up in the midst of the Turkish-Cypriot conflict, theorized about the association between ethnicity and territory during territorial conflicts. Her perspective is sometimes called world-system theory, and it focuses particularly on the role of globalization in present-day land conflicts. World-system theory begins as an inequality theory that divides the world into core areas of overdevelopment, parasitically surviving via exploitable "peripheries." The structural inequality in the core-periphery dynamic is seen as formative, if not generative, of local land conflicts. The Ruaka area, due to its proximity to Nairobi is viewed as the core areas of overdevelopment causing competition for space resulting to occupation of every available “free space” aggravating the issue of riparian reserves encroachments.

**2.3 Factors that Influence land use conflicts**

**2.3.1 Public interest**

In the recent past, it has been difficult to identify common traits in a singular civic sense. Social forces such as globalization, polarization, and fragmentation, have made any singular identity more of an inspiration than a reality. In reality, there are multiple publics, conflicting and divergent (Healey1993), competing for scarce resources left to their own devices to create their place. These publics, or discourse communities, have their own goals, ways of understanding, and means of furthering their aims (Healy 1993, Swales1990). The need for planners to define a singular public interest can reinforce and ease conflict between the interests of various publics or discourse communities.
2.3.2 Public space
Not only are people becoming more private, but also there is a general consensus that public space especially the perceived free land is increasingly privatized and exclusionary in regulatory and physical terms (Mitchell 2003; Soja 1996; Davis 1990). This is partly a response to increased concern for order and security in the public realm. Following severe disinvestment in cities, especially central cities, the urban and peri-urban environments worldwide have witnessed and continue to be impacted by physical, economic and social deterioration. Private property owners have abandoned buildings leaving them to deteriorate.

It is a natural reaction for spatial planner to exhibit concern for these marginalized and deteriorated areas and the condition of the public space. There have been a myriad of responses and trends to combat the condition of the public spaces that inform our perception of communities.

2.4 Understanding Riparian Reserves
The term riparian is frequently used to mean the interface between land and a flowing surface water body. Older and more classical riparian interpretations identify primarily woody vegetation associated only with lotic (surface of flowing water) systems. More recent interpretations include a broader view involving both lotic and lentic (sub-surface of flowing water) systems, lentic systems, surface and sub-surface water influences as well as human–induced activities that affect the woody and emergent vegetation (Karisa 2010).

Riparian areas are the transition zones between land and water environments. They are the narrow strips of land located along streams, lakes, potholes, springs, coulees, wooded draws, or anywhere water is plentiful.

The abundance of water and plant communities which are different from the drier uplands sets riparian areas apart from their surroundings. Riparian areas are productive and a valuable resource providing numerous social, economic and environmental benefits.

2.4.1 Historical uses of riparian reserves.
Riparian areas have long held importance on the ancient men landscape. For thousands of years, aboriginal communities depended on riparian reserves for water, wood, shelter, food and
medicinal plants. Traditional Africa setting had life revolving along the river line for agricultural activities and other livelihoods. Ancient Egypt, for example, civilization thrived along the Nile River in northeastern Africa for more than 3,000 years, from about 3300 BC to 30 BC. It was the longest-lived civilization of the ancient world. Geographically, the term ancient Egypt indicates the territory where the ancient Egyptians lived in the valley and delta of the Nile. Culturally, it refers to the ways ancient Egyptians spoke, worshiped, understood the nature of the physical world, organized their government, made their livings, entertained themselves, and related to others who were not Egyptian. (Microsoft ® Encarta ® 2009.)

Early European settlers located along the shores of lakes and streams for the same reasons. Waterways were also important as transportation and trade routes. It was not until the coming of the railroads that the focus of development shifted away from the waterways.

2.4.2 Riparian encroachment
Encroachment refers to as the gradual or stealthy intrusion and often taking away somebody’s or something’s authority or rights. Simply put, it’s the act of exceeding accommodation limits (Encarta Dictionary). Riparian encroachment therefore can be described as continuous intrusion and contestation for space along the river ecosystem by land use activities such as logging, grazing, agriculture, road-building, and urbanization consequently leading to its degradation. For a long time this has occurred in many areas all over the world because riparian ecosystems are often productive areas of a landscape and are relatively accessible. During settlement, rivers and higher-order streams served as preferred travel routes through wilderness and mountainous terrain, and thus these riparian features are frequently developed with roads or railways (GOMI et al. 2002). Numerous economic opportunities have made riparian areas preferred real estate, which, has frequently resulted in a loss of riparian habitat and impaired ecological functions.

2.4.3 The Role of Riparian Zones
Naturally, an intact riparian reserve serves numerous functions that maintain the integrity of the river ecosystem and that of the surrounding. The riparian zone presents numerous significant ecological, social and economic functions (Hawe 2005). Riparian reserves value is priceless. Benefits includes and not limited to increase of property values, reduce property loss from
excessive erosion and flooding, protect water quality, enhance wildlife habitat, contribute to the natural beauty of the land, dissipate noise from the reservoir traffic and nearby properties, provide privacy, screen unsightly views and enhance scenic view.

Streams and riparian areas provide water, livestock forage, fish and wildlife habitat and recreational opportunities. A “healthy” riparian area is one that is able to perform certain basic functions. These functions include primary vegetative production, protecting stream banks from erosion, trapping stream-born sediments which build up stream banks, promoting water absorption and storage, recharging groundwater reserves and regulating stream flow.

**Stream bank protection and development**

Riparian vegetation protects shorelines and river banks from damaging erosion caused by water as it moves downstream, especially during heavy flows associated with spring runoff or downpours. Friction between the plants and water slows the stream flow, reducing the water’s potential to erode and carry sediments. A deep, binding root mass holds soil in place, stabilizing stream banks (Stream bank Stewardship, 2013).

In a healthy riparian system, floodwaters come out of the banks and spread out over a broad flood plain, also reducing the energy of the water. As stream flow slows, suspended sediments in the water are deposited on the stream banks and floodplains. This aids in building up banks and ultimately creating narrow, deep, stream channels and fertile floodplains. (Beschta et al., 1987).
Ground water recharge and stream flow regulation

As spring run-off moves through a well-vegetated, meandering (winding) stream, the speed at which water flows is reduced. The slower stream flow allows increased absorption of water into the soil, replenishing groundwater reserves and lowering the intensity of flooding in downstream areas (Beschta et al., 1987). Silty textured soils act as a sponge to aid in groundwater recharge and underground storage. Later in the year, water is released into the streams from seeps and springs, maintaining stream flow throughout the season (Stream bank Stewardship, 2013).
Fig 2.3, Riparian reserve intact resulting to enhanced ground water recharge: Source Author 2014

Fig 2.4, Riparian reserve encroached resulting to ineffective ground water recharge: Source Author 2014
**Sediment trapping and filtration**

Riparian areas play an important role in keeping water clean. Water from adjacent fields can carry pesticide residues and fertilizers which adhere to soil particles or are dissolved in the water itself. Above ground vegetation acts as a filter to intercept sediments and pollutants found in run off. The root systems intercept the underground translocation of pesticide and fertilizer residues from cultivated uplands. When riparian vegetation is destroyed, these substances are able to reach streams and wetlands. Erosion of stream banks and shorelines after vegetation has been reduced or removed also contributes to sediment levels in water. (Beschta et al., 1987).

Sediments in streambeds and lakes reduce the quality of habitat for fish and other aquatic organisms. Plants in riparian areas use nutrients contained in run-off for growth. Using some of the nutrients slows their build up in water and reduces the occurrence of dense algae blooms. Some types of algae, such as blue-green algae, are toxic, and their presence in high concentration in the water can kill livestock and pets (Stream bank Stewardship, 2013). Algae blooms can deplete dissolved oxygen in the water after they die and decay, sometimes leading to extensive losses of fish during the winter when ice covers lakes and streams. Stream bank vegetation provides shade which keeps water cooler in summer. Cooler water contains more oxygen, necessary for aquatic life.

*Fig2.5a depicting intact riparian trapping sediments. Fig2.5b depicting encroached riparian unable to trap sediments*
**Hydrology function**

Although land use in the entire watershed has been shown to alter the hydrology, the condition of the riparian buffer, because of its direct linkage to the stream, is particularly important to hydrology. A study by Barton et al., 1985 showed that the riparian reserves, if extensive, could prevent unnaturally large fluctuations in discharge. Vegetation growth in the buffer reduces the amount of water that reach the channel, both by the interception and evaportranspiration of precipitation and by the uptake of water by roots. It also allows storm water to be released slowly, over a period of days or months, to the stream after a storm event (Booth, 1991).

**Water quality enhancement**

Preserved riparian reserve naturally moderates three particularly important components of water quality: temperature, nutrients, and sediment loads. The vegetation in the riparian buffer shades the stream and moderates extreme temperatures (Booth, 1991). A riparian reserve also traps back-radiation in the winter resulting in increased winter temperatures. The vegetation also decreases evaporation and convection in the near stream area. As a result, the riparian vegetation creates a microclimate which moderates the adjacent environment and which reduces the daily and seasonal fluctuations in stream temperature (Beschta et al., 1987).

**Aesthetic values**

The preservation of natural river reserves is integral to historic preservation and its goal is retention of the historic balance that made urbanization possible. (Karisa 2010). Thus the “natural past” is as much crucial as is the” built past”.

A research done along the Tennessee river bank revealed that native vegetation that occurring along waterfronts provided an attractive landscape with many aesthetic appealing sights. Waterfront property owners with well-vegetated riparian zones enjoy some of the most biologically diverse and scenic communities in the Tennessee Valley and these land attracted higher economic values than those not adjacent to the river reserve.
**Conservation of flora and fauna**

Native plants have evolved under local conditions. They are tolerant of drought and extreme temperatures, and they are naturally resistant to pests and diseases. After they become established, native plants usually require much less physical effort to maintain than lawns. They can reduce or eliminate the need for lawn mowers, trimmers, and other gasoline-powered equipment. Native plants are also less costly to maintain because they generally don’t need the fertilizers and pesticides that turf grass and other non-native species may require. Waterfront vegetation enhances habitat for wildlife and increases opportunities for wildlife viewing. Native plants along waterways provide food and shelter for a variety of insects, amphibians, reptiles, songbirds, mammals and fish. (Booth, 1991).

Vegetation is responsible for performing the majority of the functions carried out in riparian areas. Without vegetation, streams are little more than drainage ditches. (Booth, 1991). Managing riparian areas involves maintaining and improving desirable riparian vegetation. Booth describes riparian areas as transition zones between uplands and wetlands. These areas beside the presence of water, have more moisture available than areas farther away. This often produces zones or belts of vegetation types that parallel the water. At the water’s edge, deep-rooted sedges and rushes stabilize the stream bank. Slightly back, shrubs and moisture loving grasses and forbs (broad-leaved plants) are found. In many regions, willows are probably the most common and important of the woody plant species, offering stream banks substantial resistance to erosion with their extensive roots while also building banks up by trapping sediment. On the upper, drier portions of riparian areas, vegetation may be a mix of riparian and upland species.

**Agriculture and riparian areas**

According to North Saskatchewan River management Board, healthy riparian zones provide many benefits to agriculture and agricultural production can be compatible with the conservation of riparian areas. Riparian areas are often critical to forage production and water supply in pastures. Properly managed riparian areas provide valuable livestock grazing and are an asset to any livestock operation. Controlled, managed livestock grazing can maintain and improve forage yields and conserve riparian areas. Many floodplains are highly fertile and have therefore been
cultivated. In regions where most of the land is cultivated, the valleys along wetlands and streams that cannot be cultivated have often been viewed as wasteland. (Booth, 1991).

Sometimes they are fenced and grazed or simply used as dumping grounds for stones, old machinery and wastes. In any case, their value is often overlooked and little effort is expended in managing them. Even if vegetation is not destroyed, cropping practices in adjacent areas can have serious effects on riparian areas and streams (Stream bank Stewardship, 2013).

2.5 The Riparian Reserve as a land use

The physical planning handbook classifies riparian reserves under conservation land use. The numerical code assigned to conservation land use is “8” and the planning color code “green”. Riparian buffers in spatial planning terms are anticipated to serve as screens along waterways, protecting the privacy of riverfront landowners and blocking views of any unsightly development. Hiking and camping opportunities are also facilitated by forested buffers, which if large enough, allow outdoor enthusiasts to enjoy the proximity of the water complementing conservation land use with recreation land use. The diversity of plant species provides visual interest and increases aesthetic appeal (Hawe, 2005). The benefits provided by riparian buffers are disturbed or lost when spatial planning does not provide for its protection and development.

In relation to environmental sustainability, urban and regional planning exists to pursue and facilitate development while striving as well to preserve and enhance market value of existing property investments (Forman, 2008). Planners have other concerns as well in relation to the environment such as, improved public health, social equity and an attractive public realm. Planners therefore do have an extended mandate over the environment (including riparian reserves) in a bid to achieve sustainable development.

The fundamental tool available to urban planning for the management of riparian buffers is zoning ordinance and development control. (Makathimo et al, 2010) These tools should set a system that allows for the protection of river resources while regulating development in the surrounding riparian areas. For effective management of riparian zones, planning should be able to provide for the following: define riparian zones and their roles within the county government and national government context area; identify and assess key values, existing uses, facilities,
improvements over time and their condition; identify and assess key issues affecting the riparian zones; addressing future allowable uses and developments; and establish appropriate management strategies based on a balanced, sustainable approach to conservation, rehabilitation and the recreational needs of the community.

2.5.1 Riparian width
According to Australian Land Planning and Environment Act, of 1991, it is recommended wherever possible, to preserve and enhance existing native riparian vegetation to provide a minimum width upslope (away from) from the top of the bank of 5 meters, plus the height of the bank, plus an additional width if the bank is actively eroding.
The erosion allowance is calculated as the rate of bank erosion in meters per year, multiplied by the number of years it will take for replanted vegetation to reach maturity or a height of 10 meters (use the lesser period). For example, if the bank height from low flow water level to the top of the channel (use the one in two year peak flow channel) is 4 meters, the bank is actively eroding at 0.2 meters/year, and replanted trees will take 20 years to reach 10 meters in height, the width of native riparian vegetation required for bank stabilization is:

<table>
<thead>
<tr>
<th>Minimum width</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank height</td>
<td>+ 4</td>
</tr>
<tr>
<td>Erosion rate</td>
<td></td>
</tr>
<tr>
<td>0.2 m x 20 years</td>
<td>+ 4</td>
</tr>
<tr>
<td>Total width</td>
<td>= 13 metres (min)</td>
</tr>
</tbody>
</table>

*Chart 2.1 riparian width calculations. Source Australian Land Planning and Environment Act, of 1991*

On larger streams, account should also be taken of the natural process of channel migration. The rule of thumb for channel migration is 1% of the channel width per year. Therefore, half a channel width is the suggested minimum distance on each side of a river for vegetation whose primary purpose is for erosion control (Rutherford pers. comm.)
According to USDA Forest Service, riparian Reserves consist of the stream and the area on either side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of two site-potential trees, or minimum of approximately 81 m slope distance on each side of the stream, whichever is greatest.

According to the Kenya physical planning hand book (2007), a riparian reserve is defined as land on each side of water course. It provides a width of minimum 2 meters, or equal to the full width of the river as measured between the banks of the river course up to a maximum of 30m. (Seasonal and perennial rivers).

2.5.2 Factors that determine the width of Riparian Reserves

**Type of vegetation cover**
Dense, rough, ground vegetation may slow the run-off more. The more spread out the flow, and the slower it moves, the quicker suspended particles are likely to drop out and become trapped. Native species are generally recommended, but if the native riparian vegetation has little ground cover and concentrates flow into a few pathways, then a grass filter strip next to it (upslope) is required.

**Physical form of the land and timing and intensity of run-off**
Gullies can concentrate run-off and sub-surface flow into narrow areas at the base of a hill slope, the size and shape of this area will influence the ability of vegetation to filter sediment. Vegetated slopes adjacent to waterways will increase the effectiveness of the riparian filter strip by slowing the flow of run-off before it enters the riparian zone. Where confined run-off results from an adjacent road, stockyards, or stock tracks, minor works may be required to spread the flow and its potential contaminant load either across a sufficiently-wide grass filter strip, or for it to be channeled elsewhere to prevent movement directly into the stream (Stream bank Stewardship, 2013).

Grass filter strips should be installed at the base of the upslope paddock, so that they are between the paddock and the high bank of the stream. Environmentalist recommend that modern practices
of soil conservation and minimum tillage be used on sloping land, with the use of within paddock contour banks and filter strips where required (Stream bank Stewardship, 2013).

**Amount and type of pollutant**

It is easier to trap pollutants attached to soil particles, so it is important to use farm management practices to reduce losses of nutrients and other pollutants in soluble form.

By combining a minimum 10 meters wide riparian vegetation buffer strip with a 5–10 meters grass filter strip, maximum trapping of sediment, nutrient and other contaminants can be achieved. Maintaining native riparian vegetation buffers also have the environmental benefits of providing shade, inputs to in-stream food webs and terrestrial habitat. This combination can achieve many riparian management objectives.

**2.6 Policy & Legal Framework**

**2.6.1 The Constitution of Kenya, 2010**

The Constitution is the supreme law of the Republic of Kenya and has given much attention to the issue of land and environment. According to Article 42, 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 and also to have obligations relating to the environment fulfilled. The Constitution under Article 61 (1) informs us that the State may regulate the use of any land for various interests among them land use planning. This gives power to the State to intervene, for example in the case of space contestation in the riparian zone, through land use planning for public safety, public order and public health among other reasons.

Moreover, the State is mandated to uphold certain obligation in respect to the environment including, but not limited to, the following;

a. Ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits

b. Encourage public participation in the management, protection and conservation of the environment
c. Eliminate processes and activities that are likely to endanger the environment
d. Utilize the environment and natural resources for the benefit of the people of Kenya

Constitution of Kenya 2010 is a crucial tool in the planning and management of the riparian zone since it also gives power to the other relevant legislation enacted for the management and conservation of the riparian reserves.


According to the Physical Planning Handbook, 2008 Edition, a riparian reserve is defined as a combination of spaces and land which is reserved as public park and recreation where activities can be organized either in the river corridor or riparian reserves. The Legal Notice 140 rule 15 (c) and (d) of the Physical Planning Act further define the riparian reserve as land on each side of water course as defined having a minimum of 2 meters, or equal to the full width of the river as measured between the banks of the river course up to maximum of 30 meters (seasonal and perennial rivers). Planning guidelines of riparian reserves are similar to those applicable to public open spaces.

Implementation policies

i. Every development must provide 3%-5% of the area for water retention reservoir
ii. Strategic River Development plan
iii. River Planning and approach must be based on ecological planning (emphasize preservation, conservation and variation)
iv. River development to be guided by river frontage development

General guidelines

i. To plan various uses of rivers to promote tourism, communication, transportation and social facilities (recreation)
ii. To plan and design the landscape, to minimize soil erosion within riverine and the built up areas
iii. To maximize natural resource and conserve the environment in designing the park
iv. To preserve the ecological values of rivers and the surrounding
v. To minimize the natural environmental threat
vi. To control sewage form of waste disposal
vii. To provide access and service to the river reserves

2.6.3 The Survey Act, Cap. 299
The Act under section 111 sets the reservation on all tidal rivers to be not less than 30metres in Width above high-water mark for Government purposes except for special conditions where the Minister allows for less.

2.6.4 The Land Act, 2012
The Land Act No. 6 of 2012 was enacted to give effect to Article 68 of the Constitution to revise, consolidate and rationalize land laws; to provide for the sustainable administration and management of land and land based resources, and for connected purposes. Several land laws have been repealed by The Land Act among them being; The Way leaves Act, Cap. 292 and the Land Acquisition Act, Cap. 295. The Act defines the riparian reserve to mean the land adjacent to the ocean, lake, sea, rivers, dams and water courses as provided for under the Survey Act or any other written law. This legislation informs on how land management and administration is to be carried out and the institution having this mandate.

2.6.5 The Environmental Management and Coordination Act (EMCA), 1999
The Act is responsible for the establishment of NEMA. The Act seeks to conserve and protect the environment and provides for the institutional framework in the management of the same. EMCA has the provision for environmental planning where a National Environment Action Plan Committee is set up to oversee the process. The action plan seeks to set out operational guidelines for the planning and management of the environment and natural resources for national development among other aims.
In regard to this research, EMCA protects the rivers, lakes and wetlands by barring certain activities which include, to;

i. Erect, reconstruct, place, alter, extend, remove or demolish any structure or part of any structure in, or under a river, lake or wetland

ii. Deposit any substance in a lake, river or wetland or in, on or under its bed, if that substance would or is likely to have adverse environmental effects on the river, lake or
wetland

2.6.6 National Environment Policy, 2012
Environment Policy aims to provide a holistic framework to guide the management of the environment and natural resources in Kenya.

The policies set by the Government concerning the freshwater and wetland ecosystem include, but not limited to the following:

i. Develop and implement integrated wetland and water resources management strategies and action plans.

ii. Promote sustainable use of freshwater and wetland resources and the conservation of vulnerable river and lake ecosystems through development and implementation of river basin management plans.

iii. Develop and implement a national wetland policy and regulations.

iv. Map wetland areas countrywide.

v. Develop and implement catchment-based wetland management plans for all Ramsar convention sites through a participatory process.

vi. Ensure rehabilitation and restoration of degraded wetlands, riverbanks and lakeshores and, where appropriate, promote and support establishment of constructed wetlands.

vii. Harmonize and coordinate the roles of various regulatory agencies charged with the management of freshwater and wetland ecosystems.

The policy is keen on environmental stewardship which attaches the responsibility for environmental quality to all stakeholders whose actions affect the environment. These activities include, but not withstanding trade, consumption and production patterns, industrial and infrastructural development, human settlements and disaster management among others.

On consumption and production patterns, the Policy directs that the Government will:

i. Provide economic incentives for investment in more efficient, clean and environment friendly production technologies.

ii. Promote sound environmental management tools.

iii. Promote corporate and social responsibility and accountability.

iv. Promote public procurement policies that encourage development and diffusion of environmentally sound goods and services.
v. Promote, strengthen and support consumer organization

On regard to sustainable human settlements, the Government will;

i. Integrate demographic issues into environmental management and natural resources conservation

ii. Develop and implement an Integrated Housing Policy and Housing Master Plan that takes into account environmental considerations.

iii. Develop and enforce integrated land use planning at all levels.

iv. Develop and promote a policy on eco-settlement centres.

v. Mainstream environmental considerations in the refugee policy and legislation.

In addition, the policy addresses the issue of land and environment and also on environmental health; air quality, waste management, toxic and hazardous substances and noise. This research will aim to establish the manifestation and application of this government policy at the study area.

2.6.7 Kenya Vision 2030

Kenya Vision 2030 is the new long-term development blueprint for the Kenya where the Kenyan society envisions “a globally competitive and prosperous country with a high quality of life by 2030”. It aims to transform Kenya into “a newly-industrializing, middle-income country providing a high quality of life by 2030.” However, the major developments anticipated by Vision 2030 will heavily rely on natural resources and affect the environment too. Urbanization also will occur at a rapid rate; by 2030, it is estimated that more than 60% of Kenyans will be living in cities and towns. These changes are likely to impact adversely on the environment, which will require effective management to ensure sustainability. All these changes will exert immense intense pressure on the already declining natural resource base and on the country’s fragile environment. This has necessitated the need for strong policy on environment. The vision for the environmental sector is “a nation living in a clean, secure and sustainable environment.” Through Vision 2030 the country will build institutional capacity in environmental planning, and improve the impact of environmental governance to improve the overall management of the environment. Some of the strategies under the Environmental planning and governance sector
include:

i. Upgrade capacity for enhanced geo-information coverage and application
ii. Harmonize environmental related laws
iii. Strengthen institutional capacities
iv. Use of incentives for environmental compliance
v. Strengthen negotiation skills on MEA’s (Multilateral Environmental Agreements) and enhance coordination of their implementation

This development plan will ensure that all environmental regulations and standards are enforced and that major projects of land cover and land use mapping are undertaken to conserve and protect forests, water catchment areas, wildlife ecosystems and fragile areas like the riparian zones.

2.7 Institutional Framework

2.7.1 United Nations Environmental Programme (UNEP)
UNEP is a UN organization composed of member states and is a secretariat charged with the responsibility of carrying out the member states’ decisions established in 1972, UNEP’s mission is: “To provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.” UNEP’s mandate was expanded and rearticulated by the Nairobi Declaration adopted in 1997 “to be the leading global environmental authority that sets the global environmental agenda, that promotes the coherent implementation of the environmental dimensions of sustainable development within the United Nations system and that serves as an authoritative advocate for the global environment”. With the headquarters based in Nairobi, UNEP has a fundamental role to play in its immediate environment. The UNEP alongside its sister agencies, that of UNDP and UN-Habitat have sponsored and undertaken programmes and projects on Kenyan rivers restoration and rehabilitation in the past years. Some of the roles UNEP plays are as follows:

i. Promoting international cooperation in the field of the environment and recommending appropriate policies.
ii. Monitoring the status of the global environment and gathering and disseminating environmental information.

iii. Catalyzing environmental awareness and action to address major environmental threats among governments, the private sector and civil society.

iv. Facilitating the coordination of UN activities on matters concerned with the environment, and ensuring, through cooperation, liaison and participation, that their activities take environmental considerations into account.

v. Developing regional programmes for environmental sustainability.

vi. Helping, upon request, environment ministries and other environmental authorities, in particular in developing countries and countries with economies in transition, to formulate and implement environmental policies.

vii. Providing country-level environmental capacity building and technology support.

viii. Helping to develop international environmental law, and providing expert advice on the development and use of environmental concepts and instruments.

2.7.2 Ministry of Environment, Water and Natural Resources
This is the ministry in Government, whose mandate is to monitor, protect, conserve and manage the environment and natural resources through sustainable exploitation for socio-economic development aimed at eradication of poverty, improving living standards and ensuring that a clean environment is sustained now and in the future. The core functions of the ministry are as follows:

i. Environment and natural resources policy formulation, analysis and review

ii. Sustainable management of mineral resources and conservation of environment

iii. Continuous development of geo-database for integrated natural resources and environmental management system

iv. Conduct applied research and dissemination of research findings in land resources and geology

v. Carry out geological surveys, mineral exploration and regulation of mining and use of commercial explosives

vi. Promote, monitor and coordinate environmental activities and enforce compliance of environmental regulations and guidelines
vii. Meteorological services

2.7.3 Integrated National Land Use Guidelines
This policy done by the National Environment Management Authority identifies gaps, overlaps, sectoral conflicts and examines existing land use patterns and trends and further strive to materialize harmony and build synergies to ensure sustainable land use and natural resource management in Kenya. The Guidelines should be a tool to avoid conflicts and other environmental degradation problems. According to the policy document, the key land use challenges and threats include, but not limited to, the following: incompatibility and land use conflict; urbanization; poor land use planning; water pollution; encroachment; inadequate planning for the informal sector; conflicting sectoral land use statutes; inadequate capacity for planning and management of natural resources.

The land use guidelines on the protection of groundwater, rivers, lakes and wetlands are intended to do, but not limited to, the following;

i. Provide buffer zones of between 2m-30m width measured from the highest water mark for rivers/streams depending on the width, water volume, whether permanent or seasonal and the use of that water. Where the highest water mark cannot be determined consider the width of the river on either side to arrive at an appropriate buffer.

ii. Establish Water Resource Users Associations (WRUAs) and develop water allocation plans to minimize water use conflicts.

iii. Riparian areas should be identified by the WRUAs

iv. Management of the riparian areas should be considered once they are identified-specify activities that can be allowed in such areas such as bee keeping and indigenous vegetation through WRUAs and District Environmental Committees (DECs) who can come up with by-laws

v. All activities within the riparian area must be reviewed and approved by the DECs

vi. Water Resources Management Authority (WRMA) to coordinate the development, adapting, and implementation of management plans that shall rationalize the use of resources and mitigate on the negative impacts on rivers and lakes

vii. Profile and report on human activities around such lakes, rivers and wetlands, clearly indicating the impact of such activities
Encourage inter-agency coordination and public-private partnership in planning and management efforts of these resources

2.7.4 National Environment Management Authority (NEMA)
The National Environment Management Authority (NEMA) is established under the environmental Management and Coordination Act (EMCA) No. 8 of 1999, as the principal instrument of government in the implementation of all policies relating to the environment. The mandate of this government agency is to exercise general supervision and co-ordination over all matters relating to the environment. The core functions of NEMA relevant to this study include, but not limited to, the following:

i. Promote the integration of environmental considerations into development policies, plans, programmes and projects, with a view to ensuring the proper management and rational utilization of environmental resources, on sustainable yield basis, for the improvement of the quality of human life in Kenya.

ii. To establish and review land use guidelines.

iii. Examine land use patterns to determine their impact on the quality and quantity of natural resources.

iv. Carry out surveys, which will assist in the proper management and conservation of the environment.

v. Undertake and coordinate research, investigation and surveys, collect, collate and disseminate information on the findings of such research, investigations or surveys.

vi. Publish and disseminate manual codes or guidelines relating to environmental management and prevention or abatement of environmental degradation.

Currently the Kiambu County NEMA office is undertaking the stock of all development that may have adverse effect on the environment and instructing mitigation measures through environmental impact assessment studies.

2.7.5 Water Resources Management Authority (WRMA)
The Water Resources Management Authority (WRMA) is a state corporation under the Ministry of Water and Irrigation established under the Water Act 2002 and charged with being the lead agency in water resources management. The Water Act 2002 stipulates the duties of WRMA to
include: water apportionment and allocation; catchment protection and conservation; water resource assessments and conservation; delineation of catchment areas; gazetting water protected areas; protection of wetlands; gazetting water schemes to be state and community owned; establishing Catchment Management Strategies; and collecting water use and effluent discharges.

In order for WRMA to undertake its stipulated responsibilities, the Act provides for decentralized and stakeholder involvement. This is implemented through regional offices of the Authority based on drainage basins (catchment areas) assisted by Catchment Area Advisory Committees (CAACs). At the grassroots level, stakeholder engagement is done through Water Resource User Associations (WRUAs).

2.7.6 County Government of Kiambu.
The mandate of the county government would be to provide and manage basic social and physical infrastructure services to the residents of Kiambu County. These services include basic education, housing, health, water and sewerage, refuse and garbage collection, planning and development control, urban public transport and fire services among others. The county government has formed a fully fledged executive department of environment and natural resources and is the arm of the county government which houses the section on Environmental Planning and Management whose mandate is to: yearly plan, formulate, co-ordinate and implement environment programmes/projects for improved county environment and; implement, monitor/evaluate projects/programmes for efficient and effective solid waste management services together with other relevant stakeholders through issuance of yearly authority letters.

2.8 Relevant studies done in the study area

2.8.1 Changing land use and the environment studies done in Ruaka
According to international journal of scientific & technology research volume 2, issue 7, July 2013 which studied the impacts of urbanization on land use planning, livelihood and environment in the Nairobi rural-urban fringe, a lot was revealed in regard to water recourses and riparian buffer of river Ruaka. In particular the study found that generated solid wastes are
disposed of on open-air sites with little or no provision for protecting surrounding soil and water from contamination. The study found there were no sewerage systems and elaborate piped water systems. Few years ago the area had few residents and the pit latrines and shallow drinking wells were prevalent. With the area becoming more urbanized several challenges are becoming manifest. As one of the informants put it –“what do you make of this? Pit latrines with shallow wells near them!”... “That’s why we are always sick!” (Interviewee 8). This is the common perception most people now have pertaining to the conditions in their residence and the safety of their domestic water sources. The problem is becoming worse with the pollution of the surface water from surface run-offs carrying sewage matter, garbage and sediment from homes and construction sites, and waste water from agro-processing industries which are being continuously emptied into the river channels. This is the concern that even the health department has identified as needing an urgent priority by indicating that, —“lack of sewerage system is a major health risk”... “as for the other wastes disposal let me not comment about it. It is everywhere!”(Interviewee 5). The seepage of waste into the aquifer and also the diversion of household liquid wastes by impermeable (because urbanization produces extended impermeable surfaces of bitumen, tarmac, tiles, and concrete, there is tendency for flood run-off to increase (Goudie, 2006) surfaces and drainage into water sources are likely to be disastrous to the residents as the area continues to densify without adequate waste management systems. This study further identified other threats to the water sources in the area included siltation, reclamation of wetlands for vegetable farming, use of fertilisers and pesticides and other chemicals which are washed into the rivers as run-offs. Pollution from municipal and agro-processing industries has also continued to undermine water supply sources. The depletion of vegetation cover during land conversions has left some of the areas their top-soils bare hence eroded during rainy seasons. This not only led to loss of aesthetic impression of the physical environment, but also contributes to the siltation of and ultimate blockage of drains, hence contributing to flooding.

2.8.2 Water Quality Degradation Trends in Kenya over the Last Decade
This study by Kithiia, 1992 reveals the quality of water in River Ruaka. The application of chemicals through agricultural production in the Nairobi river sub-basins was the main subject of the study. The substances investigated were pesticides, which are applied to control crop pests
and diseases. Pesticides are considered to be very toxic in water, even in small concentrations, and they render the water harmful for human consumption. The pesticides used in the study area included "Dithane M45", "Ambush", "Malathion", "Ridomil", copper sulphate and DDT, and both soil and water samples were tested for these substances. DDT and "Malathion" were detected in soil samples from the upstream reaches of the Gitathuru and Kamiti Rivers. These and other pesticide residues were also detected in the lower reaches of river Ruaka, Riara, and Gatara Rivers and the main Nairobi River.

<table>
<thead>
<tr>
<th>Sampling site</th>
<th>Pesticide</th>
<th>Residue (mg l⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gatara River</td>
<td>DDT</td>
<td>0.086</td>
</tr>
<tr>
<td>Gitathuru River</td>
<td>&quot;Ambush&quot;</td>
<td>0.0948</td>
</tr>
<tr>
<td>Gitathuru River</td>
<td>&quot;Malathion&quot;</td>
<td>0.14</td>
</tr>
<tr>
<td>Ruaka River</td>
<td>&quot;Ambush&quot;</td>
<td>0.255</td>
</tr>
<tr>
<td>Ruaka River</td>
<td>&quot;Malathion&quot;</td>
<td>0.63</td>
</tr>
<tr>
<td>Riara River</td>
<td>&quot;Ambush&quot;</td>
<td>0.074</td>
</tr>
</tbody>
</table>

Table 2.1, Pesticide residues in water. Source Kithiia 1992

2.9 Conceptual framework
Sustainable development requires the negotiation of a balance among the three distinct, everyday development processes: economic development, community development, and ecological development. The importance of maintaining a balance among these three processes is evident in cities, towns and regions throughout the world. For example, if a local water supply is not affordable (economic development), clean and hydrologically sustainable (ecological development), and available to all inhabitants (community development), then the livability and viability of that community will eventually decline (Physical planning hand book 2009).

Balancing the diverse interests of business, the environment, and community development requires partnerships. This is especially true in today's environment of rapid urbanization and globalization. The pressures facing local communities today make it increasingly difficult for any one institution to single-handedly develop, supply, and maintain an essential service. Traditional service roles (of government, the private sector, community organizations, trade unions, religious organizations, neighbors, and families) are rapidly changing due to fiscal
constraints, constitutional and legal reforms, resource scarcity and ecological concerns, globalization of economies and market liberalization, changing values and social norms, and demographic pressures (Physical planning hand book 2009).

Each of these processes has its own distinct imperatives. The development imperatives of the current economic system favor market expansion, externalization of costs, and sustained private profit. The current imperatives of community development are to meet basic human needs, increase economic and social equity, and create community self-reliance. The imperatives of ecological development are established in the natural order. Humans can support ecological
development by limiting the consumption of natural resources to a rate that allows nature to regenerate resources and by reducing the production of wastes to levels that can be absorbed by natural processes.
Economy without ecology means managing the human nature relationship without knowing the delicate balance between humankind and the natural world – (Satish Kumar, ecological campaigner 2008)

3.0 Overview
This chapter presents the methodology employed in the research project. It intends to give details about the respondents, sampling procedures, methods of data collection for the study area and analysis, as well as methods of presentation. Also, this chapter informs on the various types of data needs and their sources as summarized in the data needs matrix. The focus of the methodology is on the riparian belt of river Ruaka a section between Ruaka bust stage and Gacharage shopping center junction, its natural state, the users and all relevant stakeholders.

3.1 Research Design
This study applied a flexible research design where a combination of design types and sub-types were used. This approach was basically to cater for the collection of both the quantitative and qualitative data. The case study system was further employed supported by literature review and field survey in interrogating the subject land use conflict along river Ruaka.
The research design is summarized in the figure below.

**Chart 3.1. Research design. Source Author 2014**
3.2 Scope of the Study
This research study examined land use, spatial planning and management challenges in the riparian belt of River Ruaka to establish the causes and effects of encroachment. The exact location is the stretch between Ruaka bus stage and Gacharage junction, a stretch running parallel to Limuru road measuring 1.1 km.

3.3 Types and Sources of Data

3.3.1 Primary Data Sources
First-hand information was collected from the field using structured questionnaires which were administered to selected land users (owners/tenants) along the riparian belt Ruaka river. These respondents were expected to provide information on; land use activity, location of their land use activities, and knowledge on the extent of riparian reserve, challenges faced by locating these land uses along the riparian reserve, their perception on the nature, causes and effects of encroachment on the riparian buffers and suggestions on the best use and management of riparian zones.

Further, formal and informal interviews were carried out with relevant key informants involved in urban and regional planning, survey and water resources at the County and national government. These key informant included; the Kiambu county government (ministry of Environment; Environmental Planning and Management section), National Environment Management Authority, (NEMA ), Ministry of lands housing and urban development’s Physical Planning Department, Survey and lands department, and the Ministry of Environment, Water & Natural Resources.

Field surveys were also conducted to examine and observe the study area to validate the extent of encroachment and asses the visible impacts of encroaching along the riparian reserve of river Ruaka. The techniques used included photography, note taking, field sketching, mapping, GPS pickings and use of observation checklists as well as taking of measurements.
3.3.2 Secondary Data Sources
Secondary data was collected from reviewing relevant books, scholarly articles (thesis & dissertations both published and unpublished), journals, periodicals, internet resources and relevant maps on the study subject.

These provided this study with general background information on the patterns of land use scenarios and trends along the riparian reserve of Ruaka river along the study section as well as processes and interventions advanced in the field of solving such chaos to promote sustainable development which is the concept of this study.

3.4 Respondents
The research project targeted the users and stakeholders of the riparian reserve of river Ruaka at the section between Ruaka bus stage and Gacharage shopping center. Sample size was 60 households and the researcher administered 30 household questionnaires and 15 businesses operators’ questionnaires. Others included key informants, opinion leaders’ and institutions such as sub county of Kiambaa, Kiambu county Government, NEMA, WRMA, Ministry of Environment, Water & Natural Resources, Ministry of Lands, Housing & Urbanization, private organizations, business owners/operators, residents and all other users of the riparian reserve space.

Data Needs & Data Needs Matrix
The data needs of the research project will be derived from the key objectives of the study. Some of the key information the study collects and/ or observes will include the following; land use activities along the riparian reserve, user needs and user behavior, implication of location to adjacent land use activities, environmental impact, and conservation and management initiatives among others.
Table 3.1 data needs. Source Author 2014

<table>
<thead>
<tr>
<th>Study Objective</th>
<th>Key questions</th>
<th>Data needs</th>
<th>Sources of data</th>
<th>Data collection methods &amp; survey instruments</th>
<th>Data analysis</th>
<th>Data presentation techniques</th>
<th>Expected results</th>
</tr>
</thead>
</table>
| To find out the human activities encroaching along the riparian reserves of Ruaka River. | -what are the major land use activities?  
-what are the land use Patterns? | -Existing land use maps  
-Satellite maps and images of land users  
-survey maps (extent of riparian reserve vis a vis development) | -Physical planning department office – Kiambu  
-NEMA  
-Survey of Kenya  
-Google maps | Questionnaire  
Interviews  
Observation  
Field sketching  
Transsect survey  
Photography  
Mapping | GIS mapping techniques  
Trend analysis  
Thematic & group categorization  
Descriptive analysis | Maps  
Spatial models  
Photographs/images  
Tables & charts  
Sketches & illustration  
Written literature | -Map of land users within the riparian reserve/activity & extent  
-Map on trends of occupation over the years  
-illustration of interaction between land uses |
| To establish the main reasons driving land users to occupy the riparian reserve of River Ruaka | -what are the forces of attraction to riparian spaces?  
-what were the push factors from their original location? | -forces of attraction into the riparian zone  
-push factors from other areas into riparian zone  
-sources of encroachment in the riparian zone | Kiambu County government  
NEMA  
Library sources  
Internet sources  
Land users | Literature review  
Questionnaires  
Interviews | -SPSS  
-descriptive analysis -content analysis | Assessment report | -An illustrative diagram of push & pull factors  
-map/spatial model of the forces on the ground |
| To assess the challenges of applying existing legal/institution guidelines set for conservation of riparian reserves. | -how can legal institutions and spatial planning approaches enable the best use and management of the riparian zones? | -all applicable data needs from the above objectives  
-available case interventions applied elsewhere  
-local interventions  
-Suggested interventions by respondents and stakeholders | NEMA  
Kiambu County government  
Ministries of environment, land, Nairobi metropolitan Library and internet sources  
Plans  
Spatial models  
Study findings | Review of study findings from;  
Questionnaire  
Mapping  
Field sketching  
Observation | Synthesis of findings using;  
GIS mapping techniques  
Descriptive analysis | Maps  
Plans  
spatial models written narrative | Proposed strategies and approaches on how to apply legal instruments that will resolve encroachments of the riparian zone in Ruaka river which can as well be replicated in other comparable areas |
"Choosing to save a river is more often an act of passion than of careful calculation. You make the choice because the river has touched your life in an intimate and irreversible way, because you are unwilling to accept its loss". — (David Bolling, 2008)

4.0 Overview
This chapter places the study area in its historical and geographical context by outlining its brief historical background and positioning the area on the globe. Furthermore, this chapter aims to give more details that are pertinent to understanding the issues faced in the study area that are relevant to this research.

4.1 Background to the Study Area
River Ruaka is located in Ruaka, Kiambaa Sub County in Kiambu County, Kenya.

The Ruaka River is one of the contributory river to Nairobi river flowing through the capital of Kenya, Nairobi. Other contributories include Mathare river, Ngong river (Motomoine-Ngong),
Ruiru River, Kamiti River (Gathara-ini), Karura River, Gitathuru River and Kirichwa river. The rivers join east of Nairobi and meet Athi River which eventually flows into the Indian Ocean.

Ruaka River originates in marshes of the lower reaches of Aberdare Mountains and flows through human settled areas. The stream experiences different impacts originating from anthropogenic sources along the channels and in the catchment. In the upper sections of Kiambaa and Kanunga areas, the stream passes through swampy and marshy areas, with subsistence agriculture and human settlement being the main types of land use. In midsections of Kiambu, coffee estates and intensive mixed farming are the major forms of land use. In the lower sections of Ndenderu, the stream is characterized by small scale farming, intensive mixed farming and some industries such as Ndenderu coffee factory. The lower stream waters are brackish and characterized by foul smell. Revering subsistence agriculture of arrowroots and kales are common throughout the study area.

Figure 4.1 showing the Nairobi water catchment basin. Source UNEP website
The vegetation supports a diversity of aquatic life like frogs, toads, dragonflies, among other fauna. Some of the commonest trees include eucalyptus, palm, jacaranda and pride of Bolivia. The commonest riverine vegetation is a mixture of grasses and sedges with Napier grass.

4.2 Location of Study Area
The study area is located along the riparian zone of the Ruaka River herein referred to as the riparian belt of Ruaka (approx. 1.1km in length). It runs from Ruaka bus stop to Gacharage junction shopping center. This area largely falls in the eastern part of Kiambu County as it borders Nairobi County. The location context of the Ruaka River in the riparian belt of Ruaka-Gacharage section is shown in Map below.

The area under study is 15 Km to the North of Nairobi and capital city of Kenya and borders Kikuyu sub county to the West, Kiambu sub county to the East, City county of Nairobi to the South and Sub county of Limuru to the North.

Kimbaa Sub County, where the study area is located is also known as Karuri and it was established as a meeting centre in the pre-colonial era where paramount chiefs used to meet. The origin of the word Karuri, was derived from one of the chiefs- Karuri wa Gakure as he used to call meetings under one of the tree located at the center of the current market. Initially the council was Urban Council under the County of Kiambu until 1997 when it was demarcated and upgraded from Urban Council to a Town Council with its area coverage increasing from 44.8 squares KM to the current 46 square KM. After the 2013 elections and subsequent implementation of Kenya constitution 2010, it was renamed Kiambaa Sub County within Kiambu county.
Map 4.1a Study location in local context. Source Author 2013

Map 4.1b Study location in local context. Source Wakimapia 2013
Map 4.2 Regional and National location context map Source Author 2014
4.3 Population
According to the Kenya Population and Housing Census 2009, the population of Ruaka sublocation where the study area lies is 15,583 people (7,507 males & 8,076 females). There are 5,067 households in the area occupying an area of about 1.3 square kilometers. The density is 11,931 persons per square kilometer. The day population is observed to be much higher and poses a threat to the riparian belt. The exact peak population however remains unknown to then researcher.

4.4 Climatic and Physiographic Conditions
4.4.1 Rainfall
The area receives an average rainfall of 925mm of rainfall per year or 77mm per month. The driest month is July when an average of 19mm of rainfall occurs across three days while the wettest month is in April when an average of 206mm of rainfall occurs across 15 days (Meteorological Department, 2014). This scenario is however being affected by the unprecedented rainfall patterns due to the climate change.

![Chart 4.1 Weather Chart. Source Metrological department 2014](chart.png)
4.4.2 Temperature
The overall temperatures are moderate and are spread over four seasons. Mid-December through to March there are mainly sunny and warm by day and cool at night conditions. April and May experience lower day temperatures and they constitute the principle rainy season. The months of June through to September are mainly dry but often cloudy and cool while October through to the start of December experience long sunny periods with warm days and cool nights.

The average temperature is 17.7 °C (64 °F) with an average temperature of 3.5°C. The highest monthly average high temperature is 26°C (79°F) in February and the lowest monthly average low temperature is 10°C (50°F) in July, August and September (Meteorological Department, 2014).

4.4.3 Humidity
The average annual relative humidity in the study area is 72.8% while the average monthly relative humidity range is from 64% in October to 79% in July (Meteorological Department, 2014).

4.4.4 Sunlight
The average sunlight hours in the study area range between 4.3 hours per day in July and 9.5 hours per day in February. The study area enjoys an average of 2525 hours of sunlight per year with an average of 6.9 hours of sunlight per day. This should therefore influence the positioning and orientation of facilities to be established in and around the study area (Meteorological Department, 2014).

4.4.5 Slope
The study area lies at the Northern end of Nairobi, 1.19 degrees south of the Equator and 36.59 degrees east of meridian 70. Its altitude varies between 1,600 and 1,850 meters above sea level. The area is gentle slopy with Ruaka River and its tributaries crossing the area. Water draining eastward from the hill area accumulates on the low-lying ground near Ruaka Bus Park forming a
perched water table above the phonolite. The sloping banks of the river Ruaka experience soil erosion and slumping which make the site to have an unpleasant character.

![Fig 4.1 Source: Ogara, 2012](image)

### 4.4.6 Geology
The geological formation of the area is mainly attributed to volcanic activity. The area mainly comprises a succession of volcanic lavas and ashes (tuffs) whose thickness reaches 400m underneath (Dahir, 2009).

### 4.4.7 Vegetation
The study area has a diverse composition of both indigenous and exotic vegetation cover.
There are a variety of vegetation species which are supported by flash floods and open sewers. These include species such as *Typha, Cyperus papyrus*, grasses and sedges along the river bank which harbor a variety of aquatic life such as frogs, toads and dragonflies among other fauna. The most common trees in the project site include eucalyptus, palm, jacaranda and the pride of Bolivia.

### 4.4.8 Soil cover
The rocks in the study area mainly comprise a succession of lavas and Pyroclastics of the Cainozoic age and overlying the foundation of folded Precambrian schist’s and gneisses of the Mozambique belt (Saggerson, 1991). The crystalline rocks are rarely exposed but occasionally fragments are found as agglomerates derived from former Ngong volcano. The soils of the Ruaka area are products of weathering of mainly volcanic rocks. Weathering has produced red soils that reach more than 50 feet (15m) in thickness (Saggerson, 1991). A number of subdivisions are recognized in the area according to drainage, climatic regions and slopes, and other categories have been introduced for lithosols and regosols.
4.5 Land Use Category and Function
In the larger Ruaka area, about 95% of the land is owned by individuals under free hold tenure (Kithia 1998). The County government owns no land in the area. Commercial activities and informal activities characterize the area adjacent Limuru road and Muchatha road junction. Upstream agricultural activities are dominant
Existing Main Land Uses in the Study Area

Map 4.2. Main land uses in the study area. Source Physical planning office Kiambu.
CHAPTER FIVE: DATA FINDINGS AND ANALYSIS

“If you’re not beside a real river, close your eyes, and sit down beside an imaginary one, a river where you feel comfortable and safe. Know that the water has wisdom, in its motion through the world, as much wisdom as any of us have. Picture yourself as the water. We are liquid; we innately share water's wisdom. “—(Eric Alan, 2005)

5.0 Overview
This chapter outlines the data findings as collected and analyzed. This analysis has been done in tandem with the research objectives.

This analysis is geared towards understanding causes and effects of encroachments along river Ruaka in the section between Ruaka Bus Park and Gacharage junction with the aim of proposing spatial and physical planning approaches and strategies that would resolve the problem in the study area. Opportunities for socio economic along the riparian reserve are also identified as well

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as identifying al threats facing the riparian reserve. During the study, special emphasis was placed on the existing land uses within the study area.

5.1 Land Use along Riparian Belt
There exist no formal development control tools to guide development along and near the study area. From the study it was noted that a number of land use activities encroach to the riparian reserve ranging from commercial and informal settlement at the most built up section of Ruaka and agricultural activities upstream. Commercial activities that have found their way into and around the riparian reserve include food vending, hawking, selling of motor vehicle spare parts, motor vehicle garages, building bricks making, car washing among other informal businesses. Informal residences have also cropped up in and around the area with some of the kiosks and informal structures serving as residential units during the night. The belt also serves other public purposes and carries utilities such as water pipes.

According to the study, 99% of land in the study area is owned by individuals under free hold tenure. However most of the developed areas have undergone change of use process from agricultural to multi dwelling or commercial units. From the sampled population, 80% of those who own land inherited it from the parents and about 20% had purchased it as shown in the bar chart below.
5.1.1 Residential Land Use
There are many temporary and permanent dwelling structures that line the study area. Residential units includes flats which primarily house the working class from other regions and single low lying farm houses for indigenous resident

Several settlements have been erected within the 30 meter riparian zone which provides housing facilities to households with an average household of size of 4 (field survey, 2014). About 33 % of the respondent dwellers have lived there since birth while the rest migrated into the area in search of jobs and employment (25%), for business purposes (27%) and in order to access affordable housing (15%). The study showed that most of the inhabitants within study area do not use the river water but those who do is for domestic purposes that stand at 55% and other (45%) for car wash business. Waste generated from these households and commercial activities and its disposal and management poses serious threats to River Ruaka.

Chart 5.1, land ownership situation. Source field study 2014
According to the sample population, the activities carried out on the land they occupy are as shown below in the map below.
Existing Main Land Uses in the Study Area

Map 5.1, existing land uses: source field study 2014
5.1.2 Commercial Land Use
A number of commercial activities are undertaken along the Ruaka River riparian zone especially near the junction of Limuru road and Muchatha road. According to the field survey 2014, these activities range from food vending (25%), automobile spare parts selling (20%), garages (18%), car wash business (15%), clothes selling (13%), hawking (3%), retail shops (3%) and cloth washing business (3%) respectively. Food selling business produces lots of solid waste daily that is dumped directly into the river obstructing the course while the garage and car wash business produce lots of chemicals and oils spills that find their way into the river especially during the rainy season. The motor vehicle garages and car wash bays lined up along the river draw up the river water and wash their wares in the river banks.

5.1.3 Agricultural Land Use
Land is seen as sacred property by native of the study area and this belief has passed from one generation to the next (Interviewee5). With increased demand for land, this belief is fast losing meaning when smallholder farmers are approached with lot of cash offers in exchange for their pieces of land which are declining in terms of agricultural productivity day after day due to problems associated with urbanization. Land now especially to the young people is becoming a commodity which can be traded in the market, and it not uncommon to see the land for sale ‘signs in most of the areas. Despite this 85% of respondent actually stated agricultural activities as the main economic activity among the household respondents.

According to Kiambu land administration officer land under the study area has undergone massive uncontrolled subdivision to an average acreage of 0.05Ha which is agriculturally unviable. This is demonstrated by a map below showing subdivisions levels at the study area.
Areas practicing agricultural activities

Map 5.2, land subdivision levels. Source Kiambu land survey office 2014
5.1.4 Other Land Use Activities

*Infrastructure & utilities*

Infrastructure is an integral part of any kind of development. Infrastructural facilities alongside utilities are herein laid side by side. The major roads that cut across the river in the study area include Limuru road Road and Banana road on one end, near Ruaka bus park and the Northern Bypass 400 m from the bus park. Motorable bridges have been constructed which caters for vehicles moving in either direction. Upstream, there are about three footbridges; stone bridge accessing either side of the study area.
Public purpose and Public Utilities

The riparian zone in the study area hosts a number of other activities. Religious activities for example are practiced by various groups and churches with the hope church constructed right at the riparian reserve near the bus park. In addition, indiscriminate dumping of wastes by the food kiosks, garage users, hawkers and riparian users are profound in the area.

Photo (5.2a) Church constructed right at the riparian reserve. (b) Water pipes along the river: Source Field survey 2014

Recreation

The field survey revealed that 3% of the riparian space users visit the location daily while 19% visits the location weekly thus making the land use activity component in the area and in specific the water fall. The main concern for this category of land users is the pollution of the river (63%), which is considered as the main problem facing the river followed by improper waste disposal (11%). The other concern is insecurity at 27%. These users engage in leisure activities, swimming and children practicing fishing.
Charts 5.3 showing place of birth and awareness of standard riparian reserves. Source field study 2014

Photo 5.3, Waterfall at the study area used for photography and diving: Source Field study 2014
5.2 Location Factors

Land use activities occupy specific geographical locations. In Ruaka due to its proximity to Nairobi and the urbanization dynamics, land uses have steadily changed especially over the last two decades as a result urban sprawl and also as a result of other pull and push factors that are in play. With regards to the study area, according to Kiambu district physical planning officer, in the early 2000, Ruaka area was predominantly an agricultural area with coffee bushes planted all over the space. Today, housing is considered to be the main economical viable land use in the area due to its proximity to Nairobi CBD, more access roads and favorable climatic conditions. Nevertheless people are relocating to other areas due to high rents as connectivity eases due to government effort to open other area within the metropolis through roads expansion and construction of new bypasses.

In respect to commercial activities, the large market (40%), availability of water for business operations (30%) and the availability of open land along the water body (20%) were found to be key pull factors into the location. Moreover, there are other factors that are also considered such
as ease of accessibility, availability of relatively cheaper lands and proximity to recreation facilities.

Land use in the study area is expected to continue changing due to the steady increase in land subdivision rates and urban population. The urban population in Kenya is projected to reach 63% by 2030 threatening to cause strain on land and land based resources. Land use along rivers in and near urban areas is founded on the concept of bid rent whereby the land user seeks to locate as close as possible to the river due to various reasons but is willing to accept locations further from the river if rents are lower in compensation i.e. holding all other topographical, climatic, legal and social factors constant. This concept applies to the study area where the occupants are willing to relocate if offered a cheaper location.

5.3 Implication of Locating along the Riparian Reserve To the River

The river in the study area is filled with rubbish and uncollected garbage from both the formal and the informal settlements, liquid effluents and solid wastes from the business enterprises, and petro-chemicals and metals from micro-enterprises and overflowing sewers. Evident in the river channel in Ruaka are plastic paper bags, silt from soil along its banks, green water and solid waste showing presence of raw sewerage

Photo 5.5 pollution along River Ruaka riparian
According to findings from the study, much blame is laid on the reluctance by national government and the Kiambu county government on the part of solid waste management. Negligence on the part of land users also plays a major role in increasing the level of pollution as reported by an officer in the National Environmental Management Authority, Kiambu County.

**To the Land Users**

The land users in the study area cited a number of challenges they face for locating along the river. Majority (62%) of the residents of the informal economic activities for example, admitted to be facing problems of different kinds for having located along the riparian zone. The major problem facing the residents is nuisance from adjacent land uses (bad odor from the garbage, noise from mechanics, choking fumes from garages and improper human waste disposal), threats of eviction and demolition, and environmental and health hazards such as flash floods, increase in mosquito breeding grounds. These problems are as a result of low level environmental policy awareness and enforceable policies (the research revealed that 84% of the respondents were not aware of the standard distance of developments from the river), low level commitment from the county government to effectively manage the resource and the lack of proper planning to cater for the needs of rapidly increasing growth. The land users propose that proper environmental laws to be enacted and enforced to the latter. Other proposed solutions to the identified problems include relocation of some of the activities, proper waste management and planting of more trees.

**5.4 The Nature of River Riparian Encroachment**

Encroachment into the riparian reserve of River Ruaka is manifested in the competitions staged by different land uses for accommodation as well as the struggles they present for control of the spaces. Some of the land encroaching on the riparian includes residential developments, commercial developments, small-scale industries (informal garages and automobile mechanical enterprises), infrastructure and agricultural activities.

Actually, the space near the river near Ruaka Bus Park is one of the highly encroached areas with businesses fronting the river extending into the perceived “idle space”, hawkers taking advantage of the high riparian park space population, car wash draining water from the river and garage users all competing for accommodation and control of space.
5.5 Type of Encroachment

*Functional/ space needs;*

This is revealed through the competition for accommodation of prime locations and control of such spaces by different land users. This is a battle between users e.g. residents vs. traders, recreational users vs. hawkers, garage operators vs. food vendors etc. Such locations include the footpaths, green open space and where two land use activities occupy the same space.

*Environmental;*

This happens when man occupies sub-optimal environments for their settlement. These include areas prone to flash floods, soil erosion and other environmental hazards. Areas along the river bank which act as a reserve for nature are encroached by users who want to access river resources including the water and clay soil.

*Legal;*

Such kind of encroachment and competition for space are witnessed where land users locate outlawed/illegal activities especially in prohibited spaces. These result in battles between the land users and the authorities e.g. hawkers vs. county officers. These spaces include parcels with activities other than the intended use provided for by existing legal frameworks of, the riparian reserve (30m) and other way-leave reserves.

*Ownership/ appropriation;*

These are conflicts between the stakeholders and the authorities due to land ownership wrangles. Such conflicts occur on parcels with double allocation, those with unclear ownership (areas at the boundary of Kiambu and Nairobi counties), also where land users have no title to the land they operate in etc.
Chart 5.2, distance in meters of households along River Ruaka source: Field study 2014

Chart 5.3 reasons for locating near the river. Source field study 2014
Situation analysis

Chart 5.4 (a) current situation Source Author 2014
Chart 5.4 (b) current situations Source Author 2014
5.6 Causes of encroachment into the Riparian Reserve
The land users along the study area generally show minimal concern for the conservation of the riparian zone and they perceive the space as either idle or free land for construction and dumping of all kind of waste they produce from their premises and operations. Others perceive it as private land for their own determined use whilst others still perceive it as community land. These distorted perceptions and low level environmental awareness have catalyzed the use for the ‘free’ space in the study area. The multiplicity of interests from different stakeholders has also led to the struggle for control of spaces so as to attain dominance and social power.

The riparian zone in the study area covers the interests of politicians, opinion leaders, NEMA, County Government of Kiambu, the Physical Planning Department, ministry of environment and all other relevant land users. This case is further worsened by the poor coordination from these institutions which are responsible for conserving and managing the riparian reserve since this study found that even they have varied vested interests.

The study reveals that residents rate the inadequacy and high land values as the main cause leading to encroachment into the riparian reserve. This coupled with a high number of informal businesses which increase daily to take advantage of the available market and high population during peak hours contribute to the competition for favorable location. Businesses near Ruaka Bus park stage stretch compete to locate in areas where they can maximize on the profits; these include areas easily accessible to by the customers, areas where other businesses are located for mutual benefit and areas near the river resource especially for the car wash business.

5.7 Effects of encroachment into the Riparian Reserve
Competing land uses struggling to control certain locations along the riparian zone have had far much greater effects on the environment. Activities inappropriately located along the river have caused extreme environmental degradation, habitat loss and unpleasant riverfront scenery. The soil along the river bank has been scooped or dumped in large masses to reclaim land for various land uses exposing the river bank to extreme erosion. Furthermore, the area along the riparian zone has been a battleground for various casts. Chaos and conflicts of different magnitudes and
intensities have rented the space in different occasions. This study found out that some illegal activities are carried out along the reserve. Drug peddlers selling marijuana for example and illicit brews find home along the riparian reserve creating serious security effects.

Another effect observed as a result of encroachment is the incompatibility of land use activities. Activities locate where they deem beneficial, where the spaces save on costs and/ or reap profits to their operations. This has led to establishment of incompatible uses lying side-by-side thus compromising one of the activities from enjoying location advantages.

The informal settlements are located right within the informal market structures, food vending kiosks are located next to car mechanic workshops and car wash bays while churches and kiosks are located next to sanitation facilities. Moreover, the land use activities were observed to have fallen short of minimum space requirements and standards due to the competition. This can be further elaborated by the problem tress analysis shown below.
Problem tree 1

PROBLEM TREE - RIPARIAN ENCROACHMENT

EFFECT
- Theft
- Loss of Property
- Poverty

PROBLEM
- Crime: Mugging along the Riparian Route
- Death/Suicide At The Water Fall
- Lack of Investors
- Development Decrease

INSECURITY/ DRUGS DEN

CAUSES
- Poverty
- Unemployment
- Moral Decay
- Inadequate Enforcement Of The Penal Code
- High Population

Chart 5.5 Problem tree- Insecurity
Problem tree 2

RIPARIAN ENCROACHMENT: FLOODING PROBLEM TREE

EFFECT
- Low Agricultural Productivity
- Siltation downstream
- Death
- Water Borne Diseases
- Loss Of Property
- Environmental Degradation
- Soil Erosion

PROBLEM
- FLOODING

CAUSES
- Over Subdivision Of Land
- Construction Along The Riparian
- Cleared Riparian Vegetation

Chart 5.6 Problem tree- flooding
PROBLEM TREE - RIVER POLLUTION

PROBLEM

RIVER POLLUTION

EFFECT

Death

Health Issues
Problem

Lack of Environmental
aesthetics

Contamination of
Water

Climate Change

Environmental
Degradation

POISON

Problems

Land
(At the Riparian)

Ineffective
Institutional
Frameworks

Business Effluent

Dumping

Pesticides
From Agri Activities

Surface Run off

Untreated
Sewer

Chart 5.7 Problem tree- pollution
## Proposed solutions to the Challenges faced in the Study Area

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Proposed solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Threats of eviction &amp; demolition</td>
<td>• Relocation to a secure place&lt;br&gt;• Proper market management&lt;br&gt;• Mediation for mutual understanding</td>
</tr>
<tr>
<td>• Environmental hazards such as flash floods</td>
<td>• observance of 30 m riparian reserve&lt;br&gt;• Planting of trees and cover crops</td>
</tr>
<tr>
<td>• Increased disease due to pollution</td>
<td>• Proper solid and liquid waste disposal&lt;br&gt;• Elaborate drainage system&lt;br&gt;• Creating environmental awareness</td>
</tr>
<tr>
<td>• Foul smell &amp; odor from poorly managed wastes</td>
<td>• Proper waste disposal&lt;br&gt;• Drainage system</td>
</tr>
<tr>
<td>• Noise pollution from Mechanics and stage operators</td>
<td>• Enforcement of the Penal code&lt;br&gt;• Provision of standard bus park elsewhere</td>
</tr>
<tr>
<td>• Poor waste disposal</td>
<td>• Provision of toilet faculties&lt;br&gt;• Provision of proper waste handling mechanism from the county government</td>
</tr>
<tr>
<td>• Insecurity</td>
<td>• Securing and tapping the water fall for ecotourism&lt;br&gt;• Enforcement of the Penal code</td>
</tr>
<tr>
<td>• Legal</td>
<td>• Government intervention&lt;br&gt;• Enforcement of environmental law&lt;br&gt;• Stakeholders involvement&lt;br&gt;• Enforcement of the penal code</td>
</tr>
</tbody>
</table>

*Chart 5.8 Proposed interventions source Author 2014*
CHAPTER SIX: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

CONCLUSION

“Rivers run through our history and folklore, and link us as a people. They nourish and refresh us and provide a home for dazzling varieties of fish and wildlife and trees and plants of every sort. We are a nation rich in rivers”
- Charles Kuralt

6.0 Overview
This chapter offers a summary of the preceding chapter on data findings. It presents the summary of findings and their implication for land use planning, recommendations for better planning and management of the riparian zone as well as concluding of the subject matter. The recommendations are derived from the synthesis of data findings and observations studied within the study area, best practices locally and internationally and proposals from key institutions. The conclusion remarks thereafter sum up the study by highlighting the key lessons and the steps to be undertaken.
6.1 Summary of Findings

Human activities encroaching on the riparian reserve of river Ruaka along the study area include residential developments, commercial developments, small-scale industries (informal garages and automobile mechanical enterprises and making of building bricks) and agricultural activities. The riparian reserve near the bus park the most highly encroached with businesses fronting the river extending into the space perceived as idle, hawkers taking advantage of the high riparian park space population, car wash draining water from the river and garage and bricks manufacturers all competing for accommodation and control of such a space. Moreover, the situation is worsened by the rigid land use planning regulations which does not accommodate some of the land use activities along the riparian zone. The multiplicity of mandates of institutions responsible for conservation and management of riparian zones has also worsened the situation. An average of 83 three per cent (83%) of the agricultural land users in the riparian reserve of Ruaka river are not aware of the recommended riparian reserve.

6.1.1 Identified Causes of riparian reserve encroachment

a. Low level awareness of environmental and land use standards

Majority of land users in the area confess of the lack of knowledge on the width standards of the riparian reserve. Respondent practicing agricultural activities and whom are natives of the area were completely unaware of riparian management standards and urged thy own land to the stream. It surely goes without saying that most of the land users in the area do not know of the allowable and unallowable activities within the riparian zone. Also, many are unaware of the conservation measures under the environmental policies. This poor appreciation of environmental policies and land use standards has led to occupation of whichever space one deems fit. However, officers from Kiambu NEMA office stated that land users are aware of the environmental policies but are negligent.

b. Negative user perception and sub-optimal design of space

Following the literature review, it is clear that users of space assign uses to a particular place according to design and guidelines provided for by planners, environmentalist, and architects among other professionals. If the guidelines are vague and not enforceable, the land users resort
to their perception. The case in the study area is that the land users perceive the riparian zone to be either idle or free land which they therefore use for construction, doing business or dumping of waste. Others perceive it to be government land thus free for all. These perceptions have led to encroachment with a belief that the riparian zone is land for none and land for all simultaneously.

c. **The need for entrepreneurs to locate appropriately and competitively disregarding riparian ecosystem:**
Business owners/ operators and garage owners in the study area seek to locate appropriately in relation to conducive sites and access to clientele. Markets and businesses desire to locate along traffic corridors, car wash businesses desire to locate along the stream while residents desire to locate in secure and accessible areas. The Ruaka bus park is located near the river attracting car wash works due to proximity of (river) water. Uncontrolled business activities have also scrambled at the same area all aiming to tap on many commuters who are potential customers. Due to concentration of these uncontrolled activities, some have spread to the riparian reserve causing encroachment.

d. **Relatively high population against scarcity of land**
Due to increased population growth due to in migration, the study revealed that land values increase as the proximity to the city decreases. The study area is approximately 15 Km from the city centers and has experienced rapid population increase hence high land values. This has led to human activities locating at every available “free space “including the riparian belt which is deemed to be less costly in terms of rents and rates causing encroachment

d. **Un coordination of land use policy guidelines and institutional framework**
Despite a number of policies and laws in regard to riparian conservation, the study found out that enforcement of these standards has failed in the conservation of the riparian reserve of the study area. The Kiambu county government have licensed and collect levis from the very businesses encroaching on the reserve. Moreover, during land subdivision, physical planners provide for delineation of riparian reserves but surveyors in most cases fail to implement the same during actual ground surveys. This has contributed to an extent the menace of encroachment witnessed along the riparian belt of Ruaka river.
First and foremost, there are various institutions mandated with the responsibility of planning and management of the riparian zone. These institutions (WRMA, NEMA, PPD, and the Kiambu County government) provide for different and sometimes diverging measures of planning and conservation. Those aware of these institutional flaws have been quick to take advantage by occupying fragile ecosystems. Enforcement of these standards has but partly failed in the conservation of the riparian reserve of the study area.

6.1.2 Identified Effects of encroachment
Effects of encroachments are witnessed within the bounds of the riparian reserve along the study section of river Ruaka riparian belt triggered by functional and legal factors. Businesses have found their way into the riparian reserve to tap on the market high population in the area. Households close to the river draw water from the river, conduct domestic activities such as washing of clothes along the river bank and dispose of waste within the riparian reserve. All this is based on the principle of ‘survival for the fittest’-those who cannot withstand the competition and struggle for space around the area find them within the riparian zone.

Other effects of encroachment in the study area include:

Establishment of incompatible land uses
These include activities that have been forced to sit side-by-side due to lack of sufficient space e.g. food vending kiosks next to garages and car wash bays, houses next to informal markets and dumping sites, hawking, car washing and small scale traders on trunk roads and bridges. Moreover, the physical planning guidelines treat the riparian reserve as an open space within a special context. Some of the developments therefore within the riparian reserve are illegal establishments. The District physical planner stated tough their exist no approved plan to guide development in the study area, the allowable activities within the riparian zones can include recreational, educational (arboretum, botanical gardens and internet parks) and support facilities.

Congestion
The limited riparian space is not adequate for all the activities carried out along the riparian space. Some of the land users complain of over crowding in the area. Land use activities that have been pushed out by other land uses to occupy traffic corridors making movement difficult too.
Hawking and washing and drying of car spare parts for example are activities that obstruct and obscure movement along the footpaths and the park space in the area.

**Insecurity**
The study revealed that the riparian reserve of Ruaka river has provided a breeding ground for several immoral occurrences. Mugging, drug peddling and brewing of illicit brews have occupied the area near Gacharage junction riparian reserve. People committing suicide and murder cases were also reported to be taking place at the water fall near the bus park.

**Environmental degradation**
The major negative impact the land users in the riparian zone in Ruaka contribute is pollution. Land users indiscriminately dispose solid waste, release raw sewage and untreated waste water into the river while garage operators spill waste oil indiscriminately. The solid waste chokes the river, reducing it to narrow channels while the oil spill and raw sewage affect the water quality. The situation is worsened during the rainy season when dirt is swept from farther slopes into the river. The inhabitants of the study area also complained of the noise that arises from the garages and mechanical workshops and also the fumes that come from chemical and burnt car parts.

**Soil erosion and Flooding**
Due to loss of vegetation and over cultivation flooding and soil erosion has become a menace in the study area. Human activities at the study area have led to clearance of riparian vegetation which protects shorelines and river banks from damaging erosion caused by water as it moves downstream, especially during heavy flows associated with runoff or heavy downpours.

**6.2 Recommendations**
The research findings reveal that encroachment in the riparian reserve of river Ruaka at the section between Ruaka Bus Park and Gacharage junction has negative implications on the development of the riparian zone in the study area. The effects of this phenomenon pose a critical challenge to sustainable development in these fragile places. If the scenario in the study area is left unattended to then the future of the land users in the location and the residents of
Kiambu County at large is compromised. The study therefore proposes intervention measures which can be implemented to ease on the problem of encroachment and struggle for space control along the riparian zone.

i. **Ownership and responsibility in conservation and protection:**

The land users who have encroached into the riparian zone cite lack of awareness on existing riparian management guidelines as their excuse. Kiambu County and line ministries in charge of planning and the environment should take the initiative of setting up clear signage and mark-ups informing the public of the designated space for the riparian reserve and what is prohibited in that space to avoid the establishment of incompatible land uses and outlawed activities. The Kiambu County Government should also secure the custody of the riparian reserve environment for the community. This would control and regulate the use of the space. Civic education by all stake holders aiming at sensitizing the community on the requirement of the constitution of Kenya 2010 article 42 which states that —Every person has the right to a clean and health environment which includes having the environment protected for the benefit of present and future generations. The County Government should therefore among other duties, enforce the environmental rights as stipulated in the constitution by representing and demonstrating in a jury, losses and injuries for victims of a violation of rights to clean and healthy environment for compensation.

ii. **Delineation of an adaptable riparian reserve:**

From the field survey, it is seemingly impossible to attain the maximum 30 meters buffer zone (stipulated in the Survey Act, Cap. 299) on either side of the stream in the study area considering the rapidly increasing population and land use needs without risking rejection of the attempts to reclaim the riparian reserve by the stakeholders. Therefore, this study proposes the riparian reserve to be surveyed, analyzed, and freshly delineated according to the prevailing circumstances where possible and be clearly demarcated since policy can be harmonized to allow for 2 meters to 30 meters width (Integrated Land uses Guidelines, NEMA). This can be done using a hands-on approach using GIS techniques where buffering and overlaying of images is done to identify areas for preservation (with
emphasis on conservation and maintenance), restoration (with emphasis on areas for acquisition) and those needing further investigation (research and exploration of better methods of restoration and management). This process will require GIS layers with data on the parcels, land use, river width and flood plain history, zoning, existing protected areas and high definition satellite images of the study area. Also, the survey should consider the present temporary and permanent structures near the junction of Limuru road and banana road that have encroached and also land use activities that are harmful and those that are harmless. This approach seeks to control the effect of encroachment into the riparian zone.

### iii. Securing, delineating and designing of the Ruaka water fall to accommodate recreation needs:

In order to achieve the social economic benefit of the existing water fall and avert the increasing effects of its encroachment, this study proposes a falling waters park accommodating public outdoor recreation and conservation of the riparian reserve. The plan design will serve as the basic statement of policy and direction for the management of water fall as a unit of Ruaka river riparian reserve system. The park design plans therefore will identify the objectives, criteria and standards that will guide each aspect of riparian reserve administration, and set forth the specific measures that will be implemented to meet management objectives. Based on considerations such as access, population and adjacent land uses, an optimum allocation of the physical space of the water fall park will be made, locating use areas and proposing types of facilities and volume of use to be provided. The park will also provide a detailed inventory and assessment of the natural and cultural resources of the park. River Ruaka resource management problems and needs will be identified, and specific management objectives will be established.

### iv. Promotion of green infrastructure along the entire riparian reserve:

According to the Physical Planning Hand Book, a riparian zone management design specifications and guidelines are similar to those of green open space. The riparian zone usually acts as a green belt buffer shielding the stream from encroaching human
activities. Planners and policy makers should therefore take calculated existing measures by fully exploiting legislation, zoning and other planning instruments so as to sustain and promote the green open space while locking out prohibited land use. Kiambu county government, Ministry of Environment, Water and Mineral Resources and the Physical Planning Department should revisit this role of the Ruaka river riparian reserve and expand the green space by encouraging planting more trees and grass. Vegetation serves to protect the river and water quality. This can be affected also by giving incentives to land owners in terms of indigenous and landscaping seedlings at a subsidized cost as well as training opportunities. The County government may also encourage the creation of private recreation land use along the riparian of Ruaka river. This may require relaxing the normal rigid approval conditions by the county government to facilitate efforts to restore greenery along the riparian reserve.

v. **Relocation and demolition:**

Though controversial, it is critical that developments that greatly compromise the constitutional right to a clean and healthy environment be removed. The key ministries, Kiambu county government and the relevant authorities should mark out all the informal structures and activities that have encroached on the riparian reserve for demolition or relocation. However, this study recommends engagement of all stakeholders for discussions and provision of alternative locations to land use activities where possible and undertake demolitions where applicable in accordance to existing laws such as the Constitution of Kenya, physical planning Act and the compulsory acquisition of land act.

vi. **Provision of utility and sanitary facilities:**

From the study, solid and liquid waste management by the county government was lacking hence turning the riparian reserve as the only “free” space for dumping and for sewer disposal. Provision of sanitary facilities will minimize the effects of pollution in the riverine environment. Sanitary facilities including trash receptacles and toilet facilities are key in maintaining better water quality of the river. This could be more appropriate for the areas around the bus park and near the junction of Banana road and the Bypass.
vii. **Awareness creation and sensitization of the public on environment conservation:**

Increased awareness and sensitization of the public on environment conservation and the need to understand the impacts of human activities on the riparian zone are recommended to be undertaken by the ministry in charge of environment, the private sector and NGO’s through media announcements, posters, flyers, clean-ups, seminars and community barazas. Campaigns should be launched in the study area towards environmental sustainability and against indiscriminate use of land along the riparian zone, workshops and seminars should be held between the community members and other stakeholders in environmental matters and come out with strategies on how best to manage and conserve the river ecosystem.

### 6.3 Conclusion

Riparian reserve encroachment as experienced in the study area is a threat to sustainable development. Ruaka is experiencing rapid urban population growth. This population seeks to be accommodated where there is available space which poses a threat to reserves as well as prohibited grounds such as forest reserves, way leave reserves, riparian reserves, quarries and swamps. This scenario if left without any intervention has far much greater implications than those discussed in this research including violent battles and struggle to accommodate land use activities and extreme environmental degradation.

This study has generally been able to add vital literature to the on-going discourses on planning and the environment. In recent years, planning challenges such as encroachment have ailed environmental sustainability. First and foremost, the study has been able to establish the nature of riparian encroachment and the resultant causes and effects in the riparian reserve of Ruaka. Secondly, the study has been able to muddle through literature and point out the place of spatial planning in the management of the riparian zones. Finally, the study has been able to propose spatial planning approaches which may serve as models for sustainable land use planning along riparian belts.

All in all, the government, the professionals in environmental planning and management, the community and all relevant stakeholders are urged to concentrate their efforts in striking a
mediating solution as they consider the proposal made herein. The government should incorporate integrated planning approach, empower and build institutional capacities, promote public-private partnerships and establish a comprehensive riparian buffer policy which encompasses all dimensions of use, conservation and management of the riparian zone. Planners, designers of space and environmentalist should prepare integrated plans that are inclusive, flexible, enhances comfort and safety and have proper implementation, monitoring and evaluation framework. This will enable us achieve a clean and healthy environment.

6.4 Areas for Further Research

Mixed-Use development

Mixed-use development intends to blend a variety of land use activities in one area as determined by the zoning ordinance set out by local authorities. Currently, there are no detailed zoning guidelines for the riparian zone. Further, no mega developments are allowed on the riparian belt of Ruaka area. There needs to be a further research on mixed land use zoning with a view to tailor-make flexible and adaptable development guidelines for the riparian zones of Kiambu river fronts.

Environmental Standards

Clear scientific and enforceable standards are mandatory for environmental sustainability. Some of the environmental laws and policies used in our localities are borrowed from other countries of the world and do not fit in our context. Also, there is no standard gauge against which one can measure environmental sustainability. These are data gaps which if filled would provide for effective planning and management of the riparian zones.
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APPENDIXES

UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN & REGIONAL PLANNING
PLANNING RESEARCH PROJECT ON THE CAUSES AND EFFECTS OF ENCROACHMENTS ON RIVER RUAKA RIPARIAN RESERVE

Declaration: The information and data collected will be confidential and is intended purely for this research

NAME OF RESEARCHER: Mugambi Charles (REG. NO. B65/36199/2010)

DATE: …………………………… TIME: ……………………………

Household Questionnaire

SECTION 1: RESPONDENTS INFORMATION

1. Name of Respondent (Optional) …………………………………………………………………

2. Location………………………………………

3. Age …………… (Years)……………………

4. Sex
   Male
   Female

5. Marital status
   Married
   Single
   Divorced/Separated
   Widowed/Widower
   Other

6. Highest level of education
   Primary
   Secondary
   Tertiary
   None
SECTION 2: DEMOGRAPHIC CHARACTERISTICS & MIGRATION TRENDS

7. a) What is the household size?..........................
b) No of Males…… & Females…………

8a. Were you born in this place?
   Yes          ☐
   No           ☐

8b. If No. how long have you lived here? ..........................

9. If No, state the reasons for coming to this location
   ..............................................................................................................
   ..............................................................................................................
   ..............................................................................................................
   ..............................................................................................................
   ..............................................................................................................

10. a) Have any of your household members left to settle elsewhere ?
    Yes          ☐
    No           ☐

10b) If yes why?
   ..............................................................................................................
   ..............................................................................................................
   ..............................................................................................................
   ..............................................................................................................

   c) If Yes, was it the land-related reasons and which?
   ..............................................................................................................
   ..............................................................................................................
   ..............................................................................................................
   ..............................................................................................................
   ..............................................................................................................

SECTION 3: HOUSING & LAND TENURE

11. a) Do you own the land you live on?
    Yes          ☐
    No           ☐
b) If yes, how did you acquire the land?

<table>
<thead>
<tr>
<th>Inheritance</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation by local authority</td>
<td></td>
</tr>
<tr>
<td>Cooperative shares</td>
<td></td>
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<tr>
<td>Land Buying</td>
<td></td>
</tr>
<tr>
<td>Others (Specify)</td>
<td></td>
</tr>
</tbody>
</table>

c) If yes, do you have ownership documents?

Yes [ ]
No [ ]

c) If yes, specify (Title deed, TOL, Occupation certificate, Allotment letter)

……………………………………………………………………………………...................

12. If you do not own the house, what are the arrangements for your residing here?

……………………………………………………………………………………...................

13. What is the distance of your house from the river Ruaka?

……………………………………………………………………………………...................

b) If rent, how much do you pay?

……………………………………………………………………………………...................

14. a) Do you know of the standard distance allowed for developments from the River ruaka?

……………………………………………………………………………………...................

b) If yes, what is the distance?

……………………………………………………………………………………...................

15. a) Does your household use the river water?

Yes [ ]
No [ ]

b) If yes, indicate how else (where applicable) your household uses the river

……………………………………………………………………………………...................

……………………………………………………………………………………...................

……………………………………………………………………………………...................
16. Do you face any problems for locating near the river in this location?
Yes ☐
No ☐
b) What are these problems?
   i. Threats of eviction ……………………
   ii. Environmental hazards (specify)………………
   iii. Nuisance from adjacent land users (specify)……………………
   iv. Others (specify)……………………………………………………………
17. What could be the possible solution to the problems above?
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
18. a) What are the main problems facing the river in this location and its surrounding?
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
b) What are the causes of these problems?
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
c) How can the problems be resolved?
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
   ………………………………………………………………………………………………………
19. What activities do you carry out on the land? (Tick where appropriate)
   i. Residential
   ii. Commercial
20. What are the dominant land use activities near the river and who carries them out? (rank)

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<tr>
<td>i. Residential</td>
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<td>ii. Commercial</td>
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<td>iii. Industrial</td>
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<td>iv. Agricultural</td>
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<tr>
<td>v. Recreational</td>
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<td>Others (Specify)</td>
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</table>

21. a) Do these land use activities encroach the river reserve?
   Yes [ ]
   No [ ]

b) What are the causes of the encroachment?
   ………………………………………………………………………………………………
   ………………………………………………………………………………………………
   ………………………………………………………………………………………………

c) What are the effects of the encroachment?
   ………………………………………………………………………………………………
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d) How are these encroachment resolved?
   ………………………………………………………………………………………………
   ………………………………………………………………………………………………
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SECTION 4: INFRASTRUCTURE & UTILITY SERVICES

22. Do you receive any services from Kiambu County government in this location?
23. Are you satisfied with the level of services provided by Kiambu County government among other service providers?
Yes □
No □

24. a) What additional facilities do you want to see provided for the residents living near the river?
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b) why?
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25. a) What services do you want to see provided for to improve the environment?
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b) Why?
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SECTION 5: ENVIRONMENTAL CONSERVATION

26. Do you know of any environmental programme that has been established in this area?
   Yes ☐
   No ☐

b) If yes, which one?

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27. How do we achieve a better environment while accommodating all these activities?

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THANK YOU
UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN & REGIONAL PLANNING
PLANNING RESEARCH PROJECT ON THE CAUSES AND EFFECTS OF ENCROACHMENTS ON RUAKA RIPARIAN RESERVE

Declaration: The information and data collected will be confidential and is intended purely for this research

NAME OF RESEARCHER: Mugambi Charles (REG. NO. B65/36199/2010)

DATE: …………………………… TIME: ……………………………

Observation List Guide
1. Dominant vegetation type:
   - Grass
   - Tree species (natural/artificial
   - Flower species “
   - Distribution
   - Extent of cover
   - Their role
   - Location
2. Dominant animal species:
   - Birds
   - Mammals
   - Reptiles
   - Their role in the ecosystem
3. Drainage:
   - Direction of flow
   - Water channel (earth/concrete, obstacles, width, length)
   - Spill over/visible effects
4. Soil:
   - Type & distribution
   - Grain
   - Color
   - Texture
5. Natural resources:
   □ □ Actual resources
   □ □ Potential resources

6. Pollution & environmental degradation
   □ □ Type of pollution (land, water, air, noise)
   □ □ Sources of pollution
   □ □ Causes of environmental degradation (solid waste, oil spills, exhaust fumes etc.)

7. Land use activities:
   □ □ Sources of encroachment
   □ □ Dominant land use activity (extent, points, photos)
   □ □ Visible effects/hazards of location
   □ □ User needs & behavior

8. Physical features
   □ □ Start & end of the stretch (distance)
   □ □ Boundaries/edges (mark ups)
   □ □ Slope

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
<th>Location</th>
<th>GPS Points</th>
<th>Photo No.</th>
<th>Remarks</th>
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</table>
Sketches
Declaration: The information and data collected will be confidential and is intended purely for this research

NAME OF RESEARCHER: Mugambi Charles (REG. NO. B65/36199/2010)
DATE: ...................... TIME: ......................

Business owners’/ operators’ Questionnaire

1. Name of Respondent (Optional) .................................................................

2. Type of business ..........................................................................................

3. Age ............... (Years)..............

4. Sex
   Male □
   Female □

5. What are the reasons for locating your business near a river in this location?
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6. For how long have you operated your business in this location?...................

7. What is the distance (in meters) of your business from the river?
..............................................................................................................................

8. a) Do you know of the standard distance to be observed by developments from the river?
..................................................................................................................................
b) If yes, what is the allowable distance?

9. a) Does your business consume the river water?
   
   Yes
   No

b) If yes, what for purpose?
   
   

10. Do you face any challenges for locating your business near a river in this location?

   Yes
   No

b) What are these challenges?

   i. Threats of eviction
   ii. Environmental hazards (specify)
   iii. Nuisance from adjacent land users (specify)
   iv. Others (specify)

11. What could be the possible solution to the challenges above?

12. a) Are there any challenges facing the river Ruaka environment?

b) What are the causes of these problems?
13. How much do you pay for rent? .................................................................

14. How much do you earn from your business monthly?

<table>
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<tr>
<th>Less than 5000</th>
<th>5000-15000</th>
<th>15000-25000</th>
<th>Above 25000</th>
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</thead>
</table>

15. a) What solid waste does your business generate?

b) How do you dispose solid waste? (Tick where appropriate)

<table>
<thead>
<tr>
<th>Bury</th>
<th>Burn</th>
<th>River</th>
<th>Garbage collection</th>
<th>Bins</th>
<th>Other (specify)</th>
</tr>
</thead>
</table>

16. a) What liquid waste does your business generate?..................................................
b) How do you dispose liquid waste (waste water/chemicals)? (Tick where appropriate)

| Sewerage system |   |
| River system    |   |
| Ground          |   |
| Other (specify) |   |

17. What other activities do you carry out on the land? *(Tick where appropriate)*

| i. Residential |   |
| ii. Commercial |   |
| iii. Industrial |   |
| iv. Agricultural |   |
| v. Recreational |   |
| Others (Specify) |   |

18. a) Are there any forms of competition / conflicts in relation to land use in this area?

Yes  ☐

No  ☐

b) What are the causes?

............................................................................................................................

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d) How are these conflicts resolved?

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DEPARTMENT OF URBAN & REGIONAL PLANNING
PLANNING RESEARCH PROJECT ON THE CAUSES AND EFFECTS OF ENCROACEMENTS ON RUAKA RIPARIAN RESERVE

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NAME OF RESEARCHER: Mugambi Charles (REG. NO. B65/36199/2010)
DATE: …………………………… TIME: ……………………………

National Environmental Management Authority Interview Schedule
Use recorders, note pad and collect any maps and relevant data.

Section 1: Respondents Information
1. Name of Respondent (Optional) ……………………………………………………………
2. Age ……………
3. Sex
   Male □
   Female □

4. Position…………………………………………………………………………………………

Section 2: Main Questions
5. What is the state of the riparian reserve in the Ruaka River, between Ruaka bus park and Gacharage stretch, in terms of:
   a. Physiographic (land size, carrying capacity, soil type, geological structure)
   b. Established width
   c. current width
   d. Allowable land use activities
   e. Encroaching land use activities
   f. Development versus conservation and management
6. Are there any activities known to the NEMA that are irregularly located within the reserve? What actions have NEMA taken to address this phenomenon?

7. What are the threats and dangers of locating within the riparian reserve in the study area?

8. What could be the other possible solutions to effectively manage and conserve the riparian zone in the study area?

9. Are there past, present and/or future plans for the study area?

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NAME OF RESEARCHER: Mugambi Charles (REG. NO. B65/36199/2010)
DATE: .............................. TIME: ..............................

Ministry of Lands, Housing and Urban Development, Kiambu Physical planning office

Interview Schedule

*Use voice recorders, note pad and collect any maps and relevant data.*

**Section 1: Respondents Information**

1. Name of Respondent (Optional) .................................................................
2. Age ..............
3. Sex
   - Male □
   - Female □
4. Position.................................................................

**Section 2: Main Questions**

5. Under what sub-catchment region does the Ruaka Gacharage stretch of Ruaka River fall in?
6. What is the state of the riparian reserve in the River Stretch, in terms of:
   a. Established width
   b. current width
   c. Allowable land use activities
   d. current prevailing use
   e. Development
   f. Conservation and management
7. Are there any land use activities allowable within the riparian reserve? If yes, specify their uses and their basic minimum standards according to regulations.
8. Also, are there any activities known to the Ministry that are irregularly located within the reserve? What actions have the Ministry taken to address this phenomenon?

9. What are the forces driving activities to locate in the riparian reserve?

10. How has the Ministry dealt with the issue of encroachment in the riparian reserve?

11. Are there past, present and/or future plans for the Ruaka river Gacharage stretch?

12. a) What approaches has the Ministry used to manage and conserve the riparian zone?

   b) What are the additional approaches that the Ministry can use for effective management and conservation of the riparian zone?

   **THANK YOU**
UNIVERSITY OF NAIROBI
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PLANNING RESEARCH PROJECT ON THE CAUSES AND EFFECTS OF
ENCROACHMENTS ON RUAKA RIPARIAN RESERVE

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NAME OF RESEARCHER: Mugambi Charles (REG. NO. B65/36199/2010)
DATE: ………………………….. TIME: ……………………………

County Government of Kiambu, Kiambaa Sub County - Department of Environmental Planning & Management Interview Schedule

Use voice recorders, note pad and collect any maps and relevant data.

Section 1: Respondents Information
1. Name of Respondent (Optional) …………………………………………………..
2. Age ……………
3. Sex
   Male
   Female
4. Position………………………………………………………………………………

Section 2: Main Questions
5. Are there any land use activities allowable within the riparian reserve? If yes, specify their uses and their basic minimum standards according to regulations.
6. Also, are there any activities known to the Sub county that are irregularly located within the reserve? What actions have the sub county taken to address this phenomenon?
7. What services does Kiambaa Sub County provide to the various land use activities in the study area?
8. What has Kimbaa Sub County done to conserve the environment even in the presence of the growing informal sector?
9. What is the land use tenure system in the study area?
10. How much does the county collect as land rates/rents? How much does land cost in the area?
11. Are there past, present and/or future plans for the Ruaka River riparian reserves?

12. a) What management tools/strategies does the Sub county use in regards to the management and conservation of the riparian zone?

b) How have these tools been effective?

c) What additional tools or approaches can the sub County use to effectively manage the riparian reserve?

THANK YOU