TECHNICAL UNIVERSITY OF KENYA

Education and Training for the Real World

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

SCHOOL OF ARCHITECTURE AND SPATIAL PLANNING

DEPARTMENT OF SPATIAL PLANNING AND DESIGN

PLANNING RESEARCH PROJECT

IMPACTS OF RAPID LAND USE CHANGE ON PERI-URBAN INFRASTRUCTURE: A CASE STUDY OF THINDIGUA, KIAMBU COUNTY

By

ALEX MUNYU NJUGUNA

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BBEnv URBAN AND REGIONAL PLANNING

A Planning Research Project Submitted in Partial Fulfillment for the Requirements of the Degree of Bachelor of The Built Environment in Urban and Regional planning.

TITLE; IMPACTS OF RAPID LAND USE CHANGE ON PERI-URBAN INFRASTRUCTURE, A CASE STUDY OF THINDIGUA, KIAMBU COUNTY.

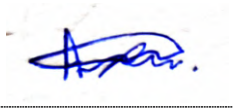
PRESENTED BY,

NAME: NJUGUNA ALEX MUNYU

REG NO: EAUR/01647/2018

DECLARATION

This planning research project is my original work and to the best of my knowledge, the work presented herein has not been presented for examination in any Institution of Higher Learning.



15/09/2023

Signed: Alex Munyu **Date**

(Student)

This planning research project has been submitted for examination and award of the degree with my approval as the Technical University of Kenya supervisor.

12/09/2023

Signed: Plan. Leina Kilesi **Date**

(Supervisor)

DEDICATION

I dedicate this work to all students pursuing Urban and Regional Planning and anyone in the research field of the built environment. I am extremely grateful to God, my family, and my friends for their unwavering support and encouragement during the research period.

ACKNOWLEDGEMENT

I would like to acknowledge everyone who either directly or indirectly contributed to the thoughts and actions that resulted in the completion of this planning research project. I want to thank you all from the bottom of my heart.

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I am also eternally grateful to my parents for their financial support: my father Samuel Njuguna and my mother Jane W. Muita for also instilling in me the spirit of dedication and my brother Nicholas for always being there for me and praying for me. I would also like to acknowledge my classmate Beverlyne Sambay for being a positive force throughout this project.

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I wholeheartedly express my sincere thanks and gratitude to each one of them as well as to those others whose names have not been mentioned for their valued contributions, which have all significantly influenced the direction of my work. **God bless you all!**

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ABBREVIATIONS AND ACRONYMS

CBD	:	CENTRAL BUSINESS DISTRICT
GIS	:	GEOGRAPHIC INFORMATION SYSTEM
LUC	:	LAND USE CHANGE

ABSTRACT

The conversion of agricultural land to residential use on the urban fringes fueled by an increase in urban population and economic growth has been a major cause of concern not only in Kenya, but around the world. Rapid urban population growth goes with a lack of equivalent growth in supply of urban land because land is inelastic and does not increase with increasing population. This therefore leads to the outward expansion of cities which causes land use land cover changes. People have in the recent years moved to the outskirts of cities in search of more cheaper housing options therefore urban Sprawl will be our future until this advantage is eliminated. Land on the outskirts of metropolitan areas will be transformed from open space (natural vegetation) or agricultural use to residential land use as long as demand for separate single-family houses remains high, but this has to be done with equal infrastructural expansions.

This study seeks to assess the effects of rapid land use change on peri-urban infrastructure specifically hard infrastructure (transport, energy, waste, water and sanitation infrastructure). The research project showed the inadequacy and ineffectiveness of the management framework used to control changes in agricultural land uses. Thindigua, Kiambu county was used as a case study to assess the effects of land use change on peri-urban infrastructure as no similar studies have been conducted on the area before. The area's good accessibility, property speculation for investments, significant investment returns by developers, demand for housing and rapid population increase were deduced to be the main drivers of land use changes. Peri-urban infrastructure is negatively impacted by onsite waste management methods, pollution and contamination of water supplies. Traffic congestion experienced along Kiambu road was also deduced to have been caused by the mass land use change. The area was therefore selected to represent such other areas in the country.

The study came to a management plan for resolving the issues by encouraging resilient and sustainable urban infrastructure planning. This will help to ensure that there is effective infrastructure, creation of an efficient neighborhood capable of promoting innovation and a higher quality of life, and economic development with shared prosperity and environmental respect.

CHAPTER ONE: INTRODUCTION

1.1 INTRODUCTION

As cities expand outward, new land uses emerge, and the tremendous impacts of urbanization may be seen at the fringes of cities and rural regions. (Barbara & Njiru, 2018) . Urban planners and policy makers therefore have a significant problem as a result of the effects of land use conversions on infrastructural and other environmental and socioeconomic challenges.

This research assesses how land use conversions affect peri-urban infrastructure with the main focus being on hard infrastructure (transport, energy, waste management and water and sanitation infrastructure). It aims to identify the factors that influence land use changes, and determine how they affect hard infrastructure in the area. The study asserts that, urbanization and exponential population increase in places with significant land fragmentation and land use changes are partially to blame for the declining state of existing hard infrastructure. Due to the haphazard nature of planning, the absence of an approved planning policy has encouraged significant land use changes in urban peripheries. contemporary agricultural land use conversions in urban fringes are highly prevalent and have both positive and negative impacts, with the latter by far outweighing the former.

Low agricultural returns, demand for housing, increase in urban population, weak and ineffective land use policies, and the proximity of the case study to Nairobi CBD are some of the contributing factors to the conversion of agricultural land use to residential and commercial uses. Together, these factors further present constraints to sustainable development and the creation of a safe, secure, and prosperous metropolitan, as envisioned by the Nairobi Metro 2030 and the Kenya Vision 2030 plans (*Kenya-Vision-2030-Sector-Progress-Project-Updates-June-2018*, 2008)

1.2 Background to the problem

Land use changes are mostly caused by urbanization, which transforms rural regions into urbanized zones. (Lambin et al., 2001) .Land use change, usually caused by urban sprawl and poor land use planning, is not a unique challenge in Kenya but a global challenge. (Knaap et al., 2007) noted that development is sprawling, not only in North America and Europe but in Africa as well. In spite of massive support, efforts to limit urban sprawl and preserve farmland remain largely elusive. Because most of the Global South is still predominantly rural as opposed to the western world, rapid developments have resulted in rapid land use conversions in developing

countries. The peri-urban zone, characterized by a variety of land uses that may change in relation to their functional linkages between urban and rural sectors, is the principal zone of direct influence as a city grows.(Nsiah Gyabaah, n.d.). The haphazard developments on major urban fringes as reflected in the numerous dormitory and satellite towns in the country can be attributed to the lack of an effective management policy framework guiding land use planning.

Thindigua in Kiambu county, formerly a predominantly rural agricultural area has over the years expanded leading to land subdivisions and conversions from agricultural to residential and commercial uses. A glance at the development trend in the area indicates that there has been rapid development projects which threaten forward planning interventions mainly in the form of un-matching infrastructure expansion. The area is characterized by among others; poor state of roads, lack of an effective supply of clean water, lack of street lighting and well-defined pedestrian walkways and the proliferation of informal settlements near high end residential properties. Despite the fact that similar studies on land use change in Kiambu county have been conducted previously, a void has been identified since those studies did not include management strategies to reduce the impact of land use change on peri-urban infrastructure. This planning research project therefore is aimed at promoting land use change-resilient peri-urban infrastructure with sustainable development.

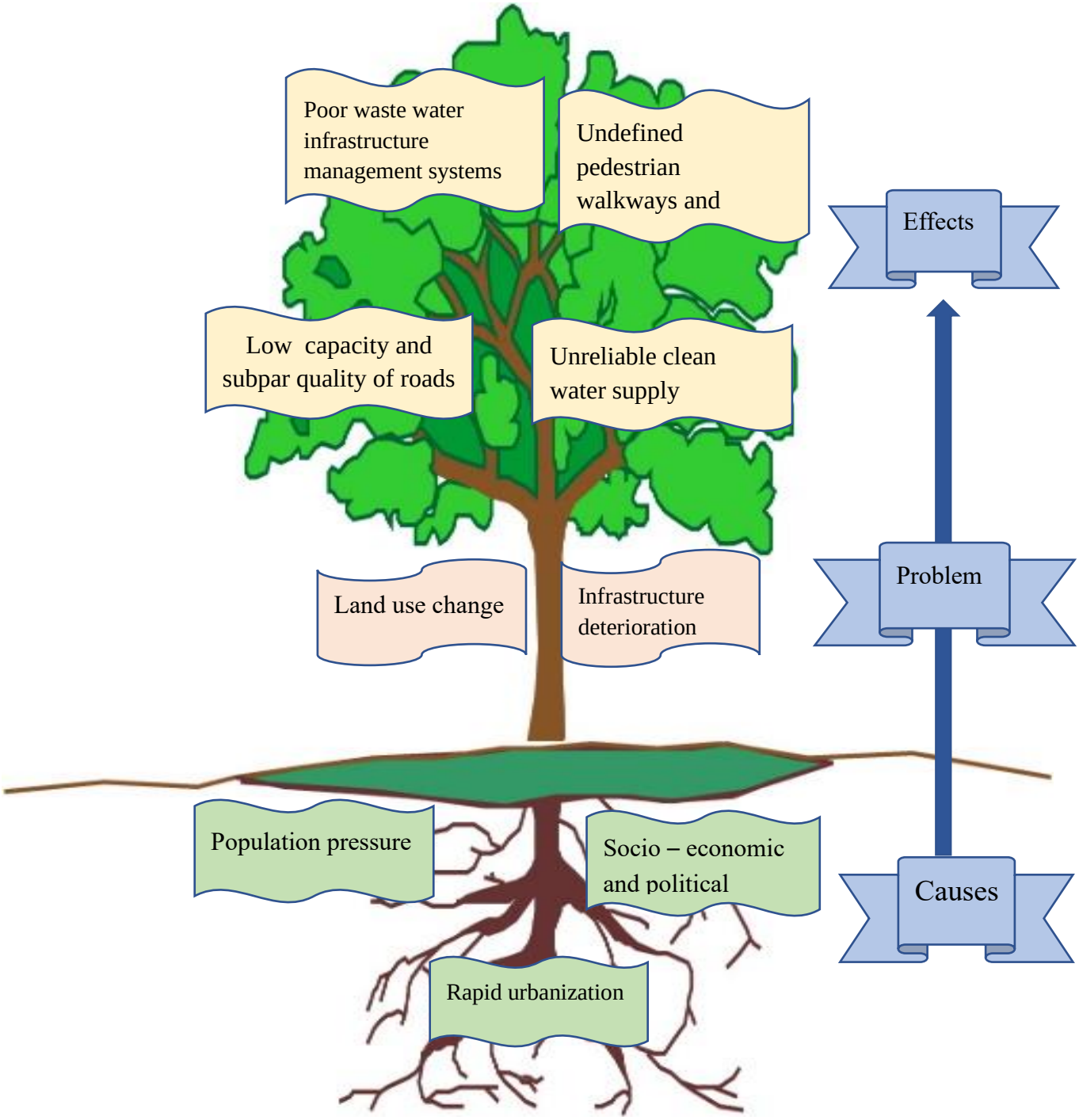
1.3 Problem statement

Nairobi city has emerged as one of Kenya's most urbanizing cities in the recent decades due to the high rate of population growth and rural-urban migration. This has increased the rate of urban sprawl into neighboring areas of Kiambu county due to its proximity to the city. (Naab et al., 2013) observed that rapid urbanization necessitates solutions to pressing social, economic, geographical, and environmental problems. The high rate of urban sprawl has therefore led to the subsequent conversion of agricultural land to real estate to accommodate the ever-growing demand for housing in the outskirts of the city. "Land that was traditionally agricultural is quickly being turned into concrete jungles to house city residents" (The Standard Newspaper, 2nd August, 2012). Despite the fact that urban areas are witnessing unprecedented land use changes, it is clear that most urban centers in Kenya are unprepared for urban growth and lack the resources to handle the impacts of land use changes on peri-urban infrastructure (Abuya et al., 2019) . Rapid urbanization and land use changes have put pressure on urban infrastructure and distribution systems, increasing the risks associated with them and raising capacity concerns due to poor planning, construction, and management. capability insufficiency, lack of guiding policies and Legal and institutional frameworks to guide in administration and development management all pose significant

challenges for policymakers attempting to manage such unprecedented urban growth. The problem has been exacerbated by the inability of county governments to strictly enforce development control.

Thindigua area has fallen victim in that a majority of coffee farms and small-scale Napier grass plantations have been faced out to give room for the construction of apartments and town houses. This uncontrolled change of land use from agricultural to residential and commercial combined with fast population growth has caused a strain on the already outdated peri-urban infrastructure. Access roads, which were previously footpaths leading to agricultural farms and single housing units, are now experiencing strain as a result of densification without corresponding hard infrastructure investment. This is due to the County Government's lack of a comprehensive policy for managing urban growth, as well as its lack of financial resources and technical proficiency to deal with the uncontrolled urban development. Kiambu County government has failed to effectively manage rapid urbanization. Due to this, hard infrastructure has suffered as a result of unregulated development and land use conversions. There has also been obstacles in managing the effects of the uncontrolled land use change on hard infrastructure, which are worsened by insufficient inter-agency coordination and collaboration. See Figure 1 below.

Figure 1: problem tree analysis



Source (Author)

This study aims at restoring the hard infrastructure in the site that has deteriorated due to pressure from the current land use. This will be achieved by carrying out revitalization, restoration, reconstruction and representing sustainable urban environment. This will help to ensure that there is effective infrastructure, creation of an efficient neighborhood capable of fostering a prosperous economy that benefits all citizens while protecting the physical environment. The end goal would therefore be to make Thindigua neighborhood "resilient" and "adaptive" to change.

1.5 Study objectives

1.5.1 Ultimate Objective

To promote land use change-resilient peri-urban infrastructure with sustainable growth through land use policy formulation and urban expansion regulation.

1.5.2 Specific objectives

- To assess the effects of rapid land use change on existing peri-urban infrastructure with more emphasis on the hard infrastructure.
- To develop a management strategy that can be used to reduce the effects of land use change on hard infrastructure.
- To come up with effective land use policies that will cushion hard infrastructure in the area.
- To plan for hard infrastructure expansion in the area.

1.6 Research questions

The following research questions have been formulated to provide a guideline for the study and analysis of the project:

- What is the extent of the strain on the existing infrastructure of the study area?
- What planning strategies can be employed to reduce the effects of land use change on the hard infrastructure?
- What land use policies have been put in place to control land use change in the area?
- What urban planning measures can be undertaken to reduce the adverse effects of land use change on the areas' hard infrastructure?

1.7 study Assumptions

The study assumes that:

- Urbanization and exponential population growth in places with significant land fragmentation and land use conversions are partially to blame for the declining state of existing hard infrastructure.
- The lack of a clear land use policy framework guiding land use conversions in the area has caused the strain on existing infrastructure.
- Thindigua has experienced urban deprivation (poor state of roads, lack of an effective supply of clean water, lack of street lighting and well-defined pedestrian walkways, among others) and thus it is declining in time.
- Revitalization of the area through hard infrastructure expansion will help combat the challenges that the area faces.

1.8 study significance

Changes in land use that result from urbanization present a difficulty for infrastructural oriented urban planning. This calls for a management plan to mitigate the blow effects on the same urban infrastructure. This study aims at giving the residents of the area a complete functioning neighborhood that caters for the needs of the present and the future generations. The study also aims at recommending ways of managing hard infrastructure deterioration to ensure that the residents live in a neighborhood that has; better service delivery, proper utilities, proper sanitation, safety and security of pedestrians and better transport solutions. The study's findings will inform the development of principles and strategies by urban planners aimed at bolstering neighborhood resilience to improve livability, economic opportunity, and social equity.

The main beneficiaries of this research project will be the residents of Thindigua, whom their neighborhood will be transformed in order to offer quality of life to them. The study will also seek to enlighten developers, property owners, land professionals and policy makers on how to achieve twin goals of infrastructural expansion and sustainable development as envisioned in Kenya vision 2030 and sustainable development goals (*Kenya-Vision-2030-Sector-Progress-Project-Updates-June-2018*, 2008)

1.9 study justification

Because of its convenient location along Kiambu Road, Thindigua has become home to a large population. Since people have discovered the area's benefits, the demand for housing has increased. This has put more

pressure on the areas' already strained infrastructure, necessitating new forms of management to mitigate the adverse effects.

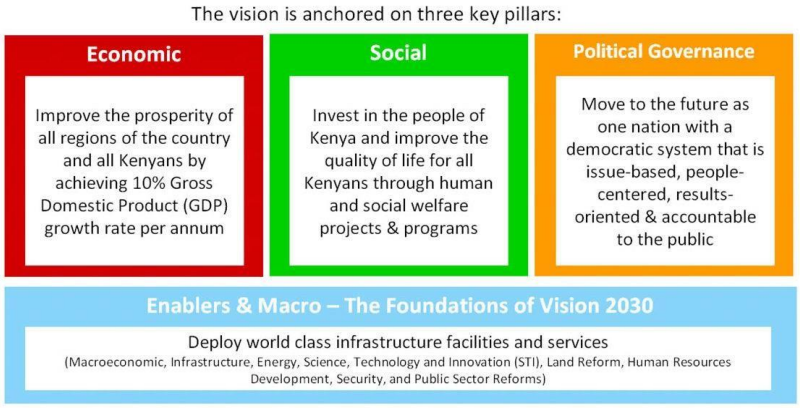
According to the National Land Policy (*2016 Physical Planning Department Ministry of Lands and Physical Planning*, 2016) , inadequate planning, rapid expansion of human settlements and activities, unrestricted urban sprawl, and a lack of necessary infrastructure have all hindered the development of land in urban and peri-urban areas. Therefore, urban and peri-urban areas will benefit from coordinated development of housing, commercial, industrial, and infrastructure if proper planning is implemented to accommodate changes in lifestyle and economic activity. Goal 9 of the United Nations 2030 Agenda (see Figure 2 below) for sustainable development - build resilient infrastructure and foster innovation seeks to "Develop quality, reliable, sustainable and resilient infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all (*Transforming Our World: The 2030 Agenda for Sustainable Development | Department of Economic and Social Affairs*, 2015)

Figure 2 : Sustainable development goals

Source (*Sustainable Development Goals - Google Search*, 2015)

This research is in accordance with the achievement of the Big 4 agenda, Kenya's vision 2030 (see Figure 3 below), the United Nations Sustainable Development Goals as well as the Global vision 2030 that aim to create just, cohesive and equitable social development in a clean and secure environment.

Figure 3: Kenya vision 2030



Source (*Kenya Vision 2030 - Google Search*, 2008)

1.10 study scope

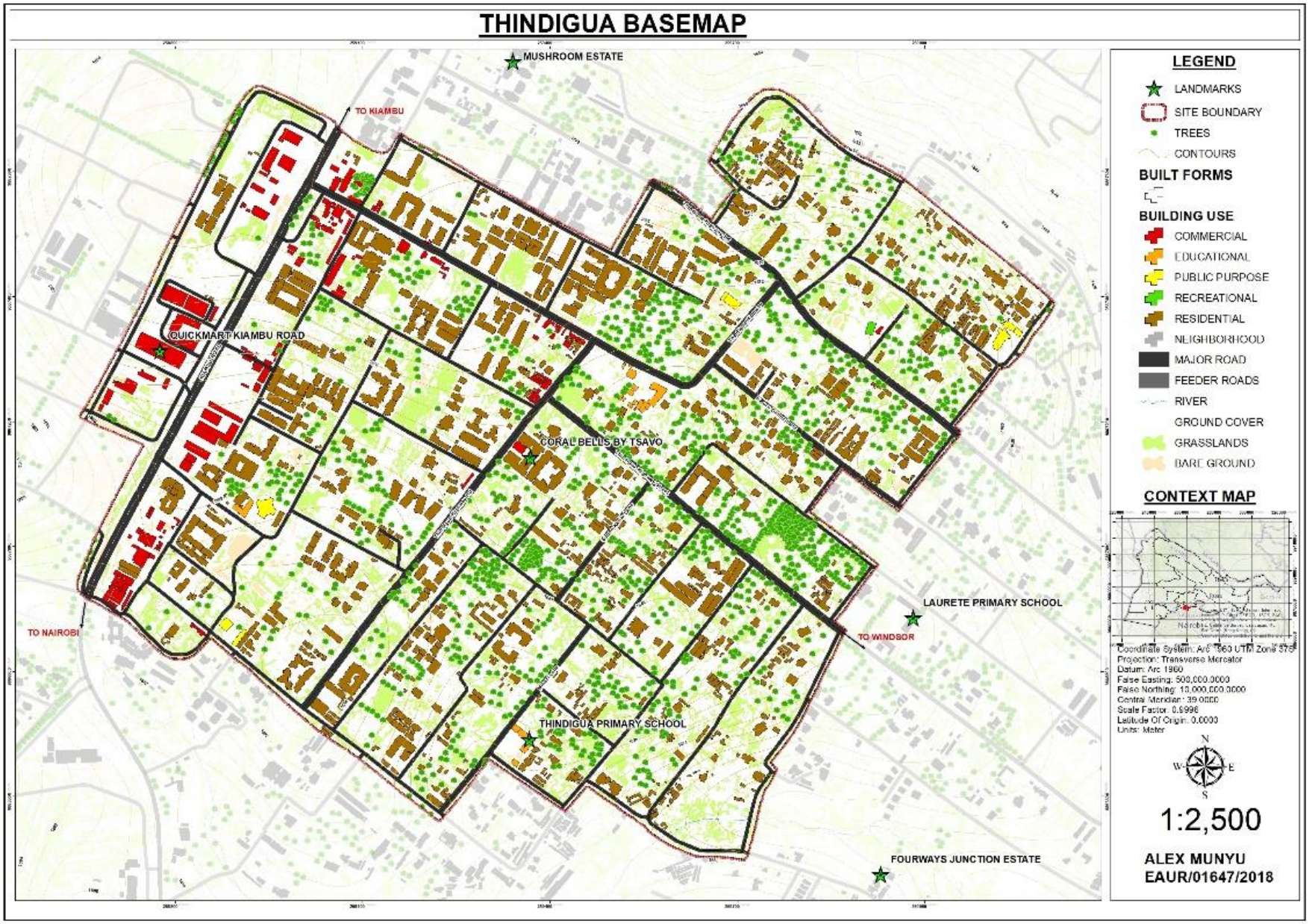
1.10.1 Theoretical scope

The main focus of this study is to manage the effects of land use change on peri-urban infrastructure. The study will review a number of case studies that have taken place around the world, as well as review publications and articles that are available about the topic, in order to come up with recommendations which will ensure the process to be a success.

1.10.2 Spatial scope

Thindigua is situated within Township Ward, Kiambu Sub-County, Kiambu County. The area is located North of Nairobi CBD and is easily accessed along Kiambu road. The area is situated between Longitude 36°49'12.17" and 36°51'25.51" East and latitudes 1°11'24.84" and 1°12'57.78"South of the Equator. See Map 1 below.

Map 1: study area Basemap



Source (Author, 2022)

1.11 study organization

This research project will be organized into six chapters.

Chapter one will focus on introduction, background to the problem, problem statement, purpose of the study, research questions, study objectives, study assumptions, study significance, study justification, study scope, study limitations and the study organization.

Chapter two entails the review of literature related to the topic. It will be in topics and subtopics, addressing itself to the objectives. It will also include theoretical and conceptual frameworks, hypothesis, statistical assumptions and definition of terms.

Chapter three features the methodological approaches that will be used in the study, the research design, research procedures and the different methods that will be used in the research. It will also focus on research ethics, work plan and timetable, as well as the research budget.

Chapter four focuses on the history and development of the areas with supported graphics, the different legal and institutional frameworks that will be applied, as well as the physical attributes of the area.

Chapter five will discuss study findings and analysis,

Chapter six will depict the results and discussions of the findings, and give conclusions, recommendations and areas of further research.

1.12 study methodology

The study intends to use qualitative, quantitative and mixed approach techniques such GIS mapping, interviews (both household and key informant), observations, taking photographs and review of different literature materials.

1.13 study limitations

The study will be limited to Thindigua neighborhood in Kiambu county.

Some of the limitations likely to be encountered include:

- Limited access to physical and online data due to bureaucracy
- Unfriendly respondents and bias by the respondents when giving out information.
- Illiteracy levels and language barrier among respondents during interviewing process.

- The time allocated for this research is limited in the sense of adequate data collection from the field and interview schedules on key informants.
- Unpredictable weather condition that occurs mainly during the data collection period.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter reviews the different relevant written materials that are available to deepen the understanding of land use change and infrastructure deterioration in peri-urban areas. Theoretical and conceptual frameworks are also looked at to inform the study.

2.2 Theoretical and operational definition of terms

Development Control: According to the (*PHYSICAL AND LAND USE PLANNING ACT*, 2019) (PLUPA)-Act No. 13, (part IV & Third Schedule), development control is the process through which a county determines whether (and with what conditions) a development proposal should be granted planning permission.

Peri-urban: refers to the transition spaces with some degree of intermingling of urban and rural uses normally found close to the cities. It is also referred to as the rural-urban fringe, urban hinterland, or the transition zone where urban and rural land uses mix and often clash.

Urban sprawl: refers to the expansion of urban areas to agricultural land caused by high population growth and rural-urban migration.

Natural expansion: refers to the creation of residential areas in undeveloped or underdeveloped regions.

Land use: purposes for which humans exploit the land resources that involve the management and modification of the natural environment.

Land use change: this refers to a change in the overall classification of land cover through a complete replacement of one type of land cover by another type due to a change in urban extent.

Hard infrastructure: refers to the large physical networks necessary for the functioning of a modern industrial nation. hard infrastructure is comprised of; transport infrastructure, energy infrastructure, communication infrastructure, waste management infrastructure, and water and sanitation infrastructure.

2.3 Overview

According to the (Kenya. & Kenya National Bureau of Statistics, 2019), Nairobi city is experiencing tremendous growth with an average annual population growth rate of 4%. This population growth rate is high in comparison to Kenya's average growth rate of 1.93%,(*Kenya Population Growth Rate 1950-2022* |

MacroTrends, 2022). Urban sprawl, environmental degradation, infrastructure deterioration, and informality are all prevalent problems as a result of the high population growth rate. There is a rising problem in peri-urban areas where population expansion and rapid developments are outpacing the development of necessary infrastructure and the availability of essential services. The lack of a coordinated planning and management framework, established for the city and its environs, is to blame for the haphazard growth of the peri-urban areas around the Nairobi Metropolitan region.

Two types of peri-urban developments are discussed by Aguilar and Ward (2017). The first is urban corridors, (such as Thika road and the by-pass ring roads around Nairobi), which are linear developments that may concentrate a dominancy of different activities along the corridor, such as commercial developments, residential areas, industrial parks, and density varies from very compact areas to low-urban density with a rural landscape in the middle. Second, new (low-income) residential developments within a metropolitan region, which may be causing the centralization of traditional towns once dominated by agricultural activities. Sub-centers, in Aguilar's view, function as mini-cities, supplying low-cost labor, centralizing a wide variety of services, and acting as dormitory neighborhoods for the larger city.

Most of the land parcels around urban areas are privately owned, according to (Thesis & Mahinda, 2016). Local governments' efforts to regulate growth are therefore hindered by the current land tenure system. Due to the shortage of funding, county governments are also unable to adequately monitor the regions where development control is weak. In addition, the peri-urban regions lack integrated strategic urban development plans to direct development. Better funding of the county government’s physical planning departments will go a long way in ensuring that there is enforcement and compliance with planning regulations. Also, it will ensure that developments in peri-urban areas are accompanied by adequate hard infrastructure expansion.

2.4 Review of natural expansion and Infrastructure Deterioration

A lot of studies have been conducted previously to show how population growth leads to natural expansion and how this, in turn, affects the existing infrastructure, both locally and internationally. From the specific objectives outlined in chapter one, the following works have informed the research, significant gaps identified and conclusions drawn;

Researchers (Abuya et al., 2019) studied land use change as a key factor in the deterioration of the infrastructure of Ruaka town, Nairobi. The purpose of the study was to determine how land use changes affected the hard infrastructure (roads, water supply, and wastewater infrastructure). The study's goals were to identify the factors that caused land use conversions and determine the resulting impacts on infrastructure.

Findings showed that urbanization and population growth in the area resulted in significant land fragmentation and land use changes, which in turn reduced vegetation and agricultural land while increasing built-up areas. The research concluded with the development of a management plan to solve the problems of rapid land use change by promoting resilient and sustainable urban infrastructure. The research however did not discuss the use of land use planning policies and zoning regulations that would best address the rapid land use conversions from agricultural to residential or commercial.

According to research conducted by (Kiita, 2013) on the good and negative implications of converting agricultural land to other uses, it was determined that such conversions were common in the outskirts of Nairobi city. Low agricultural yields, increased demand for housing, rising urban populations, inefficient development control agencies, and convenient proximity to Nairobi were the factors attributed to land conversions, according to the study. The research analyzed the spatial-temporal changes that occurred in the entire Kiambu county at a regional scale and therefore it was not possible to give a detailed analysis of the deteriorating state of infrastructure in the county. The study looked at how land conversions affected already-existing infrastructure at a broader scale, but it did not provide any guidelines for handling that strain. The research however suggested adopting a proactive development strategy (legal and institutional frameworks) to restrict developments as a means to minimize the negative effects of land conversions on the infrastructure.

(Asoka & Thuo, 2013) studied the effects of population expansion on infrastructure and service delivery in Eastleigh, Nairobi. The primary goals of the study were to; identify and characterize population growth trends; assess the effects of population growth on infrastructure and services and investigate existing initiatives and the extent to which they can ensure the long-term viability of infrastructure and the efficient delivery of services in the area. The research showed that population growth was unavoidable, and it is becoming more widely acknowledged that infrastructure development and management was crucial to resolving urban issues. Population expansion that is sudden and unanticipated has proved to put a strain on infrastructure since the rising number of people need more services that can’t be provided by existing systems. The research however did not assess the potential impacts of commercial activities that dominate Eastleigh and how the infrastructure was affected as a result of change of use applications from residential to commercial.

Another researcher (Abayomi, 2019) examined the effects of high-density residential development on infrastructure provision in Ikorodu, Lagos, Nigeria, using a case study of Ayangburen Jubilee Estate. The research sought to assess the development policy framework in the estate. The research also looked at how sustainable housing utilities and infrastructure may function in tandem with future expansion in the area. The

study's results indicated several interventions and recommendations, including; physical infrastructure upgrades, Sustainable designs, policy review, green infrastructure integration, and public participation, could help to halt and reverse the negative changes in the neighborhood. This research, however, failed to show the spatial-temporal changes that had occurred in the estate over the years, and therefore it was difficult to proactively plan for the future expansion of the estate.

2.5 Factors influencing land use changes

Examining the factors influencing land use changes and the effects of these changes over time are all necessary for effective peri-urban infrastructure planning. population increase is the key driver to land use change because it leads to urban sprawl into peri-urban areas of Kiambu county. This would be in terms of a natural increase in population or migration of people to peri-urban areas as a result of push-pull factors such as availability of land, proximity to the workplace, and perceived better facilities and services. The lack of a clear guiding policy framework for land use conversions and development control in Kiambu is also a factor and therefore developers often make independent decisions. The economic growth of the Nairobi metropolitan region has experienced land transformation with massive urban developments and land use changes from agricultural to residential or change of use from single dwelling to multi dwelling units. Land speculation which is the expectation of land price appreciation is also a factor in that investors have bought speculative land in peri-urban areas and made change-of-use applications on the parcels ready to sell to developers at an inflated price. The high living cost and property cost in parts of the city as compared to the peri-urban areas within Kiambu county has also influenced land use changes. And lastly, Land rates payable to the County Government have increased and therefore some farmers have found it uneconomical to continue practicing agriculture which has little returns as compared to real estate.

2.6 Impacts of land use changes on infrastructure

Roads, traffic patterns, and other aspects of urban mobility are affected by changes in land use. Therefore, urban development necessitates road expansions to improve mobility and safety, which in turn necessitates road extension and new road constructions. More development projects are drawn to areas with a growing population to meet the need for urban services, thus adding to the strain on the already overwhelmed infrastructure (Morimoto, 2012).

Water quality and quantity are impacted by urbanization and land use changes, but the severity of these impacts varies depending on where and how the disturbances occur (Huggett et al., 2004). Water scarcity is an increasing problem in many parts of the country due to factors such as climate change, global warming, water

restriction, and prolonged droughts. High rates of natural expansion and land use changes have been blamed for this since they put a strain on an already scarce water supply. (Wilson et al., 2016) .

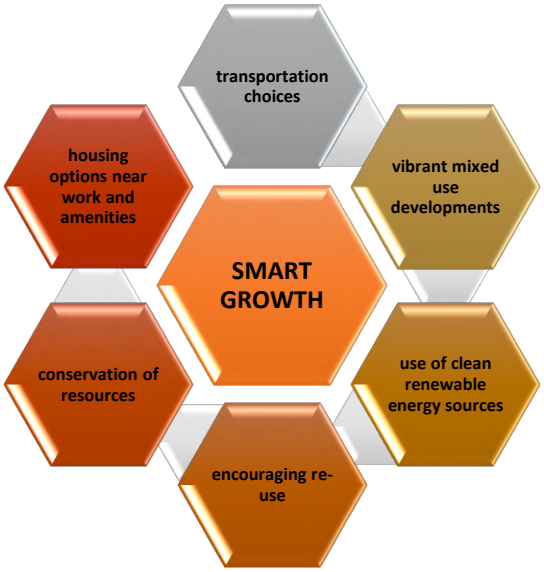
Natural expansion leading to land use change leads to water and air contamination and rising local temperatures (increase in impervious surfaces) (Wu, 2008), air pollution from people's reliance on cars, water pollution from a lack of aquifer replenishment caused by an increase in impermeable urban surfaces. Natural expansion has also been attributed to poor solid and liquid waste management. (Bhatta, 2010).

2.7 Theoretical framework

2.7.1 Smart growth theory

Development based on the theory of "smart growth" recognizes the inevitability of natural growth and peri-urban development and aims to steer it in a planned, holistic manner. Smart growth theory is an attempt to neutralize urban sprawl and the negative effects accompanying it, such as infrastructure deterioration, air pollution, road congestion, and lack of affordable housing. Among its tenets is the promotion of transit-oriented, walkable, and bicycle-friendly land uses, as well as the inclusion of adaptive hard infrastructure, complete streets, use of renewable sources of energy, and mixed-use development with a variety of housing options. By focusing on infill and redevelopment rather than "greenfield" agricultural or natural areas development, smart growth ideas aim to create sustainable neighborhoods that provide a wider variety of transportation, housing, and energy options. Instead of just thinking about the present, smart development plans for the great future of the entire area. It aims to preserve and enhance natural resources, equitably distribute the costs and benefits of development, promote public health, preserves and invest in built and natural resources, and foster livable, safe, and healthy places, all of which stimulate economic growth and development. Thindigua area, therefore, needs some aspects of smart growth principles in planning for its infrastructure and services.(Shrivastava & Sharma, 2012)

Figure 4: smart growth principles

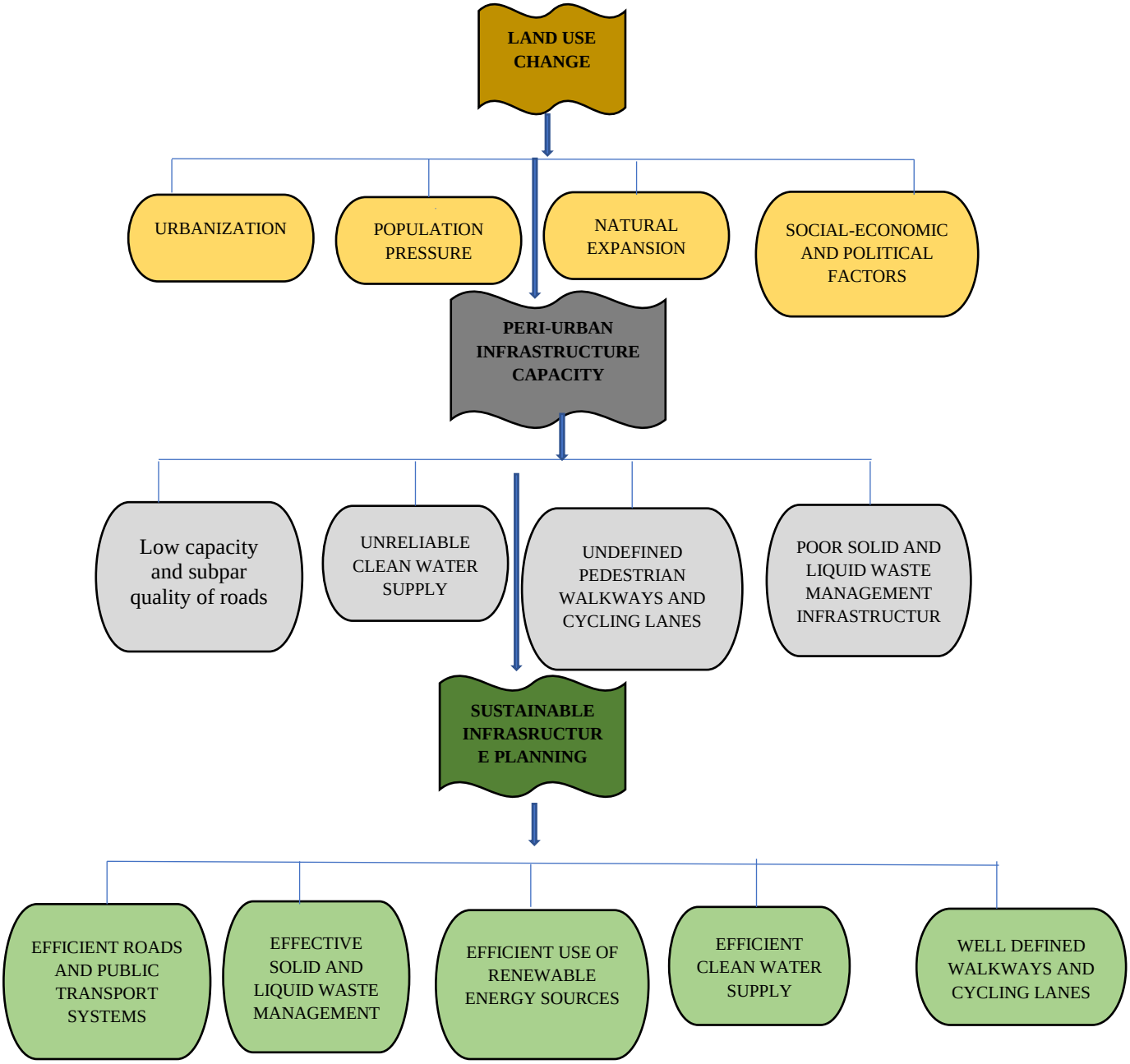


Source (Author, 2022)

2.8 Conceptual framework

As it has been established by prior research and theories on land use differentiation, land use changes include the causes and impacts of land use changes. The conceptual framework is based on these ideas. Changes in land use are the independent variable; the capacity of peri-urban infrastructure is the dependent variable; and natural expansion, urbanization, population pressure, and socioeconomic, and political factors are the intervening variables that are straining the hard infrastructure in Thindigua. The impacts of land use changes on peri-urban infrastructure capacity in the area include; poor state of roads, lack of an effective supply of clean water, lack of street lighting and well-defined pedestrian walkways, and poor solid and liquid waste management. A proactive planning approach to remedy the negative impacts on urban infrastructure would therefore need to be developed. Focus on the resilience, sustainability, and efficiency of urban infrastructure systems should be a primary goal of any plan developed to address the impacts of land use change on these systems. Resilience, which seeks to ensure the effective functioning of peri-urban infrastructure systems even after major disturbances, sustainability, which seeks to consider the meaningful exploitation of resources by the present generation without compromising the capacity of future generations to utilize the same and efficiency, which seeks to minimize wastes, all need significant attention. Figure 5 below is an illustration of the conceptual framework.

Figure 5 : Conceptual framework



Source (Author, 2022)

2.9 Research questions

- What is the extent of the strain on the existing infrastructure of the study area?
- What planning strategies can be employed to reduce the effects of land use change on the hard infrastructure?
- What land use policies have been put in place to control land use change in the area?
- What urban planning measures can be undertaken to reduce the adverse effects of land use change on the areas' hard infrastructure?

2.10 Hypotheses: Ho and Ha

Null hypothesis – the declining state of hard infrastructure in the area is caused by other factors excluding the rapid rate of land use conversions.

Alternative hypothesis-Urbanization and exponential population growth coupled with significant land fragmentation and land use conversions are partially to blame for the declining state of existing hard infrastructure in the area.

2.11 Conclusion

From the discussions above, it is crystal clear that population growth coupled with rapid land use change is causing a strain on the already outdated peri-urban infrastructure systems. This research, therefore, seeks to use land use planning policies to control land use changes in Thindigua and also match infrastructure expansions with developments in the area.

In conclusion, sustainable peri-urban growth requires proactively planning for development rather than reactively planning. Smart growth principles ought to be integrated into urban planning and development control of peri-urban areas to reduce the sprawling effects of sub-urbanization on the infrastructure and preserve Greenfields for sustainable development.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter discusses the methods and techniques that were used in carrying out data collection, analysis, interpretation, and presentation. It gives a general guideline on what procedures were followed and gives a detailed description of the research approach, research design, research methods, sampling techniques used, data processing, the ethics involved in the research, the research budget, and work plan.

3.2 Research approach

Different approaches adopted in the research include qualitative research, quantitative research, and mixed approach.

3.2.1 Qualitative research

This involved collecting data from the participant's preferred time and location, and the researcher interpreted and made conclusions from the data collected, which was in form of questions, statements, and procedures. It utilized methods such as; - observation, interviews, use of photographs, and interactions such as focus group discussions.

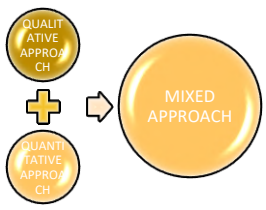
3.2.2 Quantitative research

This approach involved collecting and converting data into numerical forms that would then draw relevant conclusions. It also involved coming up with hypothesis, preparing checklists, and collecting samples.

3.2.3 Mixed approach

This involved the simultaneous utilization of both the quantitative and qualitative approaches without necessarily sticking to one. This study, therefore, used the mixed approach. See Figure 2 below.

Figure 6 : mixed approach



Source (Author, 2022)

3.3 Research design

This research study deployed the following three research design approaches:

i. Descriptive design, which relied on observation as a means of collecting data and use of photography during field survey. The design was also applied in administering questionnaires, interview schedules, and filling out fieldwork checklists.
ii. Comparative design, which was used to compare past and present or different parallel situations. This design sought to compare the interplay between land use change and infrastructure deterioration in the study area.
iii. Review design, which involved literature review.

3.4 Research situs

The study was carried out in Thindigua which is situated within Township Ward, Kiambu Sub-County, Kiambu County. The area is located North of Nairobi county, 10.3 km from the CBD along Kiambu road. The area covers approximately 1.2154 square Kilometers. The area is situated between Longitude 36°49'12.17" and 36°51'25.51" East and latitudes 1°11'24.84" and 1°12'57.78"South of the Equator.

3.5 Research methods

This planning research project adopted both observational and opinion-based methods. The observational methods used included observation and the use of photographs while the opinion-based methods included the use of questionnaires and interview schedules.

3.6 Data collection techniques

Various data collection techniques were applied to collect relevant data that would aid in answering the research questions. The methods were selected based on which technique would collect comprehensible data necessary for the research. A combination of both secondary and primary data collection techniques was established to be the most suitable technique to answer the research questions posed.

3.6.1 Secondary data collection

The majority of the secondary data was sourced online, but a few were from the library. The secondary data collection techniques deployed in the research study were:

i. Literature reviewing

It involved a review of books, reports, various publications by the county and national government, public records and statistics, international policy papers, and information from relevant YouTube videos.

ii. Case studying

The research study analyzed the study area and its relationship to other similar areas. Case studies were chosen based on best practices in the management of peri-urban infrastructure systems both locally and globally. The cases were subjected to exhaustive study to establish a better understanding of the concepts, strategies, and principles used in the management of hard infrastructure.

3.6.2 Primary data collection

Primary data collection techniques deployed in the research were;

i. Observation

The research adopted a participant observation method, whereby the researcher visited Thindigua neighborhood and observed the existing conditions i.e.; the existing land uses, state of the roads, drainage channels, and other hard infrastructure in the area. It also involved behavior observation of the residents, the economic activities, and the natural physical environment of the area. Data was recorded by writing field notes, filling a fieldwork checklist, sketching, photographing, and taking measurements.

ii. Interviews

This research used interviews mainly to get insights from key informants from various stakeholders from the county government of Kiambu. The interviews took place at the interviewee's setting (time and place). Both structured and semi-structured interview was used to obtain data from the interviewees. Table 1 below is a summary of the interview schedule.

Table 1: Interview schedule

Stakeholder	Time	Date	location
Physical planners (Department of urban development)	10 am – 12am	31/10/2022	County planning offices (Kiambu county)

Department of public works	2 pm – 4pm	02/11/2022	Public works offices (Kiambu county)
Kenya power and lighting company	8 am – 9am	04/11/2022	Kenya power offices (Kiambu town)
Kiambu water and sewerage company	8 am – 10am	11/11/2022	KiWaSCo offices (Kiambu town)

Source (Author, 2022)

iii. Questionnaires

Household questionnaires were administered using kobo toolbox which is a data collection tool that enables researchers to save responses in a server online rather than manually filling hardcopy questionnaires. Face-to-face contact with the respondents had the advantage of ensuring accurate data was captured. However, the researcher had to promise the respondent their confidentiality as this aided in building a trusting relationship with the respondents.

iv. Mapping

GIS software (Arc map) was used in the mapping of the spatial distribution of features on the site. It greatly assisted in the collection, storage, display, detection, and analysis of land use changes in the study area. Image classification was used to analyze Satellite images of the site and determine the nature of changes in the built environment and vegetation cover.

Table 2: primary data collection techniques and their tools

Technique/method	Tools
observation	Fieldwork checklist
interviewing	Structured and semi-structured interviews
questionnaire	KOBO toolbox
photography	camera
mapping	ARC GIS software

Source (Author, 2022)

3.7 sampling

The researcher was able to understand the study area better after sampling was conducted.

3.7.1 Population and sample size

According to the Kenya population and housing census (Kenya. & Kenya National Bureau of Statistics, 2019) Thindigua area has a population of 22,401 people and a population density of 1,091persons per square kilometer. However, the study area accounts for a portion of the total geographical area of Thindigua and therefore the population of the site was calculated using the population density and the area of the site in square kilometers using the formula;

population = population density * site area (in square kilometers)

population = 1,091 * 1.2154

population = 1326 people

The sample size selected was based on the following criteria; the size of the population, the margin of error (10%), confidence level (90%), and the standard deviation of 5. Based on the criteria above, the following formula was applied to come up with the sample size.

Necessary sample size= (Z-score)^2 x StdDev x (1-Std)/ (Margin of error)^2

N/B: Based on the Z-score table, a confidence level of 90% will have a z-score of 1.645.

If the target population was 1326, a sample size of 40 persons was arrived at as per the formula.

3.7.2 Sampling method

The following sampling methods were used in the study;

i. Convenience sampling

This involved selecting respondents who were available to the researcher. The researcher targeted any random resident in the study area and administered questionnaires online.

ii. Judgment sampling

The researcher utilized this method to identify “representatives” of the sample frame who would best suit the purpose and nature of the research project. In this regard apartment managers, senior citizens, and the “mama mboga’s” were selected and questionnaires were administered to them.

iii. Voluntary response sampling

Word was given out to the chairman of the resident's association of Thindigua, and to the Assistant Chief, to alert people of the ongoing research survey. Residents who were willing to participate in the survey were given questionnaires to fill out. The information given offered a better understanding of the existing situation in Thindigua.

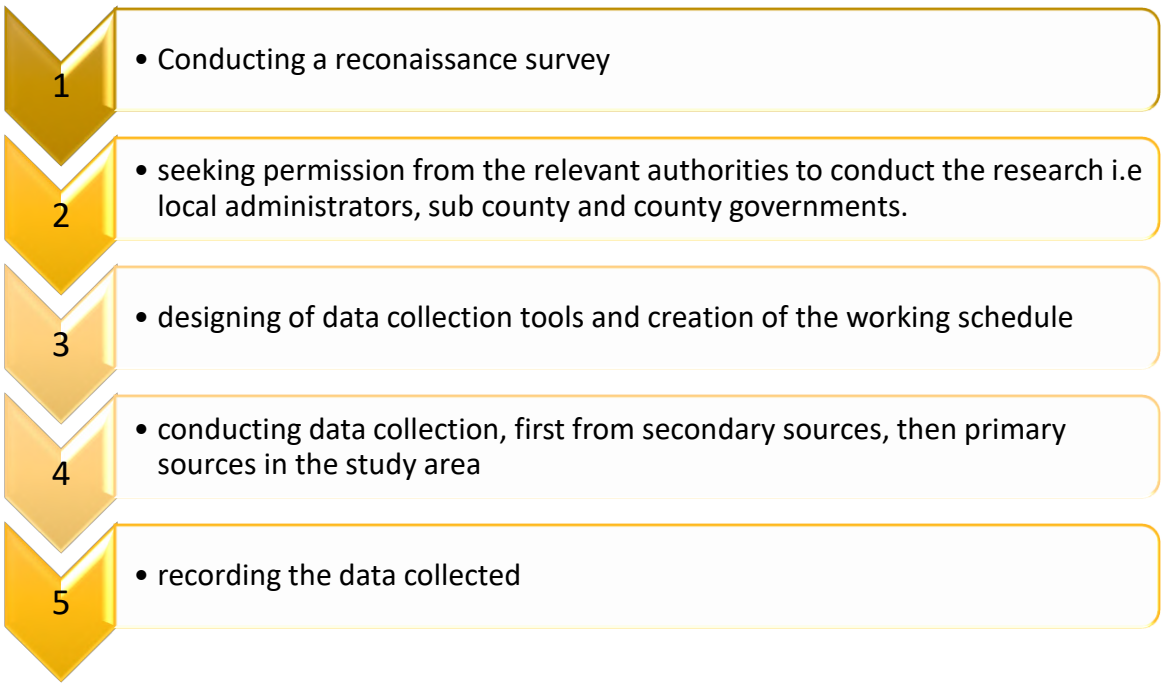
3.8 Subjects

The subjects of the research were the residents of Thindigua, officers from the County Government of Kiambu, and other relevant stakeholders.

3.9 program for data collection

Figure 7 below shows the steps that were taken during the field survey.

Figure 7 : program for data collection



Source (Author, 2022)

3.10 data processing

This was done through coding, editing, classifying, tabulating, and diagramming the research data collected. Computer software such as Arc map, Microsoft Excel, Microsoft power point, Microsoft word, and SketchUp were used.

3.11 data analysis and presentation

Data analysis involved evaluating the data collected through cleaning, processing, and transforming the raw data into simpler and more meaningful forms. After data analysis, the data was presented in form of graphs, pie charts, tables, and maps to explain the various relationships in a much simpler and easier way. For data that could not be presented graphically e.g., interviews by key informants, a report was written on the same.

Data analysis and presentation enabled the researcher to properly understand the study area by creating a visual impression of the site.

3.12 pretests and pilot study

A pilot study was conducted a day before the actual site visit to put data collection tools to test. This assisted the researcher to assess the efficiency of the data collection tools and also plan the mitigating measures for any problem that arose during the actual field day. The pilot study enabled the researcher to assess the availability of the respondents during the actual field day as well as familiarize with the behaviors of the respondents. This, therefore, enabled the researcher to plan their time and have a schedule for the various respondents thus minimize on time wastage.

3.13 research ethics

Various research ethics were applied during the study to ensure the attainment of the research goals in a manner that was true, knowledgeable, and with minimum instances of error. The research ethics also ensured that the research did not falsify, fabricate or misrepresent any data collected. The research ethics applied in the study include;

i. Ensuring voluntary participation of the respondents in the research whereby they were free to withdraw from participating in the survey
ii. Ensuring that the privacy and anonymity of the respondents was maintained throughout the study.
iii. Acknowledging the works of other authors used as references throughout the study.

3.14 work plan and timetable

Formulation of a work plan by the researcher aided in planning and time management during the study to have the various deliverables on time. Table 3 below is a summary of the work plan adopted by the researcher.

Table 3: work plan and timetable

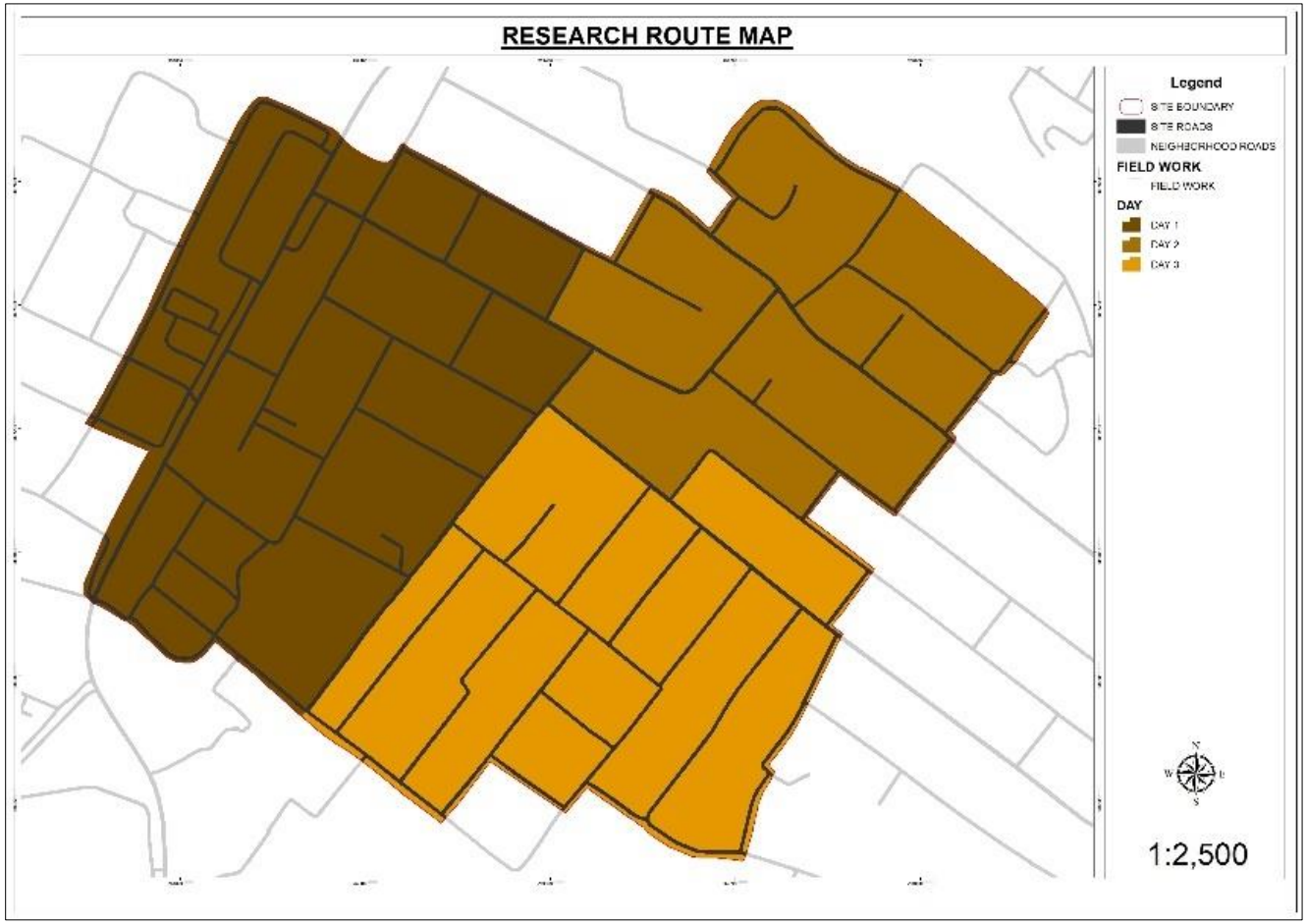
SEPTEMBER TO DECEMBER 2022																
	ACTIVITIES	DURATION IN WEEKS														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Project Formulation																
2	Literature Review																
3	Methodology and Research tools																
4	Data collection																
5	Situational analysis																
6	Case Studies																
7	Concepts and Visions																
8	Structure Plan																
9	Master Plan																
10	Part Development Plan																
11	Sections, Perspectives, and elevations																
12	Implementation matrix																
13	Project Costing																

Source (Author, 2022)

3.15 Research route map

Map 2 below shows the route map used during fieldwork.

Map 2 : Research route map



Source (Author, 2022)

3.16 research budget

The planning research budget was purely run on the researchers' own finances. Table 4 below is a summary of the research budget.

Table 4 : research budget

ITEM	DESCRIPTION	QUANTITY	COST	TOTAL COST (KSH)
Base map printing	A1	1	150 *1	150
Questionnaires	A4	1	20*1	20
Interview schedule	A4	1	20 * 3	60
Focus group discussion	A4	2	10 * 2	20
Checklist	A4	1	10 * 2	20
Report	A4	3	500*3	1500
Compact disks	-			100
Transport	Road			500
TOTAL				**2350**

Source (Author, 2022)

CHAPTER FOUR: STUDY AREA

4.1 Introduction

This chapter gives a clear picture of the area under study by detailing its spatial and non-spatial dynamics and components. This involves describing the study area's historical development, physiographic features, infrastructure, demographics, and land use changes as well as the legal and institutional frameworks concerned.

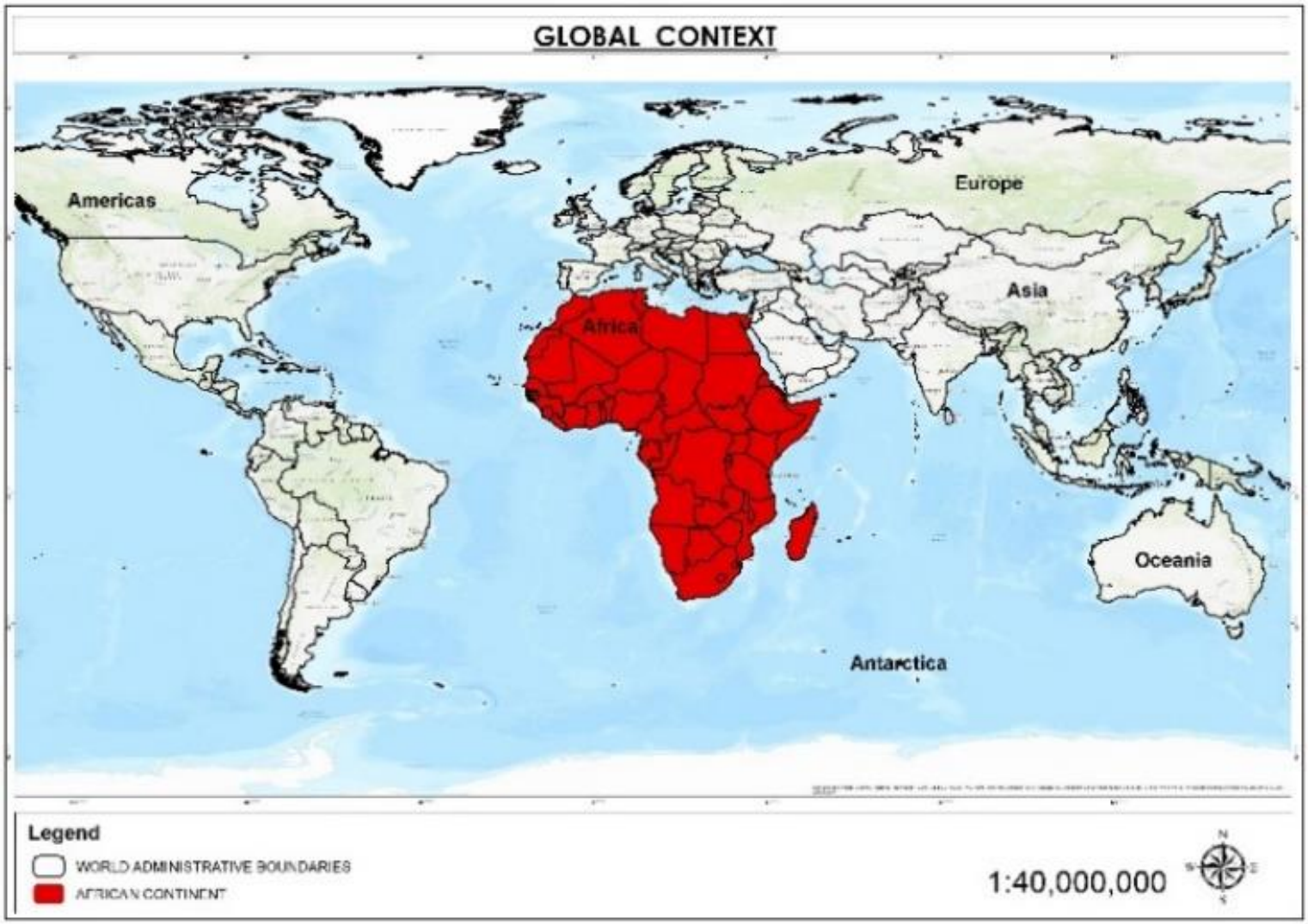
4.2 Spatial location and context

This section discusses the spatial context of the study area from global to local.

4.2.1 Global context

The study area is located in the African continent which is surrounded by the Mediterranean Sea, the Indian Ocean, and the Atlantic Ocean. See map 3 below.

Map 3: Global context



Source (Aurthor,2022)

4.2.2 Continental Context

Africa is the World's second-largest and second-most-populous continent, after Asia in both cases. At about 30.3 square kilometers, it covers 6% of the Earth's total surface area and 20% of its land area. With 1.4 billion people as at 2021, it accounts for about 18% of the world's human population (*Africa - Wikipedia*, 2022) . See Map 4 below.

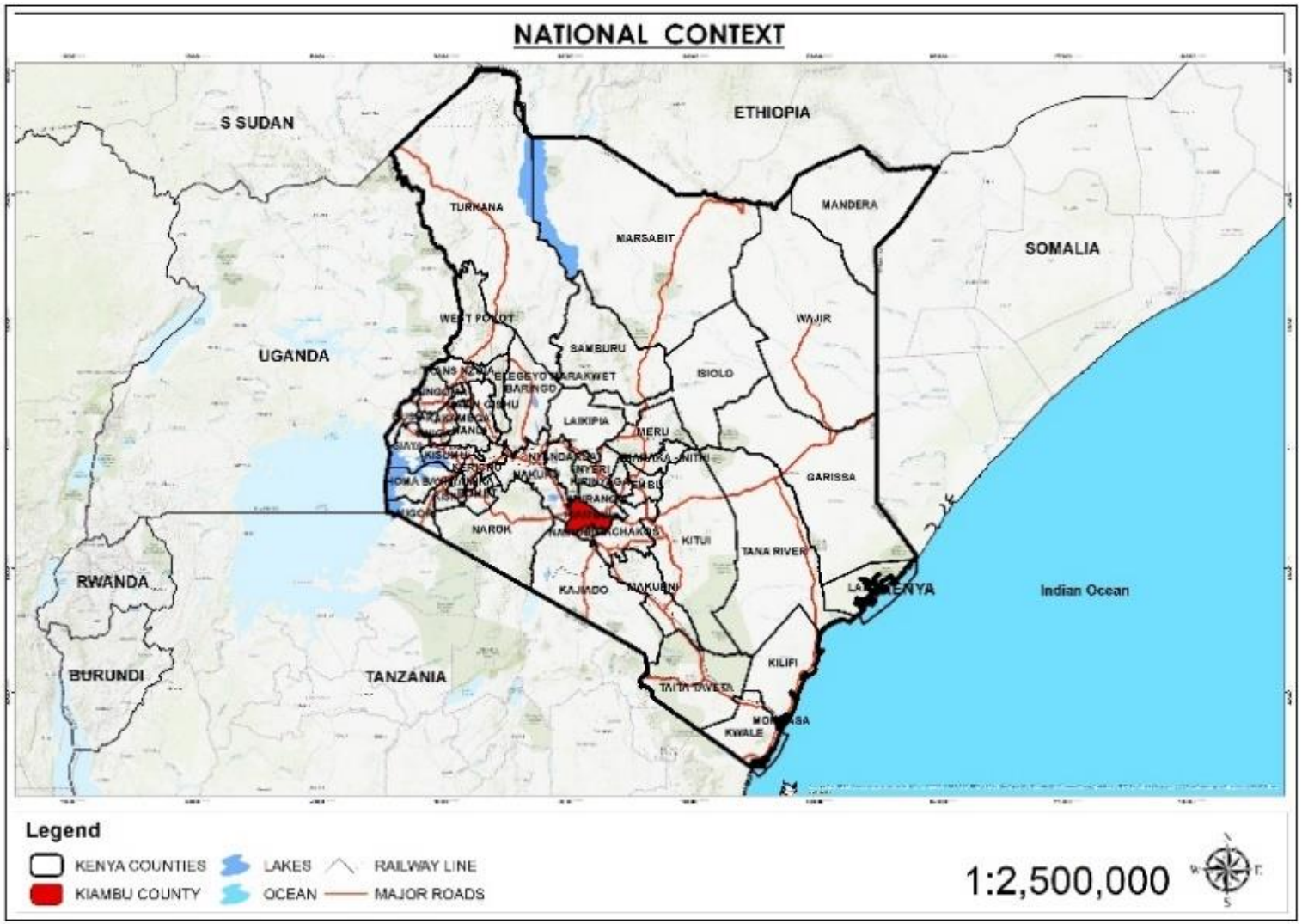
Map 4: Continental context

Source (Aurthor,2022)

4.2.3 National Context

The study area is located in Kenya which lies in East Africa. At 580,367 square kilometers, Kenya is the world's 48th largest country by area with a population of about 47.6 million according to the 2019 Kenya Population and Housing Census. (*Kenya - Wikipedia*, 2022) . See map 5 below.

Map 5: National context

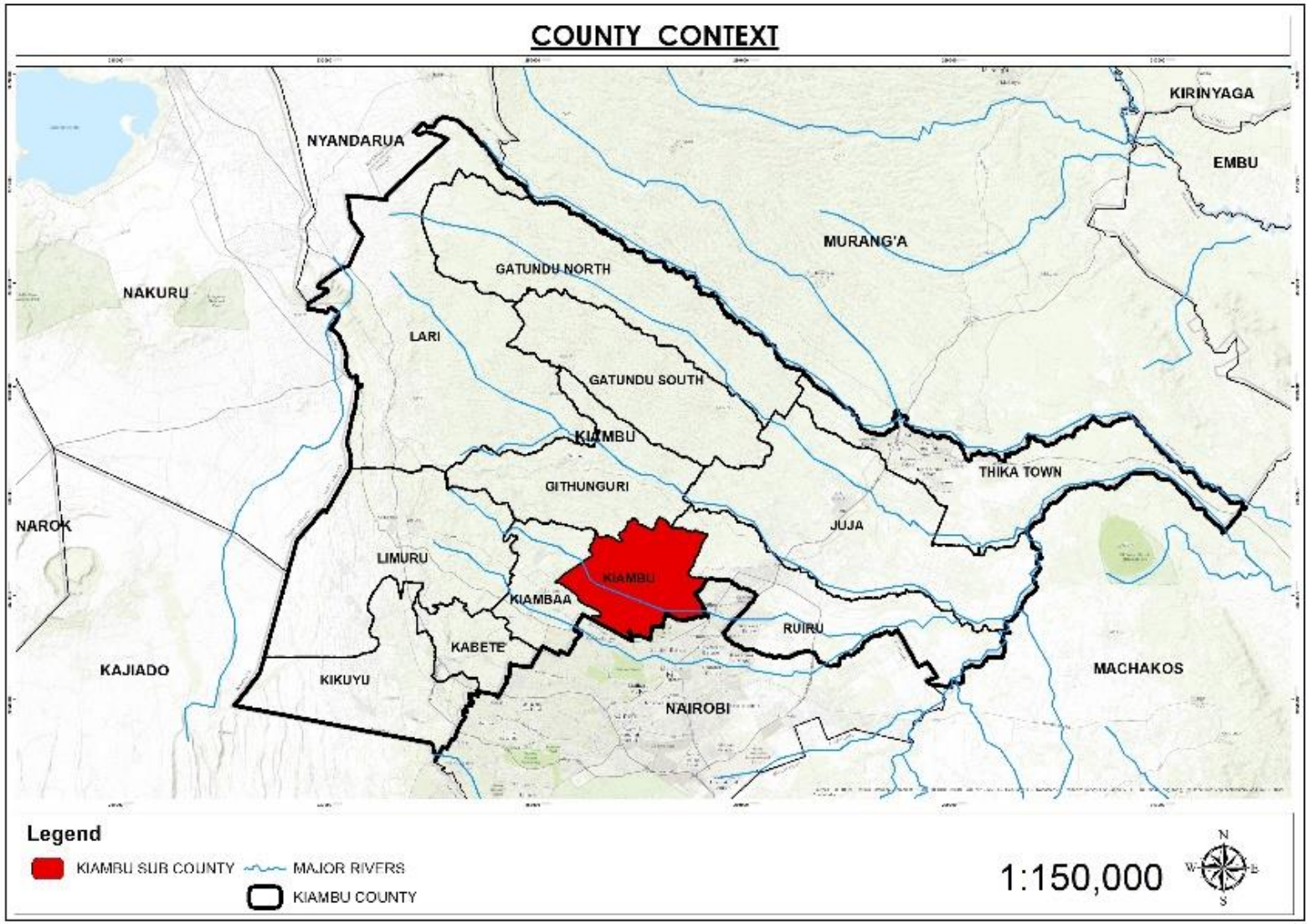


Source (Aurthor,2022)

4.2.4 County Context

The study area is located in Kiambu county in the former central province of Kenya. Its capital is Kiambu town and its largest town is Thika. Kiambu county is the tenth smallest county in Kenya and the second most populous after Nairobi County. The county is 40% rural and 60% urban owing to Nairobi's consistent growth Northwards. (*Kiambu County - Wikipedia*, 2022). Map 6 below.

Map 6 : County context

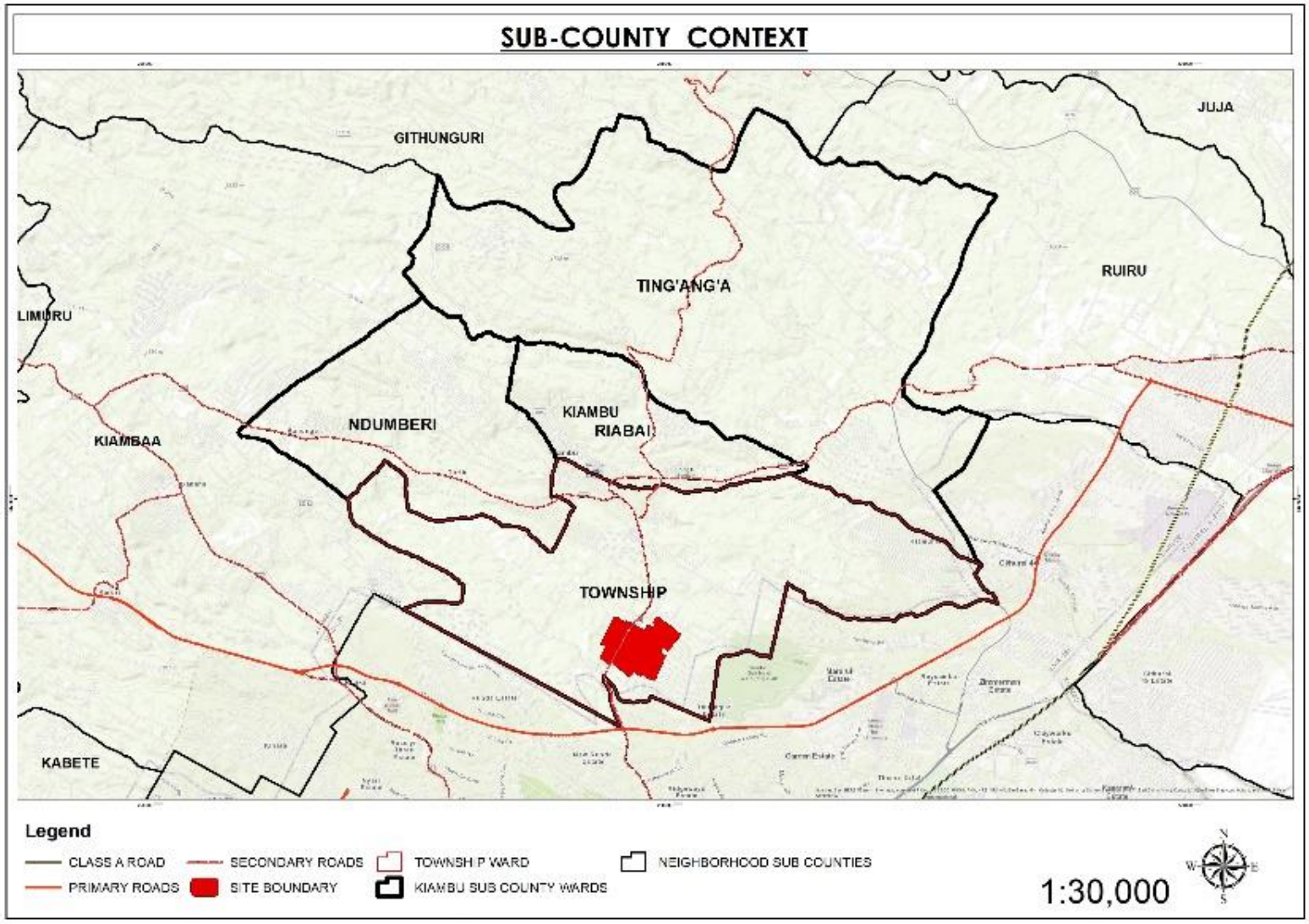


Source (Aurthor,2022)

4.2.5 Sub-County Context

The study area is located within Kiambu sub-county which is among the twelve sub-counties in Kiambu county. Kiambu sub-county is peri-urban and is experiencing developments at a rapid rate due to its location on the urban fringe of Nairobi County. See Map 7 below.

Map 7 : sub county context

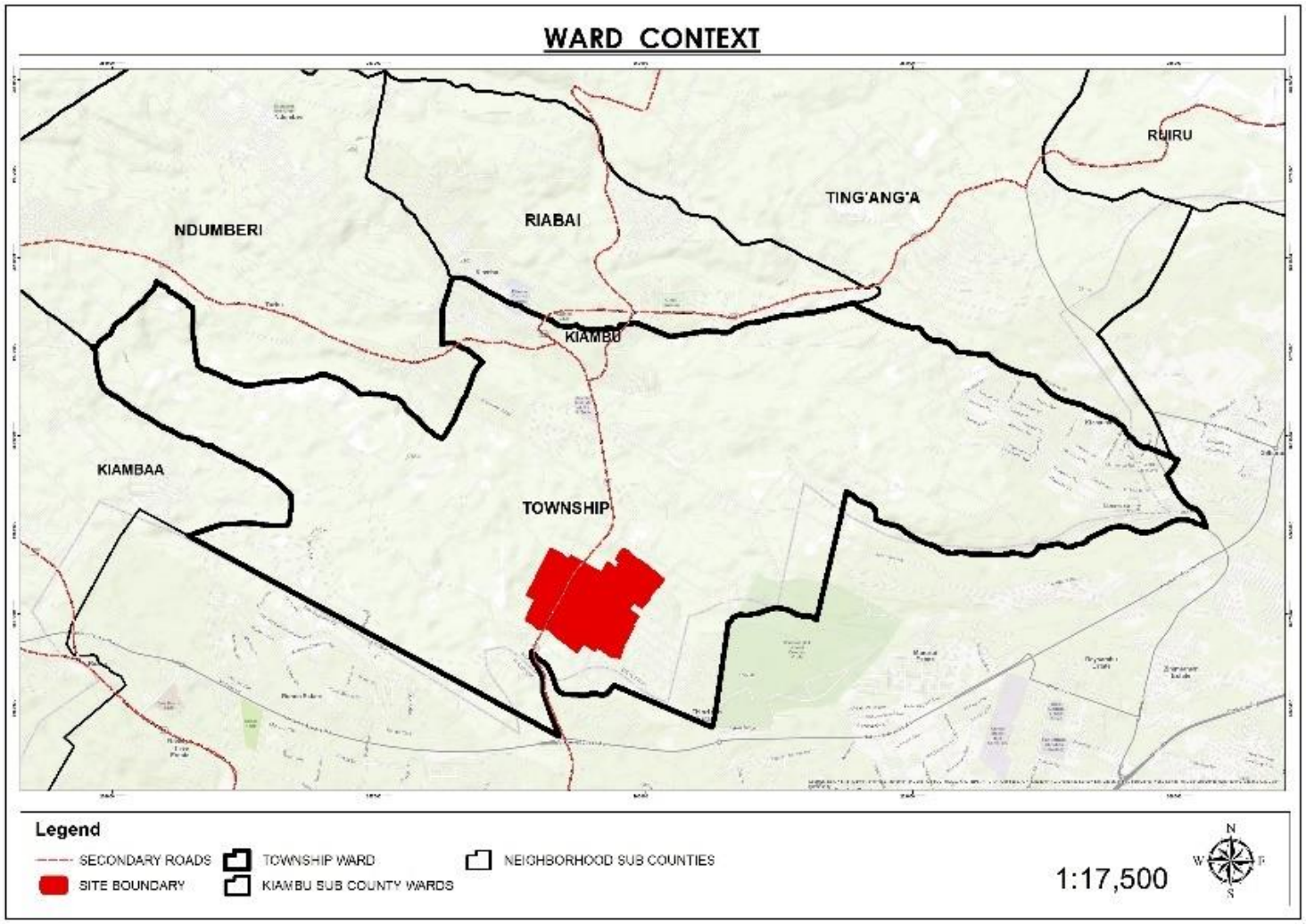


Source (Aurthor,2022)

4.2.6 Ward context

The study area is located in Township ward which is among the 4 wards in Kiambu sub-county. The ward is peri-urban and due to urbanization, it experiences rapid conversion of agricultural lands to residential and commercial uses. Its coffee estates are slowly being faced out to give room for urban developments. See map 8 below.

map 8 : Ward context

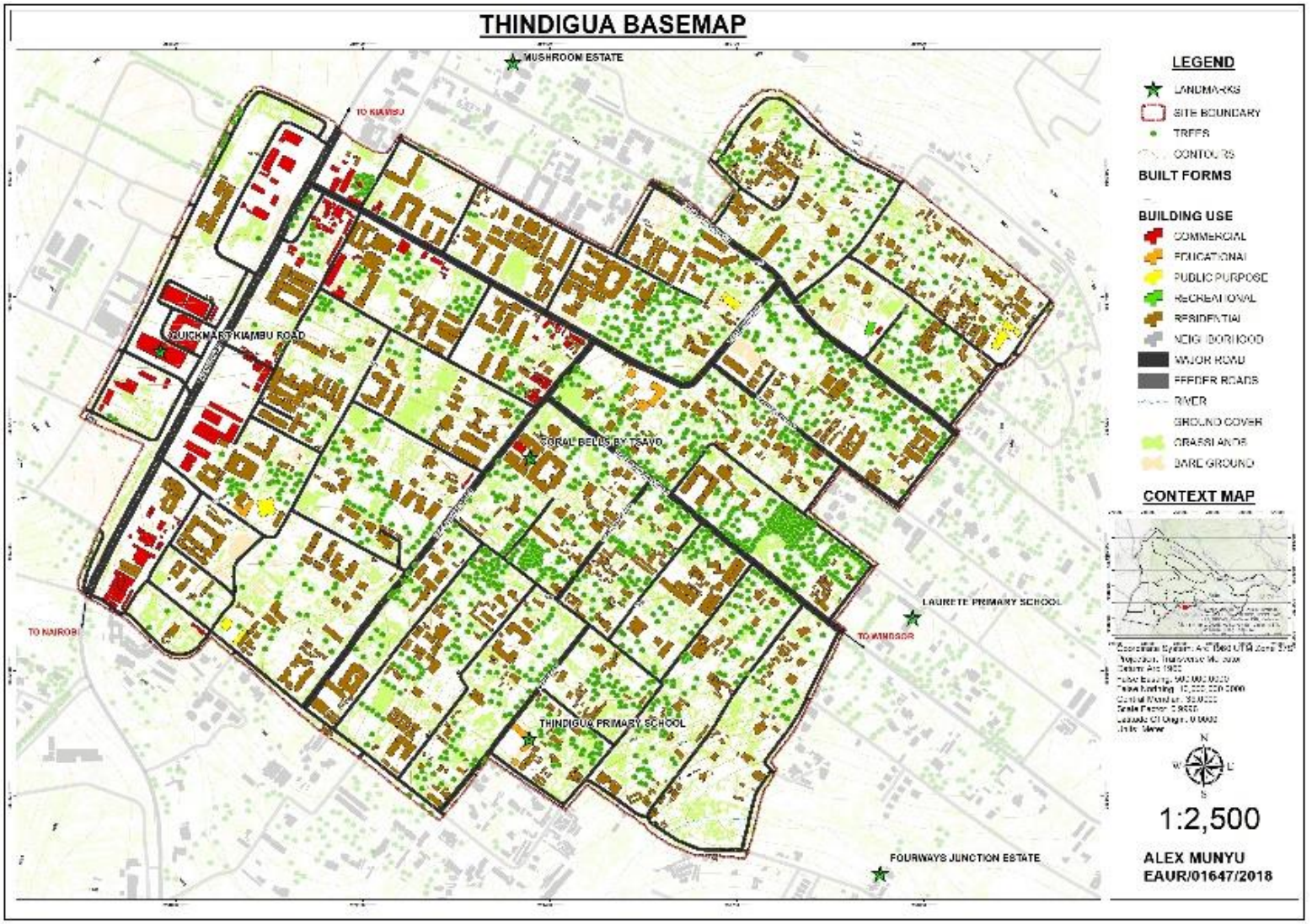


Source (Author, 2022)

4.2.7 local context

The study area is situated within Township Ward, Kiambu Sub-County, Kiambu County. It is 10.3 kilometers from Nairobi CBD and is easily accessed along Kiambu road. It lies between Longitudes 36°49'12.17” and 36°51'25.51" East and latitudes 1°11'24.84" and 1°12'57.78"South of the Equator. See map 9 below.

map 9 : Local context



Source (Author)

4.3 Legal and Institutional framework

Urban development and land use change is influenced by laws, policies, and institutional frameworks in a variety of ways. The legal frameworks include statutes, laws, policies and regulations while the institutional frameworks include institutions tasked with the role of land use planning and urban development in general.

4.3.1 Legal Frameworks

The following legal frameworks guided this research project;

The Constitution of Kenya, 2010

The constitution is the supreme law of Kenya. In article 1 (2) it stipulates that sovereign power can be expressed through direct participation or indirectly through elected representatives. It puts citizens at the center of decision-making, which serves as the foundation for including all stakeholders in a consultation process when making plans or decisions that significantly affect them. These plans may be; access to adequate and decent housing with reasonable standards of sanitation and access to clean and safe water in adequate quantities. It sets up a decentralized system of government and creates county governments with departments for transportation, water, and sanitation that are in charge of organizing and managing county roads, parking, traffic, and street lighting, as well as water supply, wastewater and solid waste management. The constitution guarantees citizens' rights to freedom of movement, a clean and healthy environment, and requires all public officials to address the needs of the most vulnerable members of society such as; minorities, women, children, the elderly, and people with disabilities.

The Physical and Land Use Planning Act, 2019

This Act provides for the preparation of development plans, contents of these plans, process of preparation and ultimate approval of plans. The Act provides for the planning of all land hence the need to proactively plan for rapid land use changes and peri-urban development to secure provisions for infrastructure facilities and services including giving provisions for new roads and their hierarchies to serve major different classes of developments and streets. Kiambu County has the mandate to control land use and developments to ensure proper and orderly developments of the area under its jurisdiction as stipulated in Part IV, Section 56 of the Physical and Land Use Planning Act. The same statute stipulates that no developments can take place within the jurisdiction of any County Government (Kiambu County) without its development application permission.

In principle, the Physical and Land Use Planning Act ensures that all developments and other changes to land are vetted and approved so as to ensure order, harmony, health and economy of the different land uses on any

land. This is enshrined in the provisions that no development should take place within areas of jurisdiction of the County Governments without due process being adhered to and subsequent approval being granted.

The County Government Act, 2012

An Act of Parliament to give effect to Chapter Eleven of the Constitution; to provide for county governments' powers, functions and responsibilities to deliver services and for connected purposes. Part XI of the Act Sections 102-115 provides for the objectives, principles, and process of preparation, types and significance of County Development Planning. It provides therefore that County Governments will have powers for preparation and approval of all types of development plans-city, municipal and Integrated County Development Plans. In this regard therefore, the Kiambu County Government has absolute powers to proactively plan for the rapid land uses changes and peri-urban development in Thindigua area.

Urban areas and cities Act, 2011

An Act of Parliament that gives effect to Article 184 of the Constitution; to provide for the, classification, governance and management of urban areas and cities; to provide for the criteria of establishing urban areas, to provide for the principle of governance and participation of residents and for connected purposes. Part V sections 36 (1), 37 and 38 provides that every city and municipality established under this Act shall operate within the framework of integrated development planning in order to contribute to the protection and promotion of the fundamental rights and freedoms contained in Chapter Four of the Constitution and the progressive realization of the socio-economic rights of the resident population.

Environmental Management and Coordination Act, 1999

An Act of parliament that provides for the management of the environment, sustainable use of land and its natural resources and it requires all urban infrastructure projects to undergo environmental impact assessment and social impact assessment before construction.

National Land Commission Act, 2012

An Act of parliament that provides for administration and management of public land in an efficient, sustainable and equitable manner. The act also mandates the National Land Commission with the responsibility of monitoring and providing oversight over land use planning and alienation of public land to private entities, monitoring registration of rights and interests in land.

4.3.2 Policy Frameworks

The following policy papers guided this research project;

Kenya Vision 2030

Kenya Vision 2030 is a long-term development blueprint for the country. The aim of the blueprint is to transform Kenya into a newly industrializing middle-income country by providing a high quality of life by 2030.The Vision 2030 describes three pillars that are crucial for industrialization, they include Economic, Social and Political pillar. As of the year 2030, the plan estimates that 60% of Kenyans would be living in urban areas. More so for rapidly growing cities like Kiambu, this calls for a proactive planning approach to boost the economic, social, and political benefits of urban growth. The National Spatial Plan of Kenya aims to create sustainable population and human activity distribution on national space to accomplish socio-economic growth, sustainable use of land, and regulated urban developments, all of which are complimented by Kenya Vision 2030.

Sustainable Development Goals

The Sustainable Development Goals (SDGs) define sustainable development priorities and aspirations for 2030 and seek to mobilize global efforts around a common set of seventeen goals and targets. Kenya's urbanization agenda is geared towards the fulfillment of the Sustainable Development Goals (SDGs) agenda which include the promotion of urban resilience in infrastructure and making cities inclusive, safe and sustainable. The broader promotion of sustainable urbanization as anchored in the SDGs is operationalized by the National Land Policy, National Housing Policy of Kenya and the National Urban Development Policy.

National Land Use Policy (Sessional paper No. 1 0f 2017)

It provides legal, administrative, institutional and technological framework for optimal utilization and productivity of land related resources in a sustainable and desirable manner at National, County and community levels. It also advocates for the development of land use plans for the country with full participation of all stakeholders and strict adherence to them. There is need to promote environmental conservation and preservation.

National Land Policy (Sessional paper No.3 of 2009)

The National Land Policy guides the country towards a sustainable and equitable use of land. It aims at providing a framework for undertaking land use planning and development control in all administrative levels

i.e., National, County and town level. It also calls for immediate actions to addressing environmental problems that affect land such as degradation, soil erosion and pollution.

The National Spatial plan

The NSP defines the general trend and direction of spatial development for the country by providing a framework for better national organization and linkages between different activities within the national space hence informing the future use and distribution of activities.

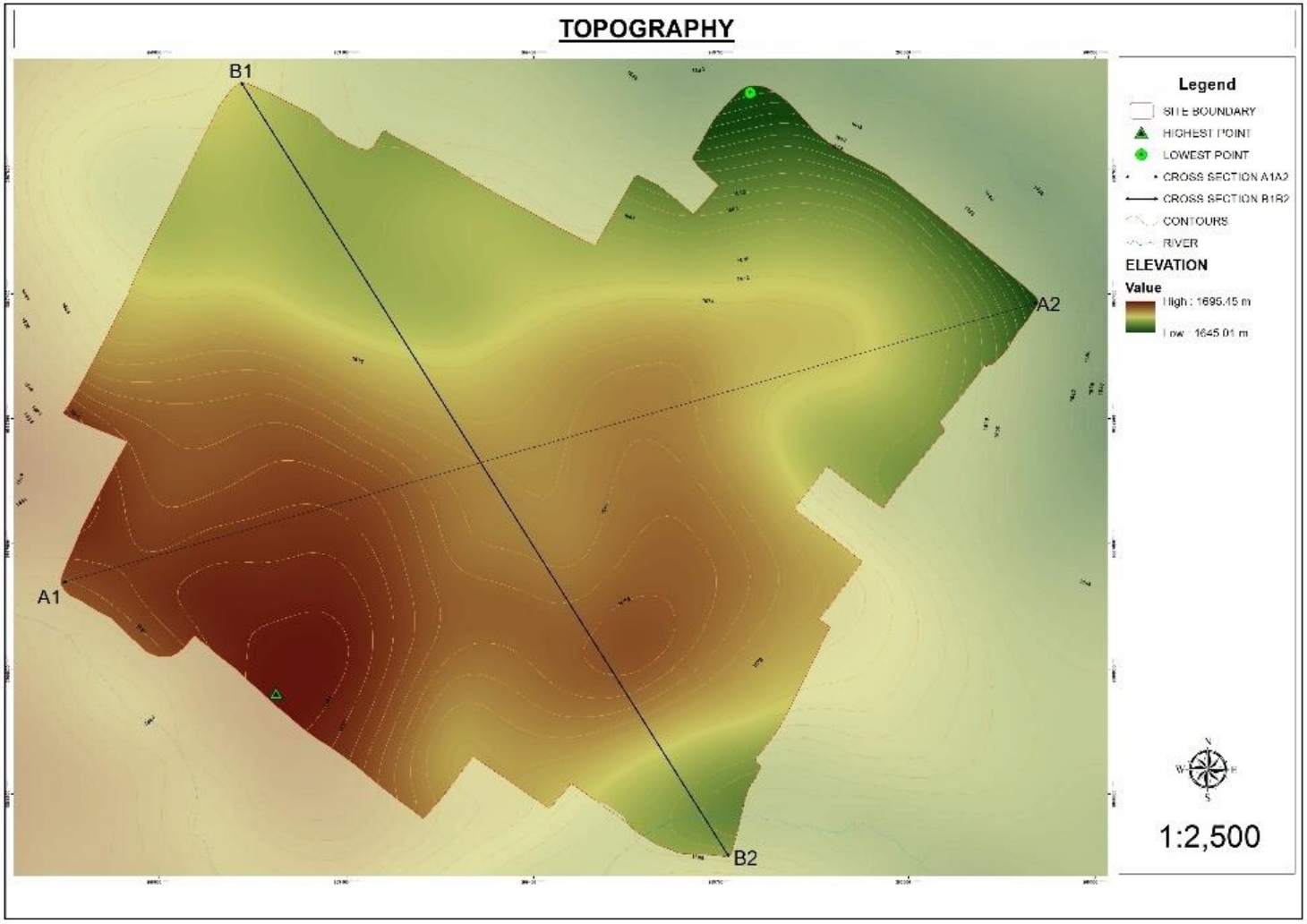
The National spatial plan seeks to provide for functional human settlements, enhanced agricultural productivity, planning and managing natural resources and the environment, providing a framework for infrastructure provision, promoting industrial and commercial development and the enhancement of good governance.

4.4 Physiographic and natural conditions

4.4.1 Topography

The study area slopes from South West to North East. The highest point is near Kiambu road with an elevation of 1695 meters above sea level while the lowest point is near the river with an elevation of 1645 meters above sea level. See Map 10 below.

Map 10 : Topography



Source (Author, 2022)

Cross section A1A2

Figure 8 : Cross section A1A2

Kiambu road Tsavo coral bells

Source (Author,2022)

Highest point – 1691 meters Distance – 1.63 kilometers

Lowest point – 1653 meters Average slope – 3.0%

Cross section B1B2

Figure 9 : Cross section B1B2

Kiambu road River

Source (Author, 2022)

Highest point – 1688 meters Distance – 1.48 kilometers

Lowest point – 1660 meters Average slope – 4.7%

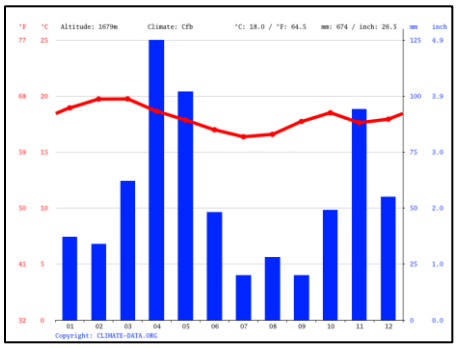
Impacts of topography in the area

- The area is easy to build due to its flat terrain.

4.4.2 Climatic conditions

Graph 1 : Kiambu rainfall and temperature by month

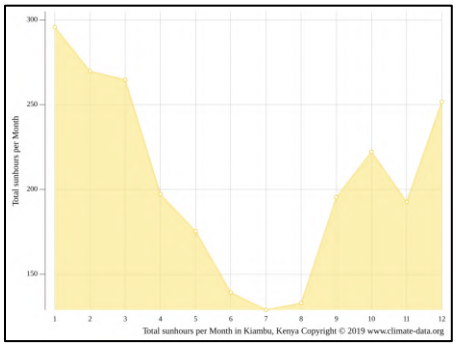
Source (*Kiambu Climate - Google Search*, 2021)



The highest amount of rainfall is received in the month of April (about 125 mm) while the lowest amount of rainfall is received in the month of July which is about 5mm.The month with the highest relative humidity is November (77.30 %). The month with the lowest relative humidity is February (55.85 %). The month with the highest number of rainy days is April (20.97 days). The month with the lowest number of rainy days is September (4.23 days). The climate in Kiambu is warm and temperate. In Kiambu there is a lot of rain even in the driest month. This climate is considered to be Cfb according to the Köppen-Geiger climate classification. The temperature here averages 18.0 °C | 64.5 °F. In a year, the rainfall is 674 mm | 26.5 inches.

Graph 2 : Kiambu sun hours per month

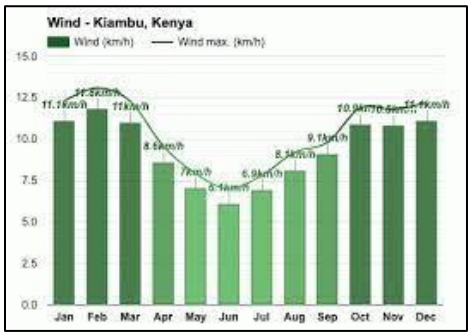
Source (*Kiambu Climate - Google Search*, 2021)



The highest number of average daily sunshine hours is measured in February at about 9.54 hours of sunshine a day a total of 295.76 hours of sunshine throughout February. The lowest number of average daily sunshine hours is recorded in January at about 4.16 hours of sunshine per day and a total of 128.93 hours of sunshine. March is the warmest month of the year. The temperature in March averages 19.7 °C | 67.5 °F. The lowest average temperatures in the year occur in July, when it is around 16.4 °C | 61.4 °F.

Graph 3 : Kiambu wind speed per month

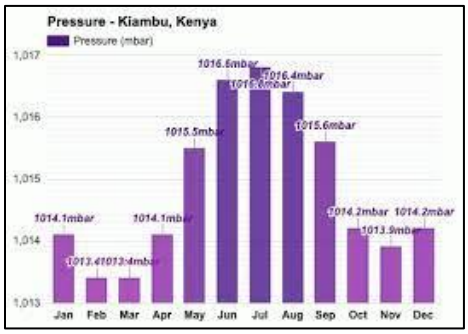
Source (*Kiambu Climate - Google Search*, 2021)



February has the highest wind speed at about 11.8km/hr while June has the lowest wind speed at about 6.1 km/hr.

Graph 4 : Kiambu pressure per month

Source (*Kiambu Climate - Google Search*, 2021)



July has the highest pressure while February has the lowest pressure.

Micro climate zones

Some parts of the study area that are under agricultural production in the form of coffee plantations or agroforestry experience a different micro climate that is different from other parts of the site. The micro climate experienced is cool temperatures

Figure 10 : micro climate area

Source (Author)

Effects of climate on the area

- The climate is favorable for agricultural production and settlement.
- The favorable climate enables the nourishment of the green environment.

4.4.3 Geology and Soils

Figure 11 : Deep, well-drained soil

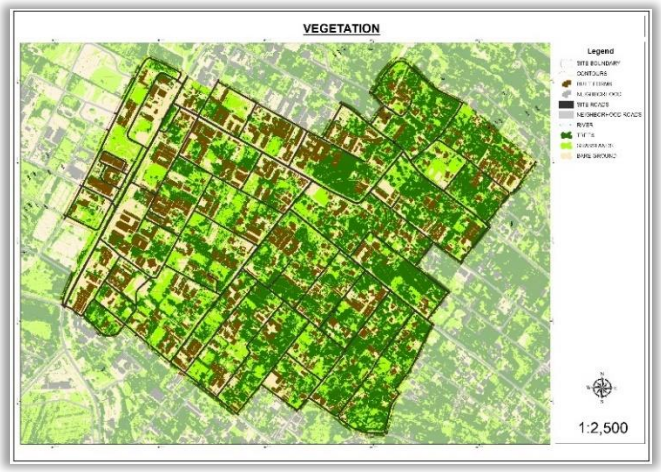
The study area lies on Orthic Ferralsols and Chromic cambisols which are forms of clay soil texture. The soils are deep, well drained and their infiltration rate is extremely slow making them good for agricultural production.

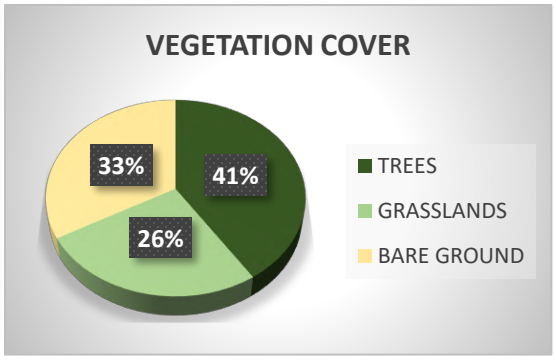
The dominant rock type in the study area is tertiary plutons. Source (Author)

4.4.4 Vegetation and Land cover

Vegetation

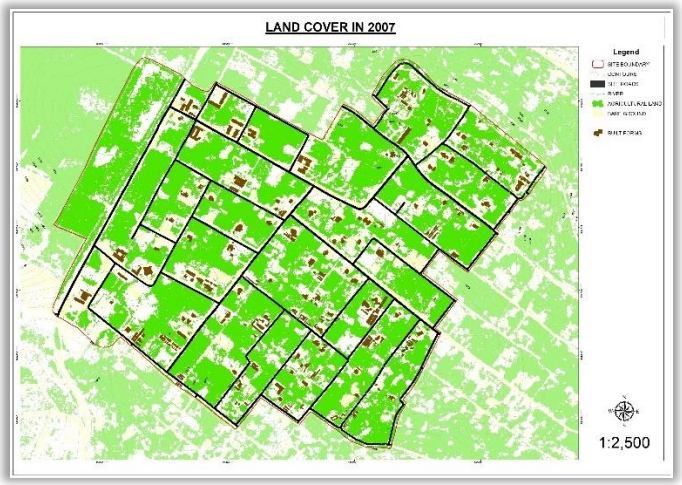
map 11 : Vegetation

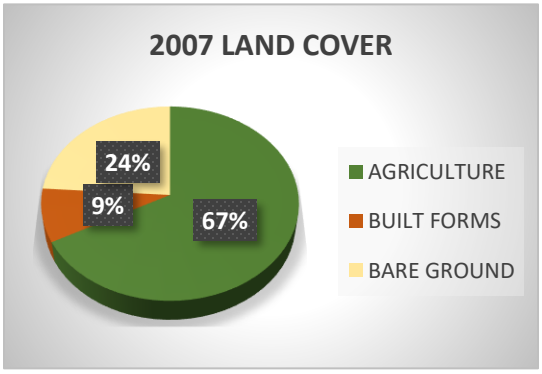




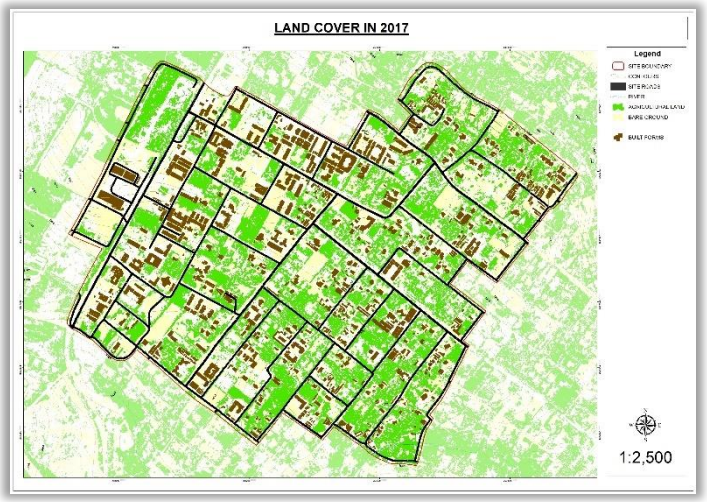
Land cover change

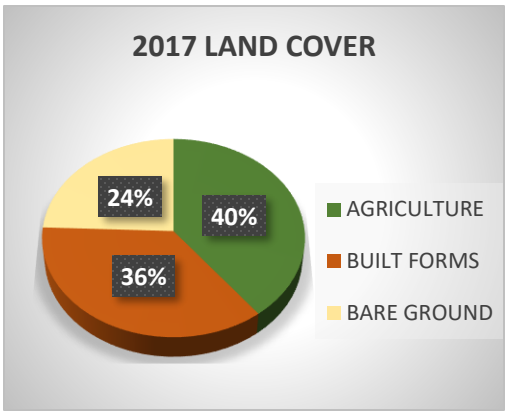
map 12 :Land cover 2007





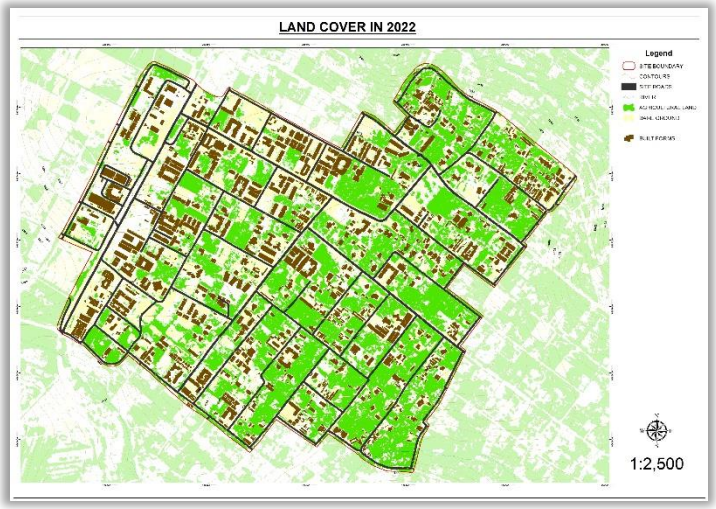
map 13 : Land cover 2017

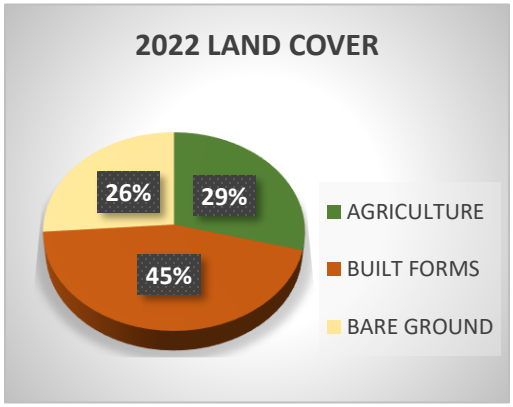




Source (Author)

map 14 : Land cover 2022





Land cover change patterns

Table 5 : Land cover change patterns

Land Use / Year	2007		2013		2017		2022	
	Area (Ha)	Area (%)	Area (Ha)	Area (%)	Area (Ha)	Area (%)	Area (Ha)	Area (%)
Agriculture	81.74	67	74.42	61	48.8	40	35.38	29
Built forms	10.98	9	14.64	12	43.92	36	54.9	45

Bare ground	29.28	24	32.94	27	29.28	24	31.72	26
Total Area	122	100	122	100	122	100	122	100

Source (Author)

4.5 Population and Demography

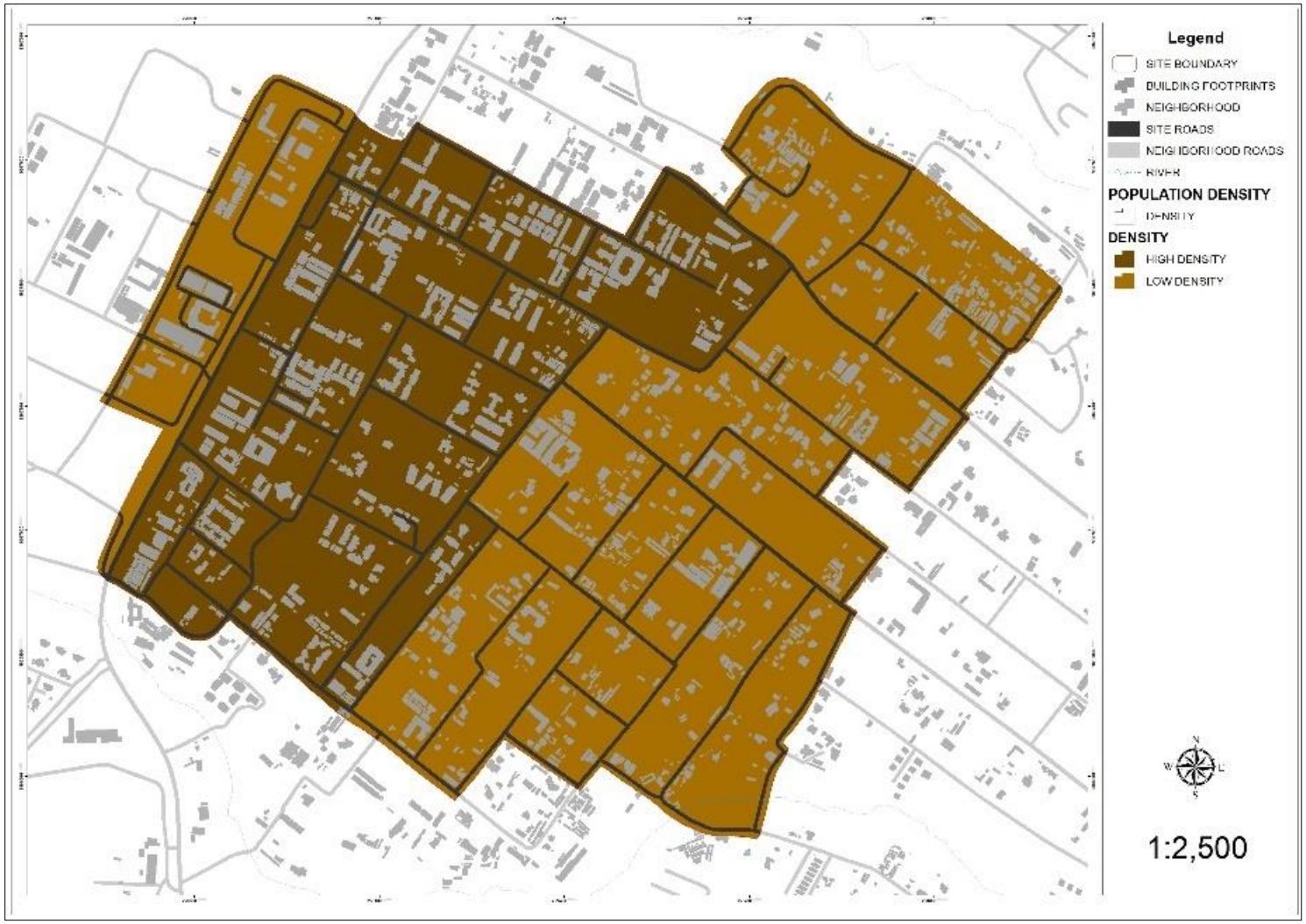
According to the (Kenya. & Kenya National Bureau of Statistics, 2019) Thindigua has a total population of 22,401 people which is made up of 10,547 males and 11,853 females and a population density of 1,091persons per square kilometers. However, the study area accounts for a portion of the total geographical area of Thindigua and therefore the population of the site was calculated using the population density and the area of the site in square kilometers using the formular;

population = population density * site area (in square kilometers)

population = 1,091 * 1.2154

population = 1326 people

Map 15 : Population and Demography



Source (Author)

4.6 Human Settlement

The neighborhood is experiencing rapid urbanization with developments coming up thick and first especially along Kiambu road. Some parts of the neighborhood that are away from Kiambu road are however still rural lands with agricultural activities. See Map 16 below.

Map 16 : Human Settlements

Source (Author)

4.7 Infrastructure

4.7.1 Transport Infrastructure

Table 6 : Transport Infrastructure

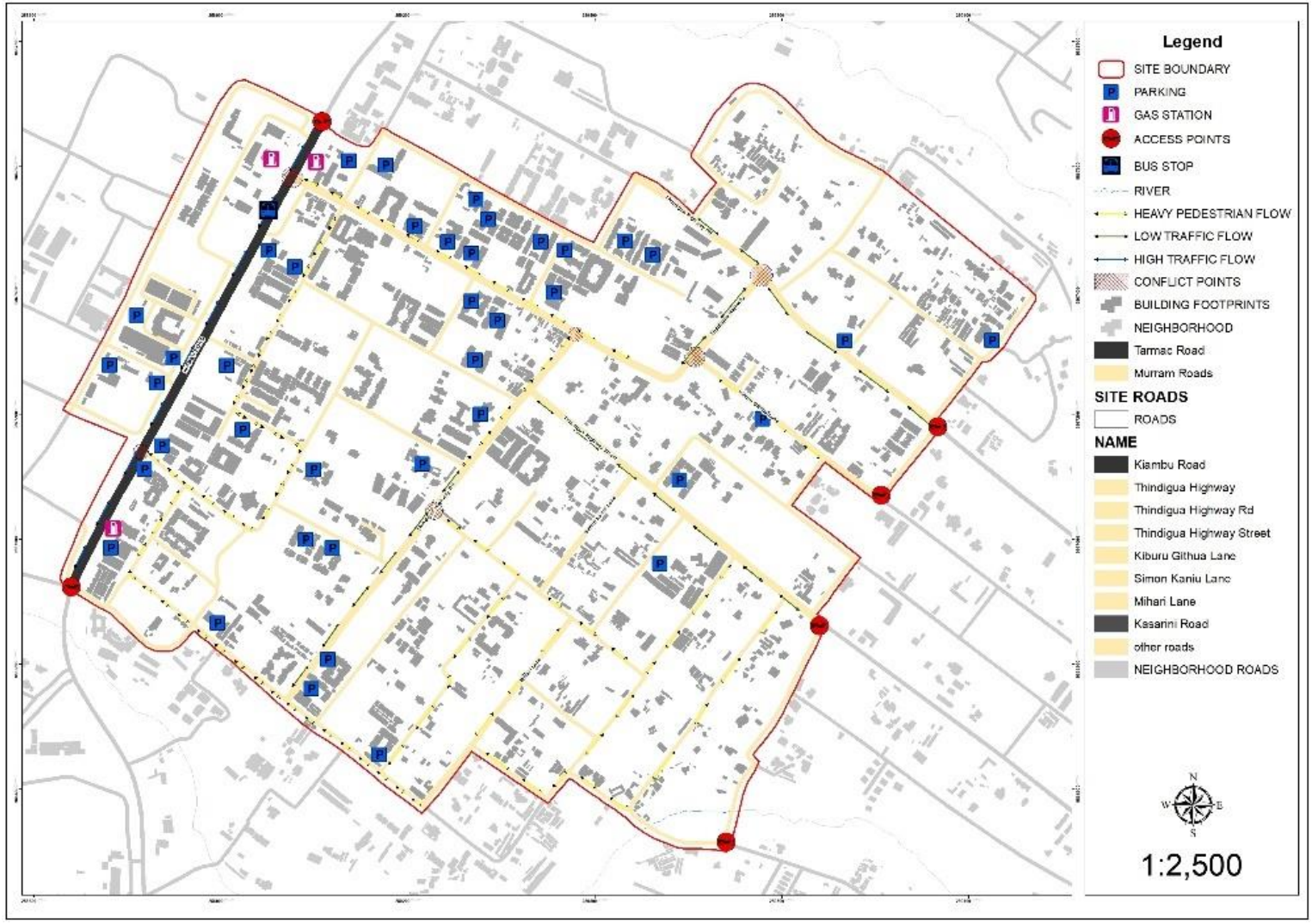
Source (Author)

Road linkage	Road class	Road Width (m)	Road length (m)	Surface type	NMT provision	Storm water	Street lighting	Name
Nairobi-Kiambu	B32	15m	856	Tarmac	No	No	Partially	Kiambu road
Feeder Road	B32	12	609	Murram	No	No	Yes	Thindigua Highway Street
Kiambu Rd – Windsor Hotel	B32	12	919	Murram	No	No	Yes	Thindigua Highway
Access Road	B32	12	752	Murram	No	No	Yes	Thindigua Highway Road
Access Road	-	9	385	Murram	No	No	No	Mihari Lane
Access Road	-	9	246	Murram	No	No	No	Simon Kaniu Lane
Access Road	-	9	382	Murram	No	No	No	Kiburu Githua Lane
Feeder roads	-	6	13274	Murram	No	No	No	Unnamed roads

Transport infrastructure inadequacy

- Lack of pedestrian walkways and cycling lanes on the roads – no provision for non-motorized transportation
- Narrow roads – most of the roads are narrow and require expansion. E.g., Kiambu road which experiences heavy traffic during peak hours
- Poor state of the feeder roads – the area has unpaved roads that do not withstand weather changes leading to muddy and dusty conditions
- Lack of storm water drainage channels along the roads

Map 17 : Transport Infrastructure



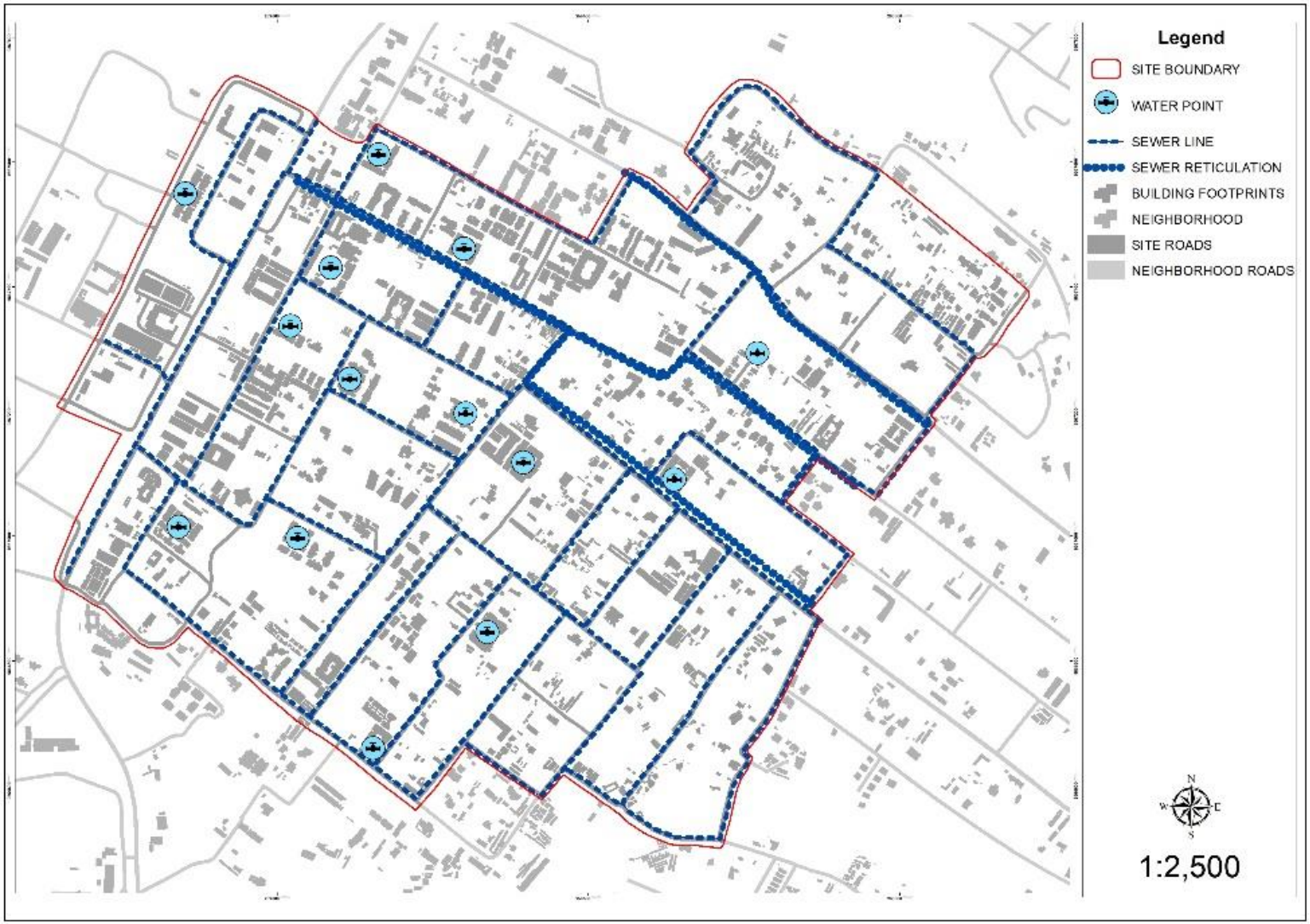
Source (Author)

4.7.2 Water and Sanitation Infrastructure

Water and sanitation infrastructure inadequacy

- There is clean water shortage from Kiambu water and sewerage company (KiWaSCo) – water is rationed and is only available three days week hence residents have to depend on borehole water which is often salty.
- Lack of an efficient solid waste management program since most household's use burning method which is not environmentally friendly.
- High rate of contamination of underground and borehole water which has been triggered from the septic tanks and pit latrine leakages and sanitation worsened by the high concentration of boreholes within short radius which leads to depletion of underground water if not controlled.
- Destruction of water supply infrastructure including water pipes with the presence of heavy machinery from the many ongoing developments in the area.

Map 18 : Water and Sanitation infrastructure



Source (Author)

4.7.3 Energy and communication Infrastructure

Energy and communication Infrastructure inadequacy

- Street lightings are only on major roads and feeder roads are dark – this leads to cases of insecurity in the neighborhood.
- Interruption in power supply – there are frequent power outages which leaves most of the households depending on backup generator services.

Map 19 : Energy and communication infrastructure

Source (Author)

Figure 12 : State of physical infrastructure inThindigua

Source (Author)

4.8 Existing Land Uses

Map 20 : Land use

Source (Author)

graph 5 : Land Use

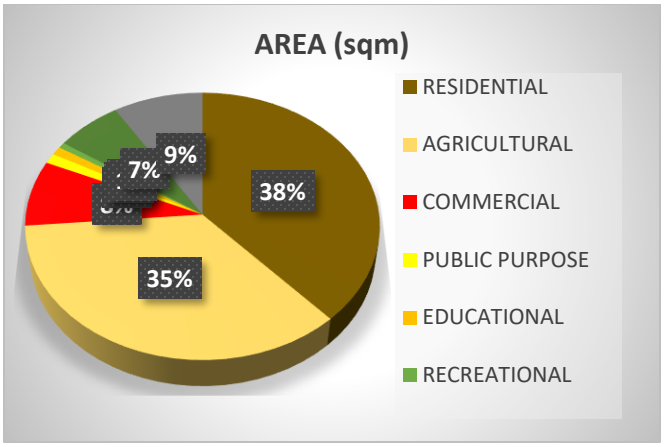


Table 7 : Land Uses

Code	Land Use	Area (Ha)	% Cover
0	Residential	47	38.52
2	Educational	1	0.82
3	Recreational	1	0.82
	Open spaces	8	6.56
4	Public Purpose	1	0.82
5	Commercial	10	8.20
7	Transportation	11	9.02
9	Agricultural	43	35.25
Total		122	100

Source (Author)

CHAPTER FIVE: DATA ANALYSIS AND DISCUSSION

5.1 introduction

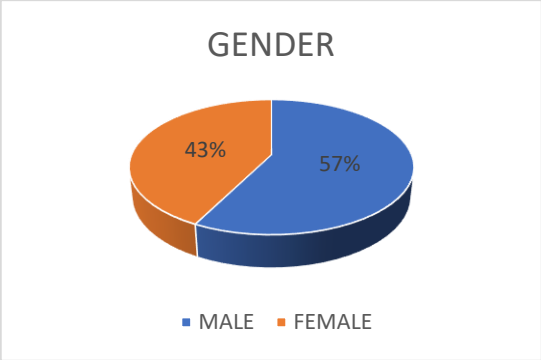
This chapter discusses the findings of the data collected from primary sources. It enables the researcher fill any gaps existing from secondary data. The data collection process was guided by the research objectives outlined in chapter one. Data collected was analyzed and presented on charts and graphs and this together with the situational analysis, enabled a clearer understanding of the problem to be handled.

5.2 data findings

5.2.1 Demographic characteristics of respondents

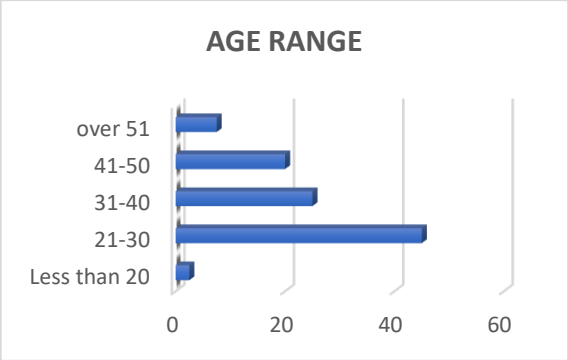
Gender

graph 7: Gender of respondents



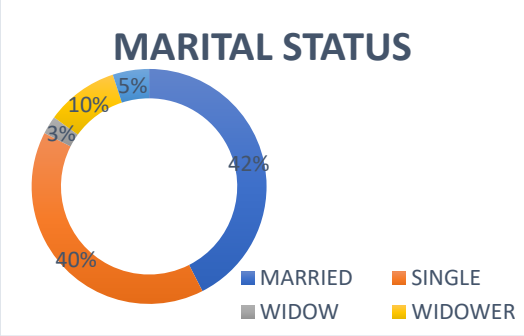
Age

graph 6: Age range of respondents



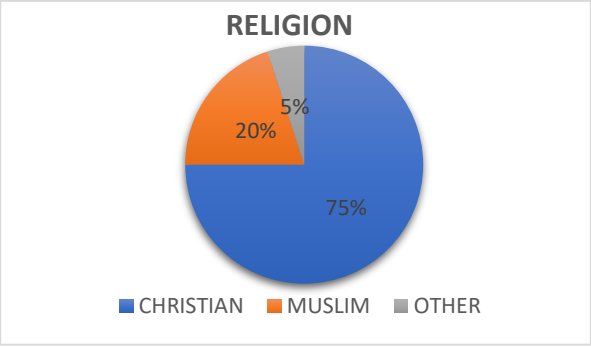
Marital status

graph 9 : marital status of respondents



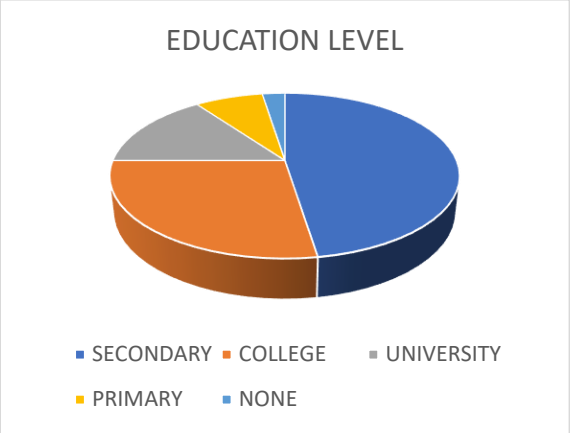
Religion

graph 8 :Religion of respondents



Education level

graph 11 : Education level of respondents

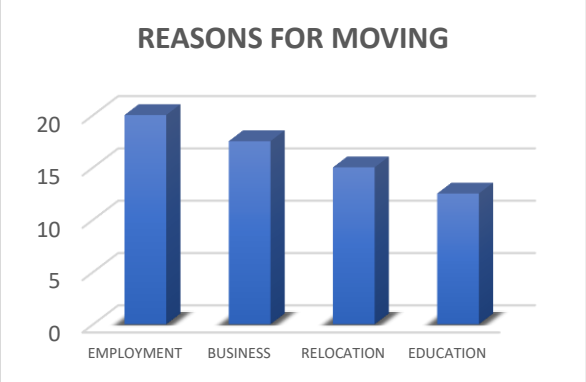


Occupation

graph 10 : Occupation of respondents

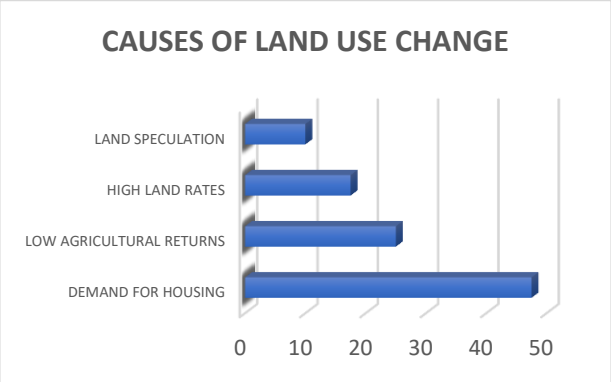
Reasons for moving to Thindigua

graph 13: Reasons for moving



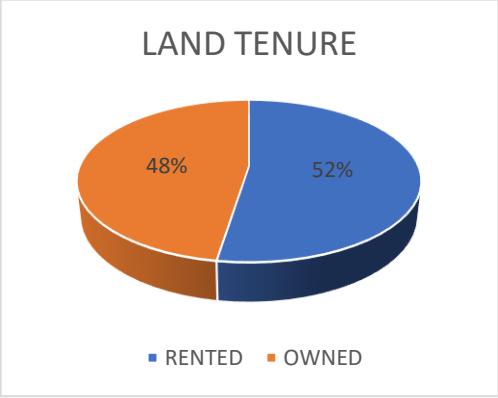
Main cause of land use change

graph 12 : Main causes of land use change



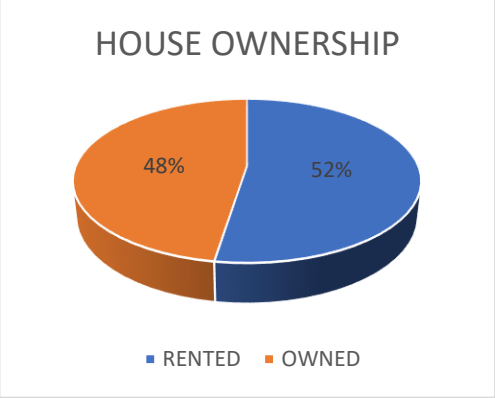
Land Tenure

graph 15 : Land tenure



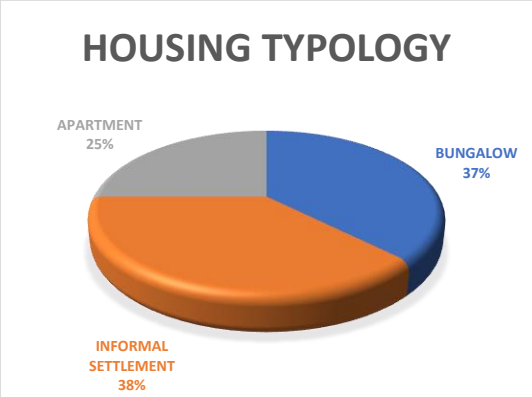
House ownership

graph 14 : House ownership



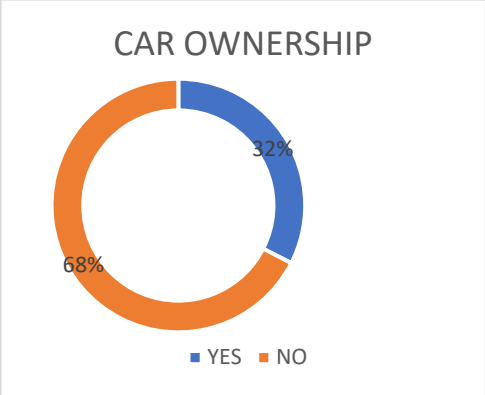
Housing typology

graph 17 : Housing typology



Car ownership

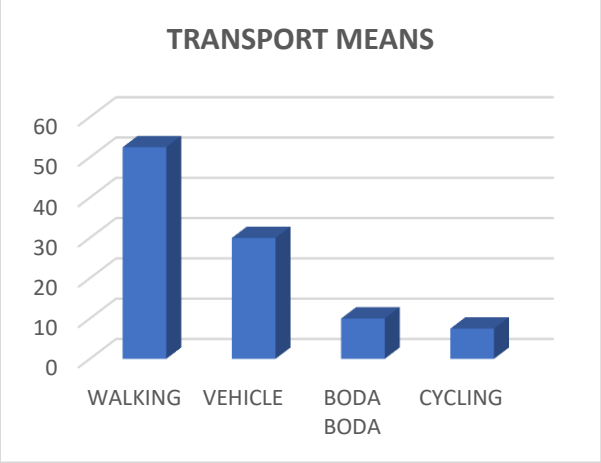
graph 16 : Car ownership



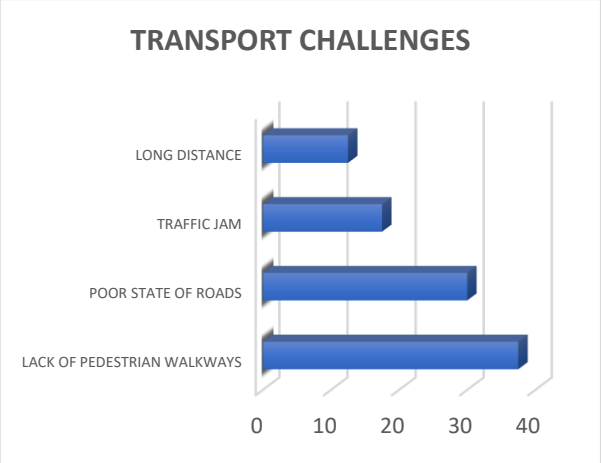
5.2.2 Transport infrastructure

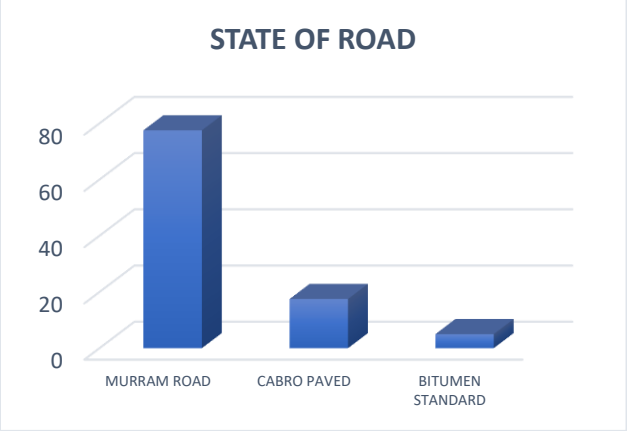
Transport

graph 19 : Means of transport



graph 18 : Transport challenges



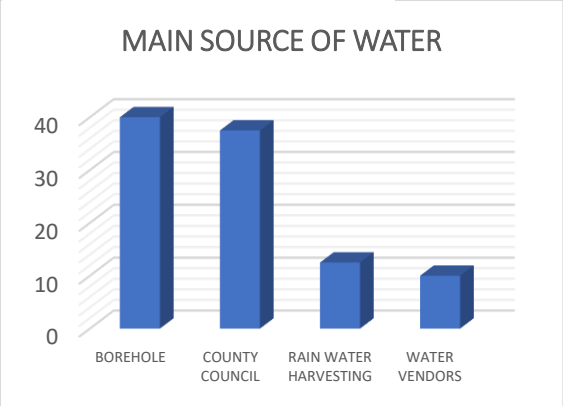


graph 20 : State of existing roads

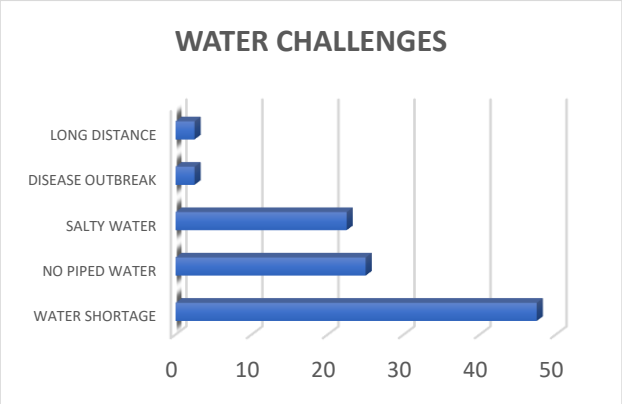
5.2.3 Water and sanitation infrastructure

Water

graph 22 : main source of water

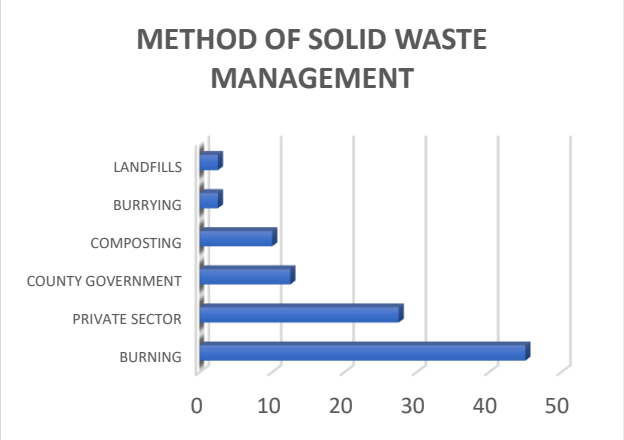


graph 21 : water challenges



Waste management

graph 24 : method of solid waste management

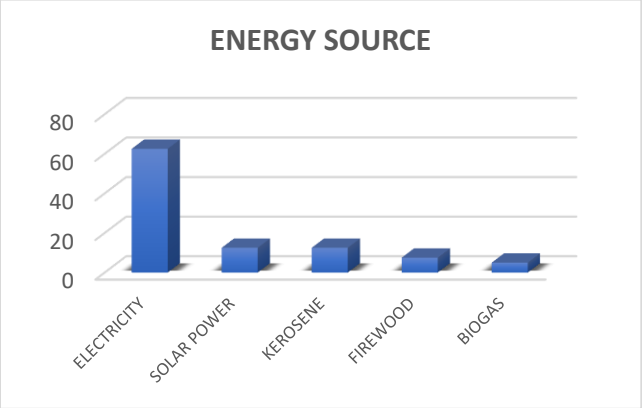


graph 23 : Method of liquid waste management

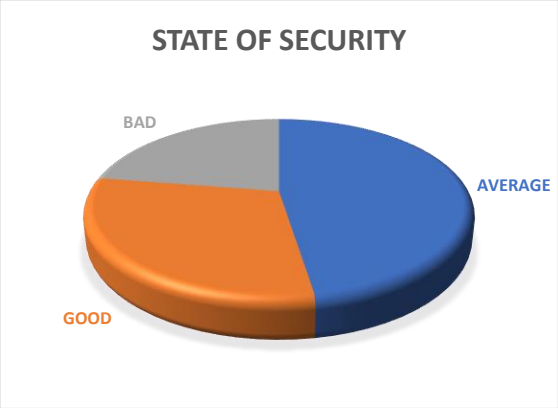
5.2.4 Energy and communication infrastructure

Main source of energy

graph 26 : Main source of energy



graph 25 : State of security



Source (Author)

5.3 summary of findings

Demand for housing is the major cause of land use changes in Thindigua neighborhood as more people relocate to the area due to its proximity to Kiambu town and Nairobi CBD. The state of hard infrastructure in the area is however deteriorating as the roads are in poor state, access to clean water is limited and energy sources are also strained.

5.4 Swot Analysis

5.4.1 Strengths

The following are the strengths of the study are;

1. Proximity to both Nairobi Central business district and Kiambu town which is about a 15 minutes' drive to both.
2. Grid pattern of streets which make the installation of basic physical infrastructure easy and convenient.
3. Kiambu road which is a major road connecting Nairobi CBD to Kiambu town
4. Ability to attract real estate investors due to the level of land subdivision and affordability of plots of land.

4.4.2 Weaknesses

1. Numerous urban voids in form of speculative land that interfere with the urban form.
2. Narrow roads that experience heavy traffic congestion during peak hours, for instance Kiambu road.
3. Poor state of the existing roads.
4. Mushrooming of informal settlements near high end residential properties that provide casual labor for the rich.
5. Agricultural land use conversion to built forms that is happening at an alarming rate

5.4.3 Opportunities

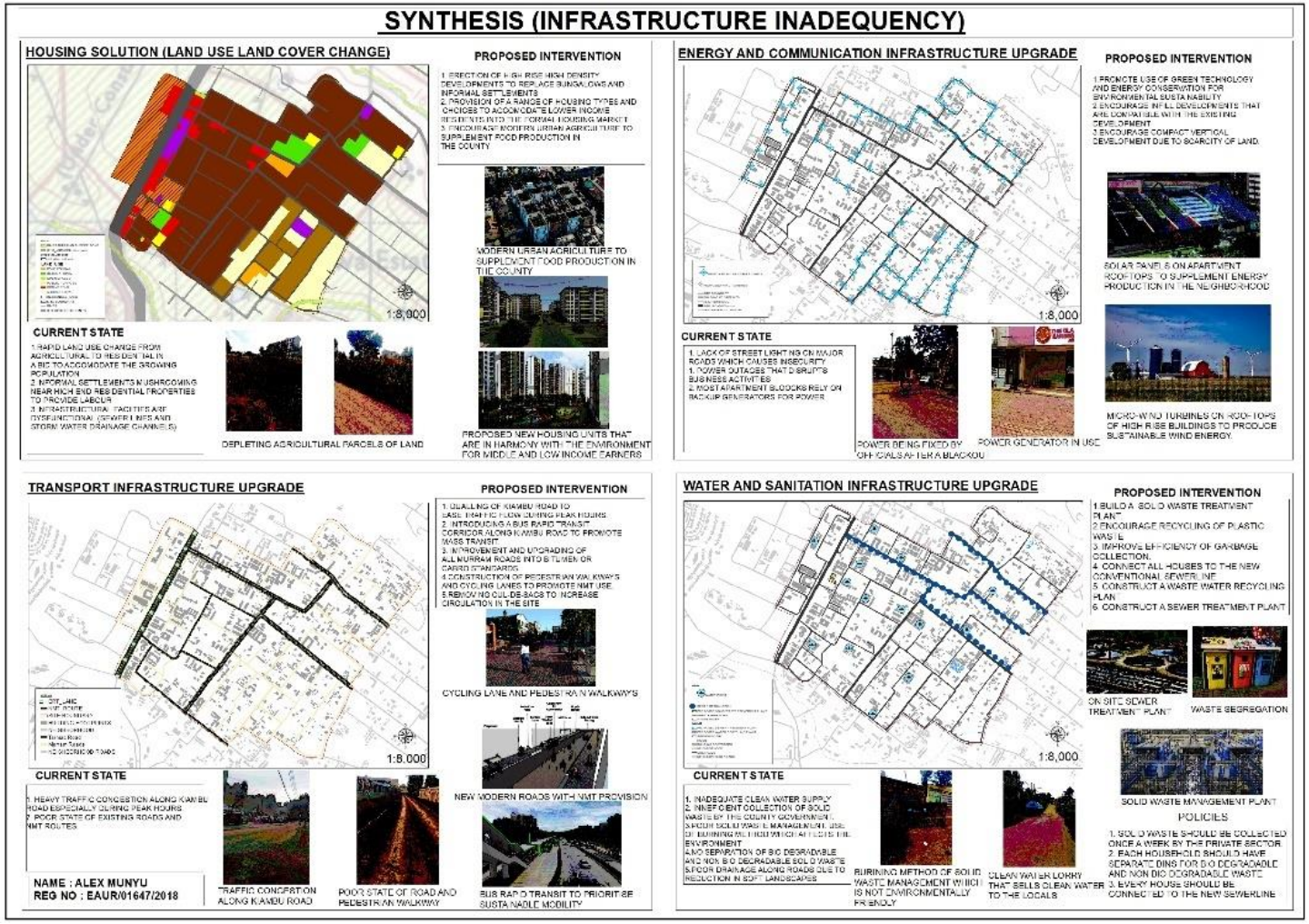
1. Proximity to both Nairobi Central business district and Kiambu town which is about a 15 minutes' drive to both.
2. Two rivers mall- a commercial hub in close proximity that offers business and commerce for residents.
3. Due to its close proximity to major towns, it attracts real estate investors from Nairobi.
4. High returns on investment by developers due to the high land valuation in the area
5. Availability of land in the urban voids for development of infrastructure that will serve the residents.

5.4.4 Threats

1. Rapid land use changes are causing climate change due to urban heat island effect.
2. Food insecurity in Kiambu county as a whole due to depleting agricultural lands.
3. Gentrification of the natives by the wealthy who by property in the neighborhood.
4. Deteriorating state of the infrastructure due to uncontrolled land use changes.
5. Encroachment of the riparian reserves by developments that will cause ecological imbalances.

5.5 Synthesis (Infrastructure Inadequency)

Map 21: Synthesis



Source (Author)

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

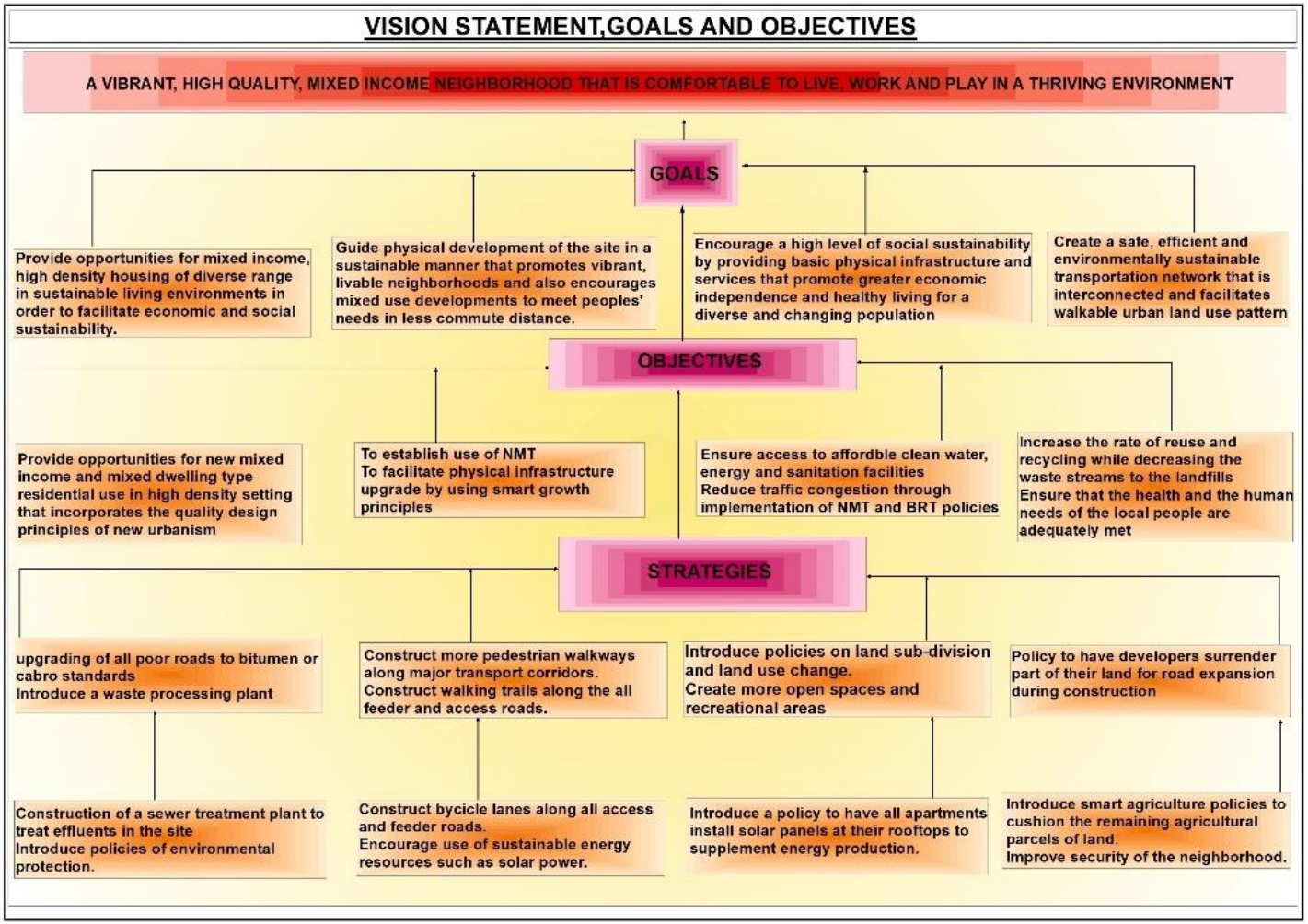
6.1 introduction

This chapter summarizes the major findings, discusses how they relate to the research's objectives, and offers recommendations on how to steer the study area toward its ideal future. Similarly, it makes use of case studies, concepts, visualizations and strategies that would be simple, clear and cost effective in the implementation and funding stages. Therefore, it culminates in strategic actions aimed at developing a management strategy to counteract any future negative effects of land use change on peri-urban infrastructure. This chapter concludes the research project by providing feasible spatial design interventions that address the study objectives.

6.2 visioning

6.2.1 Vision Statement, Goals and Objectives

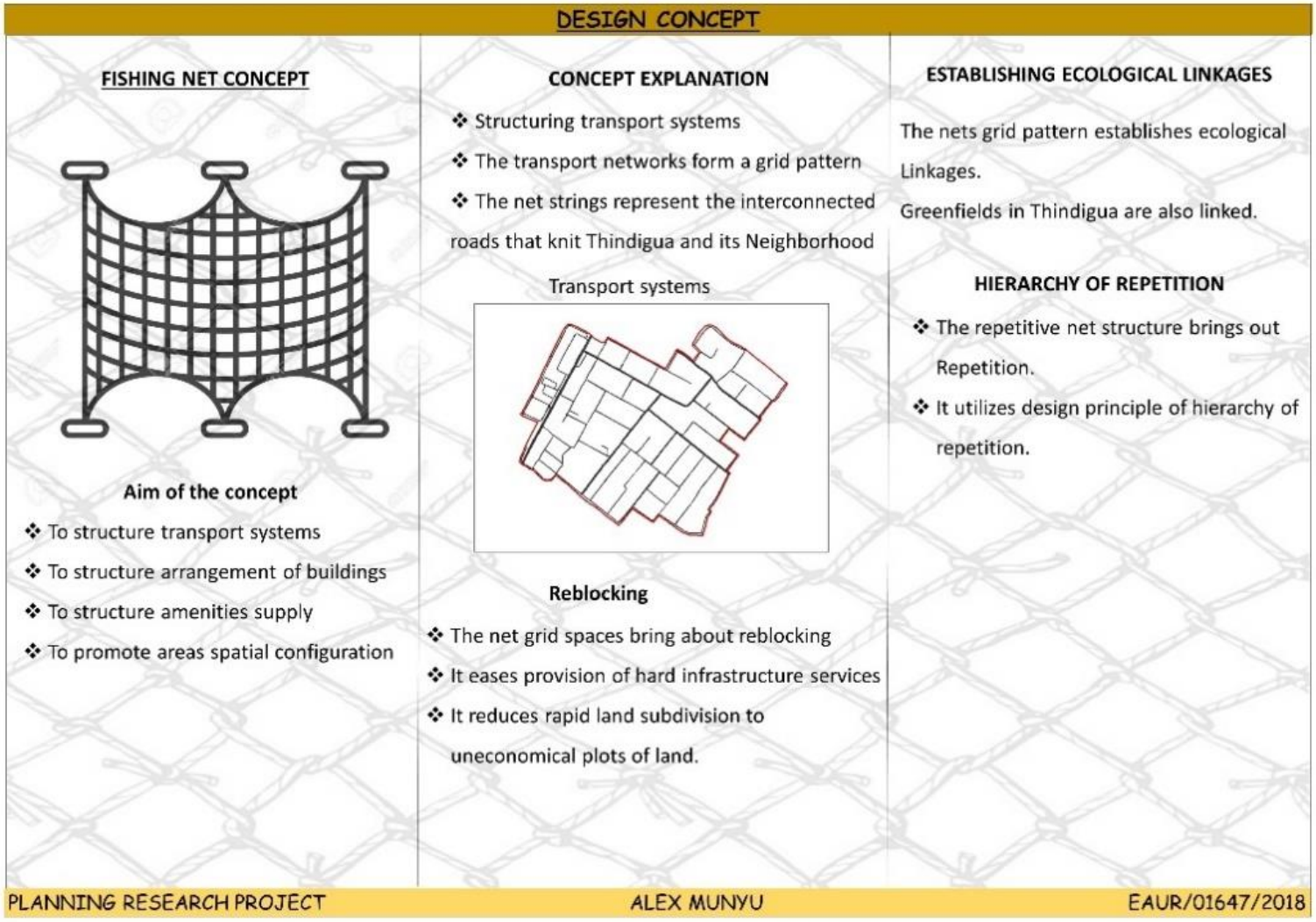
Figure 13 : Vision, Objectives and Strategies



Source (Author)

6.2.2 Design Concept

Figure 14 : Design Concept

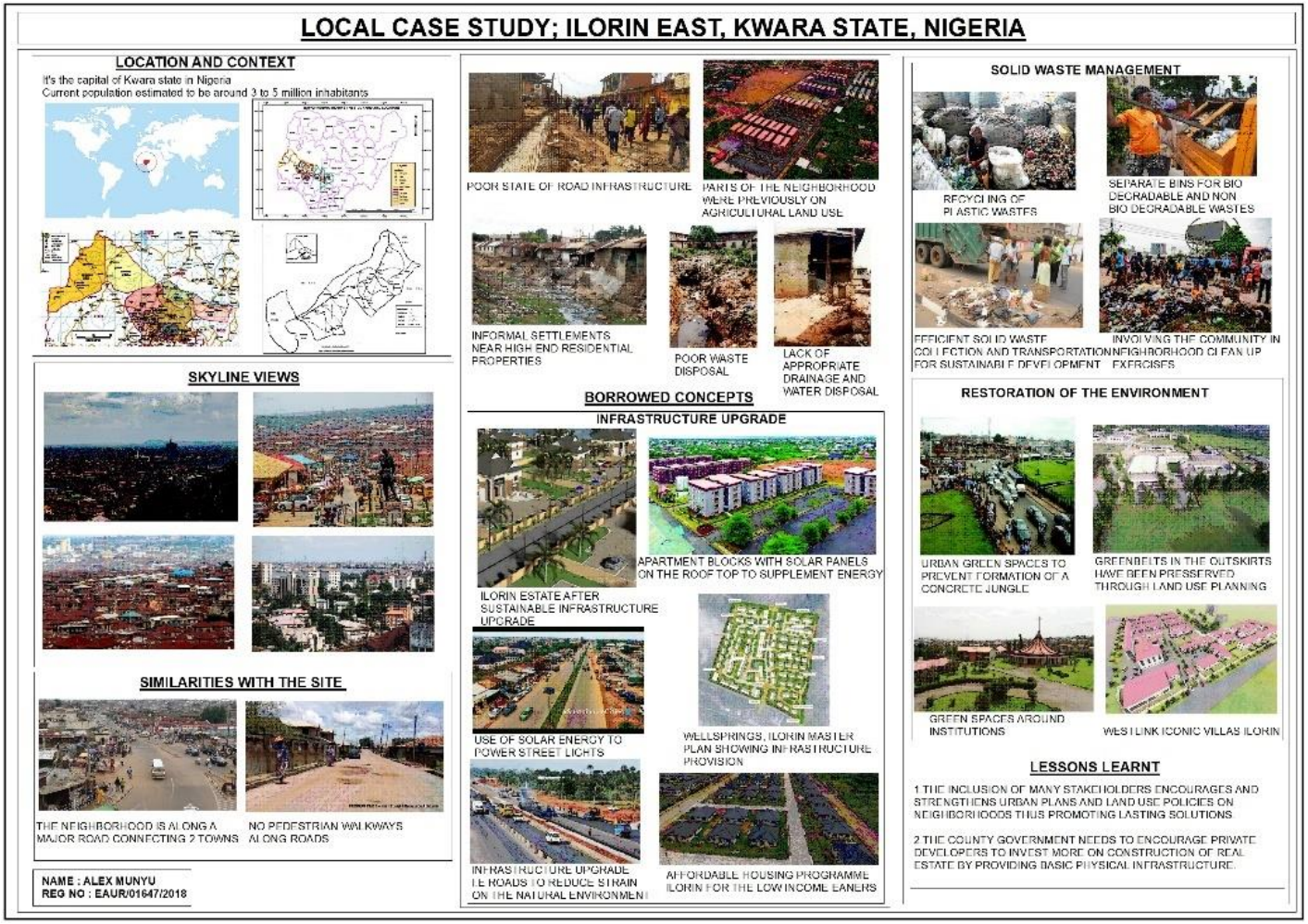


Source (Author)

6.3 Case studies

6.3.1 Local case study

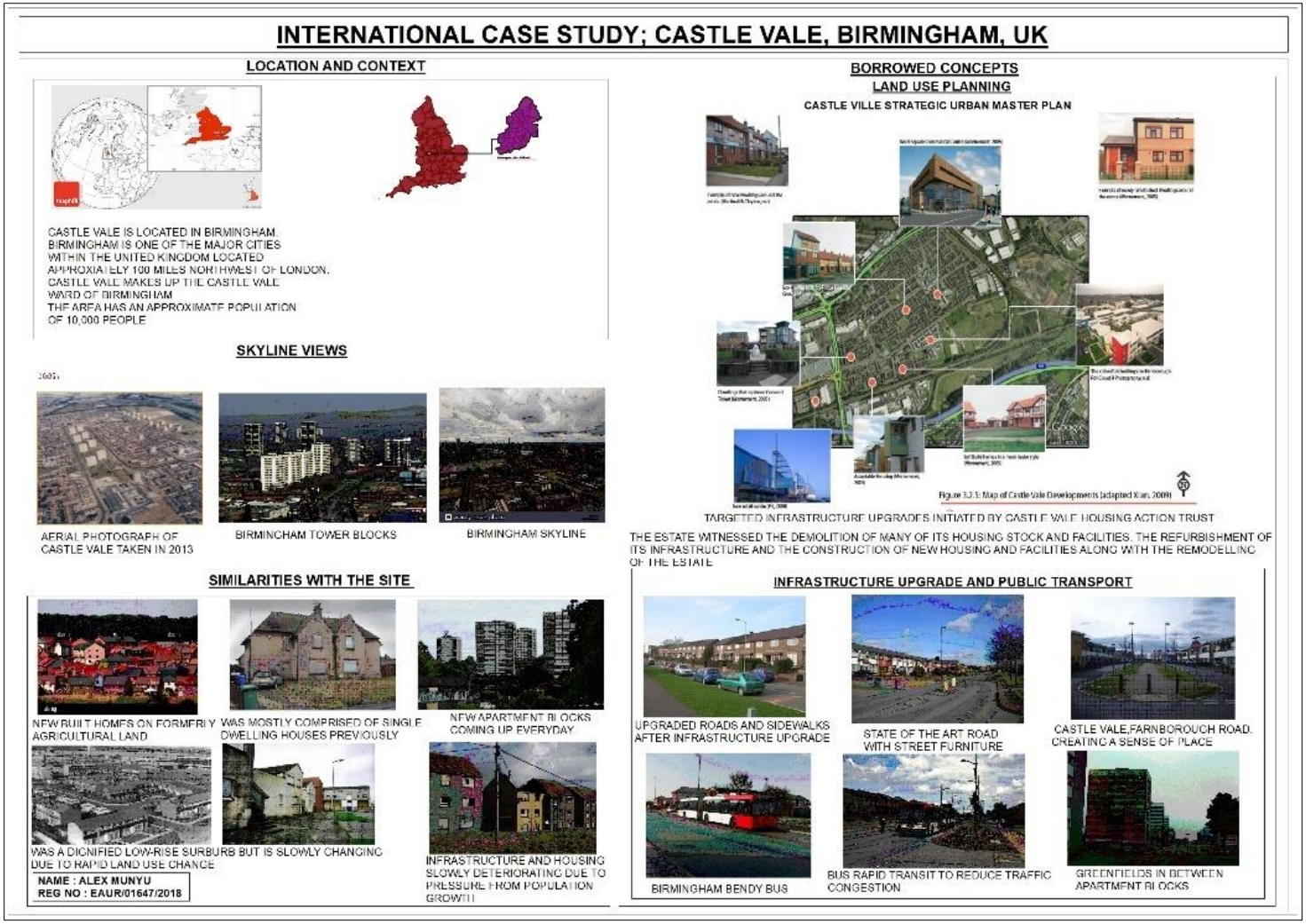
Figure 15 : Local case study



Source (Author)

6.3.2 International case study

Figure 16 : International Case study



Source (Author)

6.4 Recommendations

Solutions for peri-urban management, system efficiency, and infrastructure capacity that can meet the needs of the Thindigua community are essential for a sustainable urban infrastructure. By addressing the capacity issues of urban infrastructure and promoting urban infrastructure that is resilient to land use change, Thindigua will be able to attain sustainable urban growth. Recommendations and a management plan that accounts for the capabilities of urban infrastructure were developed using lessons learned from best practices.

6.4.1 Management of transport infrastructure

Promoting transit-oriented development

Sustainable transportation systems should promote the integration, rather than the segregation, of land uses that facilitate Transit Oriented Development. Roads should connect all the communities, and any gaps in connectivity should be filled.

Advocate for mixed-use development in the region so that people walk to nearby shops and offices, as this is an important part of Transit Oriented Development that should be encouraged along Kiambu road and Thindigua highway. Therefore, it's crucial to have an NMT network, inclusive habitat, optimal densities, and varied land uses.

Figure 17 : Proposed Bus Rapid Transit station along Kiambu road

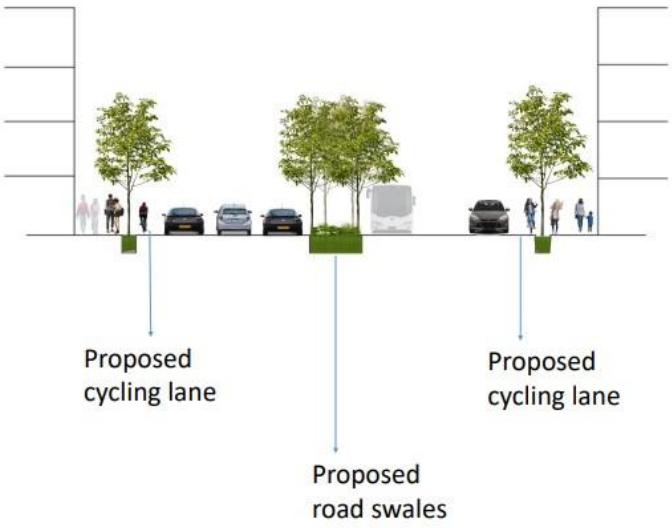
Source (Author)

Promotion of pedestrian and non-motorized transport

Elements of walkability must be emphasized. Walkways and biking lanes should be constructed on all the streets in the area. In order to promote social participation, it is important to give pedestrian and bicycle access

every three blocks and to designate some routes for use exclusively by NMT, with short travel times to work places or commercial complexes. Kiambu county's physical planning department is obligated to make the neighborhood more walkable through measures like the placement of well-maintained walkways and paths, the construction of bike lanes and bicycle boulevards outfitted with convenient amenities like benches and lighting, the combination of cycling and public transportation, and the prioritization of pedestrians' safety, comfort, and convenience. To accomplish this, there needs to be installation of traffic control devices such as speed bumps, pedestrian ramps, pedestrian crossing, traffic lights, and separate but interconnected NMT routes. Along Thindigua highway, there needs to be lively urban places with street vendors, street furniture, active frontage and public displays. Pedestrians and people who use NMTs in the area need access to safe and convenient infrastructure and services, such as the restoration of existing green spaces and clean public ablution blocks.

Figure 18 :Proposed section of Kiambu road



Source (Author)

Increasing accessibility, connectivity and network density

Improving the effectiveness of transportation systems to distribute heavy traffic volume requires increasing access, connection, and network density. This will be accomplished through a system of side streets by directing pedestrians and NMT users down the shortest route possible to bus stations and the main Transport Corridor.

Enhancing High Density-Mixed Income Developments

Integrating high-density, mixed-income developments inside TOD is crucial for accommodating a large population that walks, cycles, and uses public transportation. People who need access to public transportation, low-cost housing, and other community amenities make up a significant portion of any viable community, so promoting such areas is essential.

Enhancing Compact Developments

In order to combat the increasing urban sprawl and corridor growth caused by recent changes in land use, it is recommended that the new urbanism idea, the walkable community concept, and compact town development be advocated for in Thindigua. Some of the main measures that will promote walkability, cycling, and minimizing transport trips and, so, discourage vehicle ownership, which is on the rise in the area, include denser land uses/compact developments and structural forms of mixed-use developments.

Figure 19 : Section of compact developments in Thindigua neighborhood

Source (Author)

Management and Maintenance of Roads

To decrease the discomfort caused by the dust and mud on the roads brought by the changes in the weather, it is necessary to tarmac or gravel the marram roads and perform routine maintenance and repairs.

Figure 20 :proposed upgraded Thindigua Highway

Source (Author)

Enhance Safety and Security

It is important to increase the safety and security of all road users, especially pedestrians, by taking measures such using curbs, installing security lights, building footbridges, and designating NMT and bicycle lanes.

Road Widening Through Surrenders of Part of the Land

Every property with a high population density should be required to give up a portion of their land so that roads can be widened. This will make place for more services including utility provision, NMT, and consideration of bicycle lanes, among many others.

6.4.2 Management of water and sanitation infrastructure

Drill public boreholes

To supplement water supply, public boreholes should be drilled. water acquired needs to be cleaned up and distributed evenly so that everyone has access to clean water.

Periodic Upgrade, Check-up and Maintenance

Regular maintenance, infrastructure upgrades to meet capacity requirements, and check-ups are all necessary. To ensure sustainable development, borehole drilling should be regulated.

Boreholes ought to be drilled far from areas close to pit latrines. To reduce the significant risk of water-borne infections, borehole water should always be treated before use.

Sewer Reticulation Along the Lowest Point to Connect to Nairobi City County

Connect the integrated conventional sewerage treatment network system in the area to service all properties. Due to its low topography and convenience of connecting from Thindigua, negotiations should be conducted with other jurisdictions such as Nairobi City County to permit the sewerage connection to its limits.

Regulate and manage pit latrines and septic tanks

Thindigua neighborhood should forbid the use of wastewater management techniques like septic tanks and pit latrines. As a result, there will be less financial and health risk exposure, and the environment will be more sterile.

Construction of an on-site sewer treatment plant

Onsite wastewater systems are multi-stage systems that collect, treat, and disperse wastewater generated by a home or business. The wastewater is treated and discharged to the soils rather than collected and transported to a wastewater treatment plant. This would ensure that there was no contamination of underground water sources.

Construction of a water recycling plant

A water recycling plant which would treat water for re-use in irrigation would ensure that the neighborhood in food secure.

6.4.3 Management of energy and communication infrastructure

Use of renewable sources of energy

Policy to have all apartments and townhouses install solar panels at their roofs

Thindigua neighborhood association should put in place a mandatory practice to have solar power generated from all building rooftops. This will help in supplementing energy consumed in the neighborhood.

Installation of wind turbines on agricultural parcels of land

Wind turbines should be installed on the slopping parts of Thindigua which is under agricultural use to supplement energy consumed in the neighborhood.

Figure 21 : proposed wind turbines on agricultural land

Source (Author)

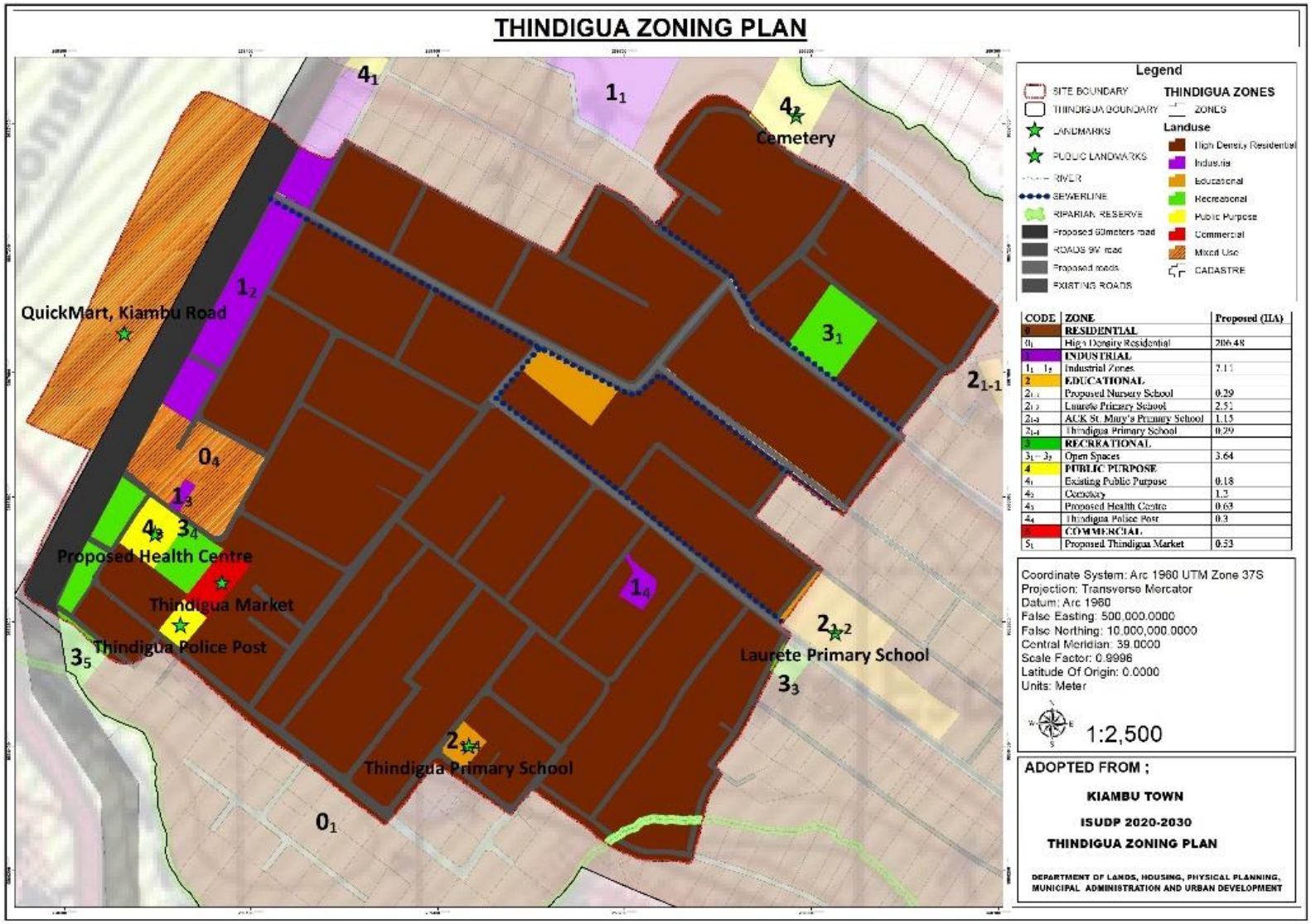
Installation of solar powered street lighting

Solar powered street lights should be installed on all feeder and access roads of the neighborhood to improve security levels.

6.5 Zoning plan

The County Government of Kiambu has recently completed the preparation of the Integrated Strategic Urban Development plan for Kiambu Municipality for 2020 – 2030 and therefore reference was made on the zones demarcated for Thindigua neighborhood. Map 22 below was obtained from the County planning offices for reference during the planning process.

Map 22 : Thindigua Zoning plan



Source (Author)

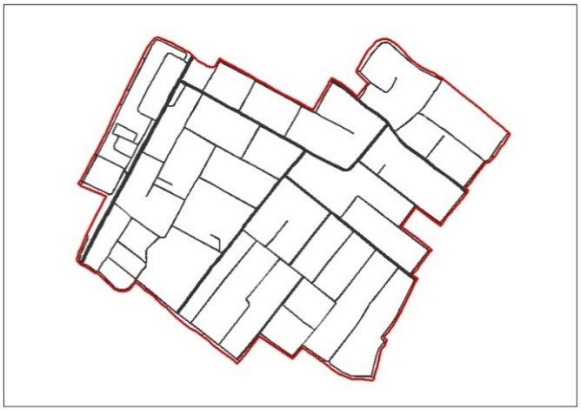
6.6 Structural analysis

The roads, the landscape, the plots and blocks of land uses all make up the site's structural elements.

Urban structure (Roads)

The grid pattern that the roads in the site form, help to guide development in the area, as well as acts as edging elements to prevent sprawl, and also gives the area its unique design. It also improves connectivity and service provision in the area.

map 23 : Roads



Source (Author)

Urban landscape (Buildings and Green space)

The buildings and the green spaces show the figure ground relationship thus showing the spatial configuration of the site.

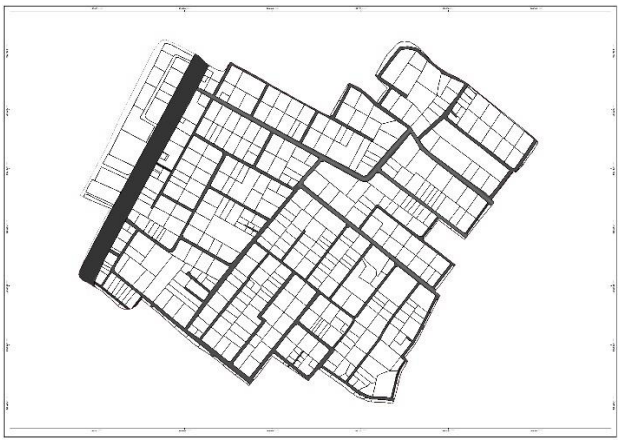
map 24 : Landscape

Source (Author)

Urban plot boundaries (Cadastre)

The urban plot boundaries which are in form of a cadastral map shows the level of subdivision in the site that makes it uneconomical for land owners to continue practicing agriculture.

map 25 :Plot boundaries

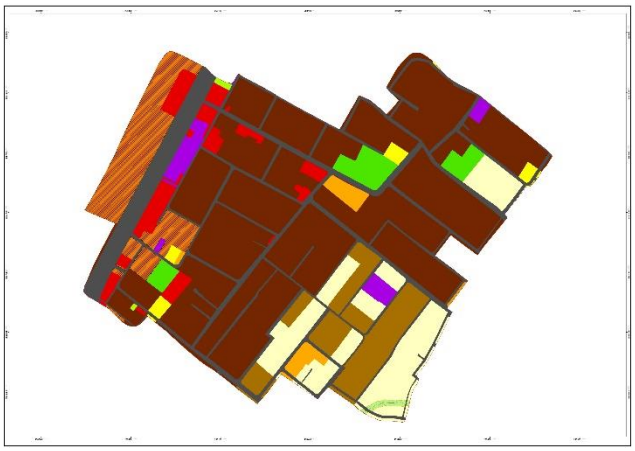


Source (Author)

Proposed Land uses

The proposed land uses will help structure the future growth and development of the neighborhood. The land uses also ought to be in harmony with the approved zoning plan for the area.

map 26: Proposed Land uses

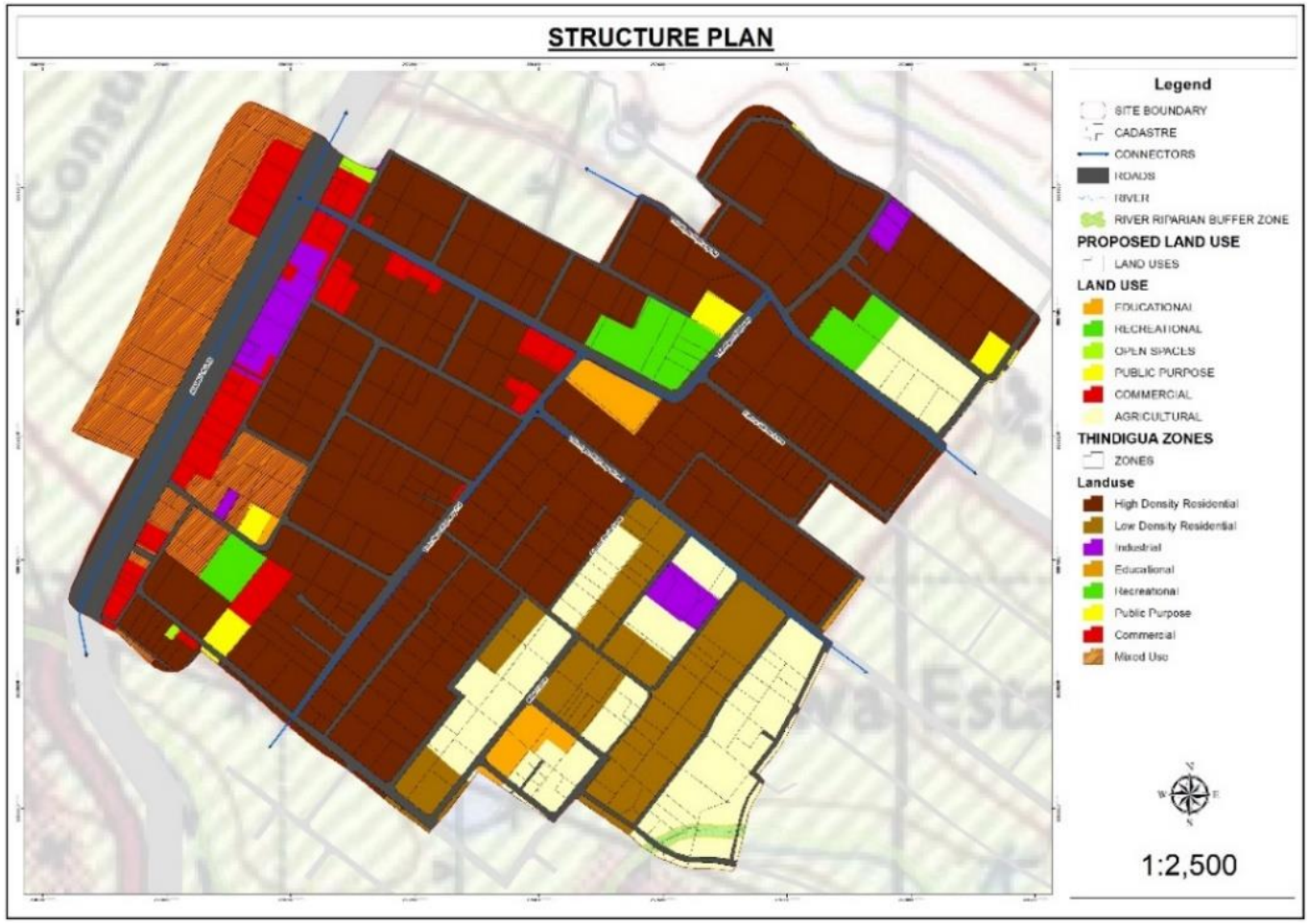


Source (Author)

6.7 structure plan

Map 27 below is the proposed structure plan for the neighborhood.

Map 27 : Structure plan

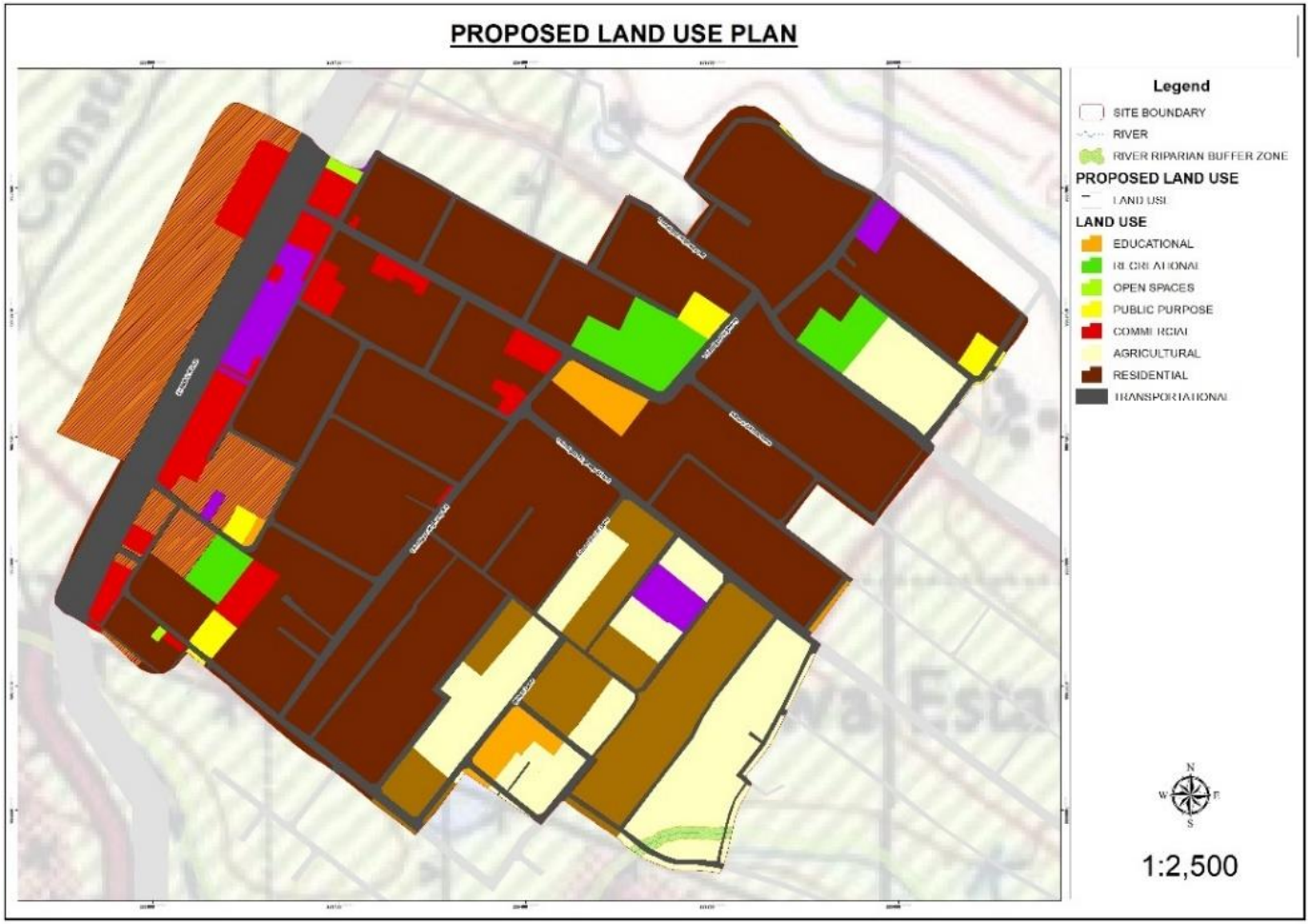


Source (Author)

6.8 proposed land use plan

Map 28 below is the proposed land use plan for the neighborhood.

Map 28 : Proposed Land Use Plan

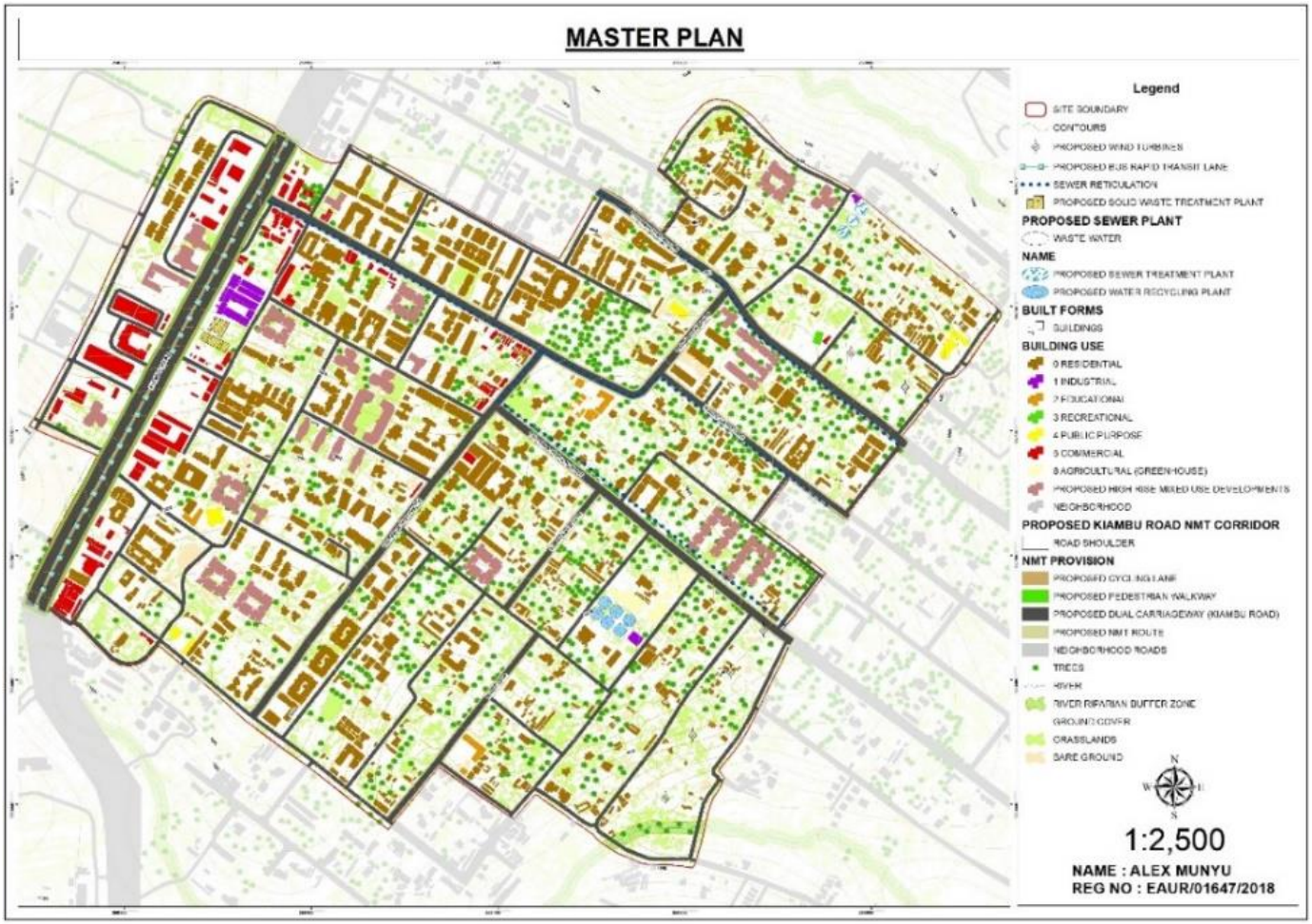


Source (Author)

6.9 proposed master plan

Map 29 below is the proposed advisory master plan for the neighborhood.

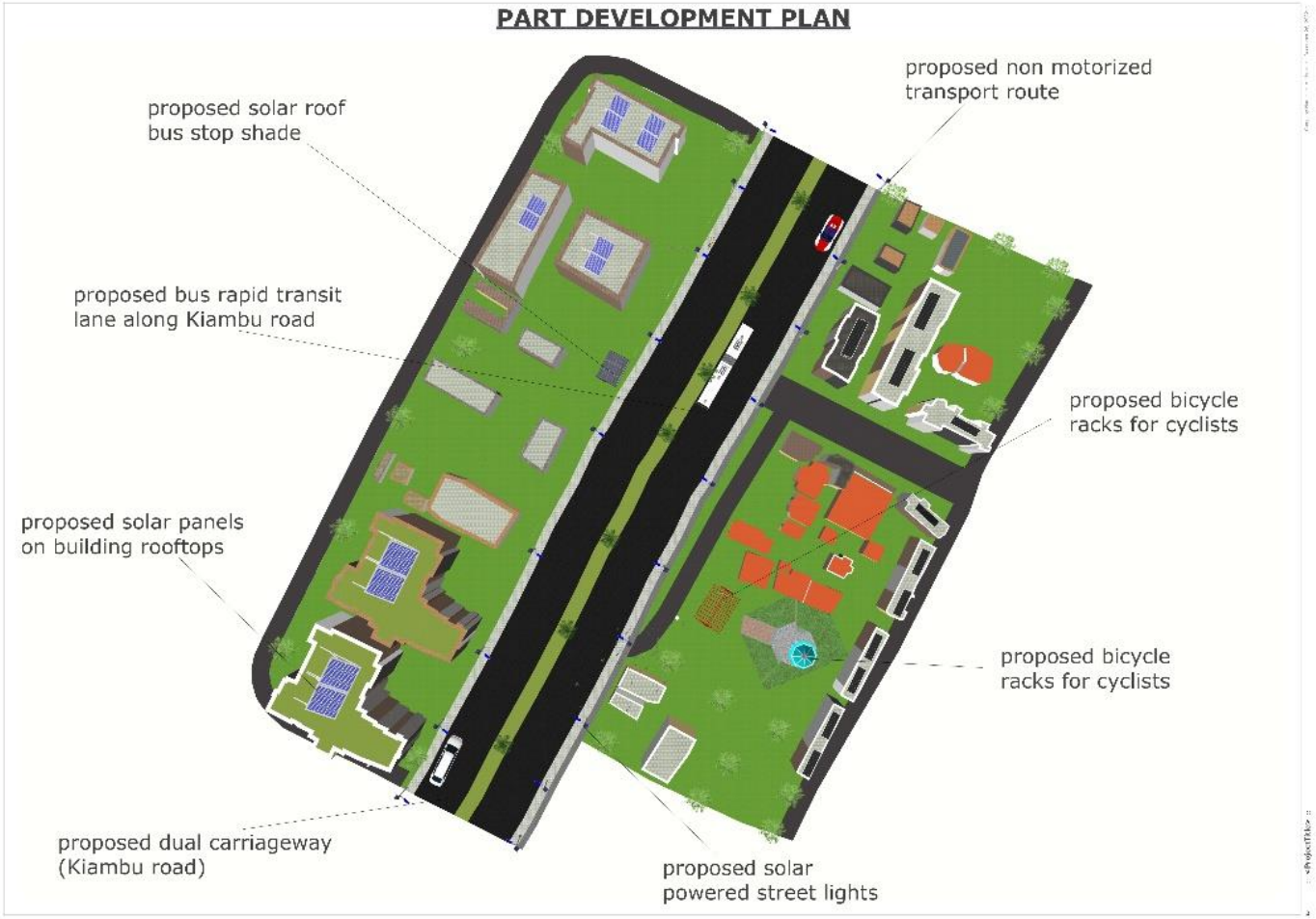
Map 29 : Proposed Master Plan



Source (Author)

6.10 part development plan

Map 30 : Part Development Plan



Source (Author)

6.11 Sections and perspectives

Figure 22: Sections and Perspectives

Source (Author)

6.12 Views

Figure 23: Part Development Plan views

Source (Author)

6.13 Proposed policy action and justification

Table 8 : proposed policy action and justification

PROPOSAL	POLICY	JUSTIFICATION
Development control	➢ Developers to provide basic physical infrastructure for their sites before construction. ➢ Developers to seek approvals from the county planning department when changing use or constructing.	➢ To reduce the strain on the existing physical infrastructure, i.e., roads, sewer line and energy. ➢ The county Government to keep tabs with any development.
Public services and amenities	➢ Provision of solar powered street lighting along all roads to improve security. ➢ Provision of solid waste collection mechanisms either by the County Government or the private sector ➢ All houses to be connected to the newly constructed sewer reticulation line. ➢ Domestic water should be recycled from the proposed-on site water recycling plant ➢ Construction of proper drainage facilities along all roads ➢ Periodic maintenance of all feeder roads by the county	➢ Minimize insecurity in the neighborhood. ➢ Reduce pollution in the neighborhood. ➢ Reduce underground water contamination by septic tanks ➢ Reduce wastage of clean water ➢ Reduce flooding on roads when it rains ➢ Improve accessibility in the neighborhood
Environment and conservation	➢ Conservation of existing trees and open spaces. ➢ Proper waste disposal.	➢ Maintaining all greenbelts in the neighborhood. ➢ Protect the bio diversity of the area.
Land use policy	➢ Ensure that the zoning policy is adhered to by private developers. ➢ Encourage mixed use developments	➢ Ensure that there is no incompatibility in the existing land uses. ➢ Reduce travel distance within the neighborhood.

6.14 Implementation matrix

Table 9 : implementation matrix

OBJECTIVE	STRATEGY	LOCATION	ACTORS	TIME SCALE (YEARS)				MONITORING & EVALUATION		TOTAL ESTIMATED BUDGET IN KES ('000')	%OF THE TOTAL ESTIMATED COST
				0-5	6-10	11-15	16-20	Output	Indicator		
To facilitate physical infrastructure upgrade by using smart growth principles.	Upgrading all murram roads to bitumen or cabro paved standards	Thindigua street Kiburu Githua lane Simon Kaniu lane Mihari lane	Kenya Urban roads Authority (KURA) Kenya Rural Roads Authority (KeRRA) County Government of Kiambu					improved accessibility	Reduce in pollution of the environment by dusty roads.	80,000	13.72
To promote use of non-motorized transportation Promote sustainable mobility	Construct pedestrian walkways and cycling lanes along major roads	Kiambu road Thindigua Highway	County Government of Kiambu					Reduced vehicle dependency	Reduce in pollution due to less vehicle dependency	100,000	17.15
To facilitate physical infrastructure upgrade.	Dualling Kiambu road to reduce traffic congestion during peak hours	Kiambu road	County Government of Kiambu Kenya Urban roads Authority (KURA)					Reduce commute distance especially during peak hours	Good living conditions attract more people to the area	300,000	51.46
To facilitate mass rapid transit on major roads	Dedicating a bus rapid transit lane along Kiambu road	Kiambu road	County Government of Kiambu Nairobi Metropolitan Area Transport Authority					Reduced traffic congestion during peak hours	Good living conditions attract more people to the area	40,000	6.86
Proper solid waste management	Constructing solid waste management plant	On site	World Bank National Government County Government of Kiambu					A clean healthy environment for all	A clean and healthy environment	50,000	8.58
Proper liquid waste management	Constructing a sewer treatment plant and a water recycle plant	On site	World Bank National Government County Government of Kiambu					A clean healthy environment for all	Reduce in pollution on the environment	10,000	1.72
To promote use of sustainable energy sources.	Install wind turbines on agricultural parcels of land	On agricultural land	World Bank National Government County Government of Kiambu					Improved health conditions	A healthy society	3,000	0.51

Source (Author)

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APPENDICES

Appendix 1:Fieldwork Checklist

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SCHOOL OF ARCHITECTURE AND SPATIAL PLANNING

DEPARTMENT OF SPATIAL PLANNING AND DESIGN

BBEnv URBAN AND REGIONAL PLANNING

THINDIGUA FIELDWORK CHECKLIST

AREA OF FOCUS	TICK	TYPE	CONDITION	COMMENT
A. PHYSIOGRAPHY a. Terrain (Hilly, sloppy, gentle) b. Physical Features i. Hills ii. Vegetation iii. Rivers/Streams/Ponds iv. Soil Type				
B. HISTORY a. Significant Landmarks b. Historical areas of interest c. Cultural areas of interest				
C. VIEWS AND NEIGHBORHOOD a. Scenic Views b. General neighborhood Conditions c. Open Spaces d. Unique Views				
D. INFRASTRUCTURE a. Access i. Roads ii. Health care iii. Education iv. Security i.e., Streetlights v. Telecommunication vi. Electrification				

b. Modes of transport i. Vehicular ii. non-motorized iii. Pedestrian iv. Other c. Water supply i. River/ Stream/ Pond/ Dam ii. Rain harvesting iii. Water Vendor iv. Piped d. Sewage and waste disposal i. Sewer line ii. Septic tank iii. Latrines iv. Dumpsites v. Compost pit vi. Burning e. Sources of energy i. Electricity ii. Solar iii. Kerosene iv. Firewood v. Biogas				
E. BUILT FORM INVENTORY a. Built spaces and Open spaces b. Plot sizes / allocation c. Building typology i. Permanent Structures - Stone wall houses ii. Semi-permanent structures -Mud -Aluminum -Wooden				
F. LAND USE a. Commercial i. shops ii. Markets iii. Wholesalers iv. Offices v. Service Industries vi. Accommodation vii. Entertainment viii. Places of worship b. Residential				

c. Agricultural d. Industrial e. Services and Utilities i. schools ii. hospitals iii. open spaces iv. Community/ social Hall				
G. SITE INVENTORY				
H. SITE ACCESS a. Major transport routes b. Conflict Points c. Level of traffic d. transport nodes e. Flow of Movement				
I. EXISTING ECONOMIC ACTIVITIES				

Appendix 2: Key Informant Interview – County Government of Kiambu

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Information provided through this questionnaire will be used purely for academic purposed and will be treated with utmost confidentiality. Your assistance and cooperation will be highly appreciated.

DEPARTMENT OF PHYSICAL PLANNING, COUNTY GOVERNMENT OF KIAMBU

1. What is the main cause of the rapid land use change in Thindigua?

2. What is the rate of change of use applications submitted for Thindigua as compared to other areas within the county?

3. What is the rate of development applications submitted for Thindigua as compared to other areas within the county?

4. Does the county have an integrated strategic urban development plan for Thindigua?

5. Does the county have an approved zoning policy for Thindigua area?

   If yes, is it implemented as per the policy?

6. Does the county have an infrastructure structure plan for the area?

7. How effective is development control and enforcement in Thindigua neighborhood?

8. What are the challenges to development control and enforcement to enhance compliance of physical planning in Thindigua?

Appendix 3: Key Informant Interview-KiWaSCO Offices

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The purpose of this questionnaire is to collect data which will be used to evaluate the effects of land use changes on peri-urban infrastructure in Thindigua neighborhood.

Information provided through this questionnaire will be used purely for academic purposed and will be treated with utmost confidentiality. Your assistance and cooperation will be highly appreciated.

KIAMBU WATER AND SEWERAGE COMPANY, COUNTY GOVERNMENT OF KIAMBU

1. How has land use changes/urban developments impacted water supply and waste water infrastructure in Thindigua?

2. What measures have you put in place to mitigate the impacts stated above?

3. What is the state of water connectivity and availability in Thindigua?

4. What is the rate of boreholes sunk in Thindigua and how is it regulated?

5. How often is water supply and wastewater infrastructure system regulated, protected, maintained and managed?

6. What challenges have you faced in water supply and wastewater management of urban infrastructure (Roads, water and wastewater)?

7. What recommendations would you make to improve the management of infrastructure (Roads, water, and wastewater)?

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The purpose of this questionnaire is to collect data on peri-urban land use change and infrastructure deterioration. The information provided in the questionnaire will be utilized purely for academic purposes and will be treated with utmost confidentiality. participation will involve provision of responses as outlined in the questionnaire and any additional information will be appreciated. Participation is voluntary and participants can stop at any moment they please. Your participation and cooperation will be highly appreciated.

Note; responses will be captured online through the use of a mobile application (Kobo collect).

THANK YOU!

THINDIGUA PROJECT

respodents details

Date

yyyy-mm-dd

Location

latitude (x.y °)

longitude (x.y °)

altitude (m)

accuracy (m)

Gender

- ◯ Male
- ◯ Female

Age

- ◯ Less than 20
- ◯ 21-30
- ◯ 31-40
- ◯ 41-50
- ◯ Over 51

Marital status

- ◯ Single
- ◯ married
- ◯ divorced
- ◯ widow
- ◯ widower

Religion

- ◯ Christian
- ◯ Muslim
- ◯ Other

Education level

- ◯ none
- ◯ primary
- ◯ secondary
- ◯ college
- ◯ University

Occupation

- ◯ formal employment
- ◯ farming
- ◯ Business
- ◯ student
- ◯ other

Birthplace

_____

Reasons for moving

- ☐ Relocation
- ☐ Education
- ☐ Employment
- ☐ Business

Land Tenure

- ◯ Owned
- ◯ Rented

House ownership

- ◯ Owned
- ◯ Rented

Housing Typology

- ◯ Apartment
- ◯ Bungalow
- ◯ Informal settlement

main cause of land use changes

- ◯ low agricultural returns
- ◯ high land rates payable to the county government
- ◯ demand for housing
- ◯ land speculation

car ownership

- ◯ yes
- ◯ no

state of road

- ◯ Bitumen standards
- ◯ cabro paved
- ◯ murram road

Main source of water

- ◯ County Council
- ◯ Borehole
- ◯ water vendors
- ◯ rain water harvesting

Water Challenges

- ◯ water shortage
- ◯ salty water
- ◯ no piped water
- ◯ long distance
- ◯ outbreak of diseases

method of solid waste management

- ◯ burning
- ◯ collected by private sector
- ◯ collected by county government
- ◯ composting
- ◯ burrying
- ◯ use of landfills

method of liquid waste management

- ◯ conventional sewerline
- ◯ septic tank

main source of energy

- ◯ electricity
- ◯ solar power
- ◯ kerosene
- ◯ firewood
- ◯ Biogas

means of transport

- ◯ walking
- ◯ cycling
- ◯ vehicle
- ◯ boda boda

challenges experienced in transport

- ◯ poor state of roads
- ◯ lack of pedestrian walkways
- ◯ traffic jam
- ◯ long distances

state of security

- ◯ good
- ◯ Average
- ◯ bad

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P. O. Box 52428-00200 Haile Selassie Avenue

Tel: +254(020) 343672, 2249974, 2251300, 251822, 2250522Fax: +254(020) 2219689

11th October 2022

Ref: DSPD/SASP/593

TO WHOM IT MAY CONCERN

Dear Sir / Madam,

RE: FIELDWORK VISIT – NAIROBI AND IT ENVIRONS

The attached listed students are 4th year BBEnv. Urban Design and BBEnv. Urban Planning students in the Department of Spatial Planning and Design.

In the course of their study they are expected to undertake field work research for various projects. For this year's **Urban Design Studio** EAPR/Q 4139, they have been tasked with undertaking analysis of **Nairobi & its Environs**. During the course of this semester (September – December 2022), they will make numerous visits to this area for purposes of data collection.

Please assist them in any way possible to get the relevant information they may be looking for.

We will highly appreciate your assistance in the research.

Yours faithfully,

ACADEMIC
DEPT. OF SPATIAL
12 OCT 2022

Dr. Lawrence S. Esho
Academic Team Leader, Spatial Planning and Design

THE TECHNICAL UNIVERSITY OF KENYA

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT
SCHOOL OF THE BUILT ENVIRONMENT
DEPARTMENT OF SPATIAL PLANNING AND DESIGN
CLASS ATTENDANCE REGISTER

Bachelor of Built Environment - Urban and Regional Planning		**Week**	
Course Code	**EAUR/2018**	**Day**	
Course Name		**Date**	
Unit Code		**Period**	

S/no	Student Number	Student Name	Signature
1	EAUR/01658/2018	JOHN KAISER ASUGA	
2	EAUR/01652/2018	POLYCARP KENMASH NAVAGWI	
3	EAUR/01637/2018	CHUMBA DAISY JELIMO	
4	EAUR/01641/2018	BALAN YVONE P ADONGO	
5	EAUR/01654/2018	CHIDZAO ELVIS NYIRO	
6	EAUR/01632/2018	WANJIRU JANEANN NYAMBURA	
7	EAUR/01633/2018	WAMBUA PURITY MUTHEU	
8	EAUR/01634/2018	BEVERLYNE CHEPNGETICH	
9	EAUR/01636/2018	MURIGI CYNTHIA WANJIRU	
10	EAUR/01638/2018	CHERUIYOT MERCY CHEBET	
11	EAUR/01639/2018	ROSEMARY NASIMIYU	
12	EAUR/01640/2018	ONDICHO HULDAH KWAMBOKA	
13	EAUR/01642/2018	WANJIRA P GATHINWA	
14	EAUR/01643/2018	MACHARIA NICHOLAS MARIGA	
15	EAUR/01644/2018	MUMBI ANTONY MUIRURI	
16	EAUR/01646/2018	THUO BEN GITAU	
17	EAUR/01647/2018	NJUGUNA ALEX MUNYU	
18	EAUR/01648/2018	KAMAU KEVIN KIERU	
19	EAUR/01649/2018	NGIGI JOHN KIBE	12 OCT 2022
20	EAUR/01650/2018	MTOTO PAUL B THUO	
21	EAUR/01651/2018	GATEI JOHN MACHARIA	
22	EAUR/01653/2018	SADIRA LESHAN KELVIN	
23	EAUR/01655/2018	SARINKON BRYAN PANAI	
24	EAUR/01656/2018	COLEMAN ABONGO OWINO	
25	EAUR/01657/2018	OLINGO JOHN MAKOKHA	
26	EAUR/01659/2018	RAMPEI TOSHI	
27	EAUR/01661/2018	OSMYNE OSORO MAKORI	
28	EAUR/02330/2018	Odhiambo Onyango sam Rholex	
29	EAUR/02392/2018	WEFWAFWA NAKHUMICHA SUSAN	

Material Covered			
Lecturer's Name			
Lecturers Signature			
Date			
Student Reps' Name			
Student Reps' Signature			
Date			