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**IMPACTS OF KIGALI MASTER PLAN IMPLEMENTATION ON LIVING
CONDITIONS OF URBAN DWELLERS.**
CASE STUDY: KINYINYA SECTOR IN GASABO DISTRICT (2008-2018)

*A dissertation submitted in partial fulfilment of the requirements for the Award of
advanced diploma*

In construction land surveying.

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DECLARATION OF ORIGINALITY

I, **NIYONSHUTI Jean Claude** do hereby declare that the work presented in this dissertation is my own contribution to the best of my knowledge. The same work has never been submitted to any other University or Institution. I, therefore declare that this work is my own for the partial fulfilment of the award of the advanced diploma in civil engineering department, land surveying option at ULK Polytechnic Institute.

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APPROVAL

This is to certify that this dissertation work entitled “**IMPACTS OF KIGALI MASTER PLAN IMPLEMENTATION ON LIVING CONDITIONS OF URBAN DWELLERS. CASE STUDY: KINYINYA SECTOR IN GASABO DISTRICT (2008-2018)**” is an original study conducted by **NIYONSHUTI Jean Claude** under my supervision and guidance.

The supervisor’s names: **Dr. CLAIRE DUSABEMARIYA**

Signature of the supervisor:

Submission date:

DEDICATION

I dedicate this project to:

- Almighty God
- My family

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This Thesis has benefited greatly from substantial inputs, guidance and comments from many people and institutions.

First of all, I would like to thank to the Almighty God for giving the wisdom and granting me resources whether financial and non-financial that has made a great contribution to this research project and my education in general.

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May God bless you all!!!

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ABSTRACT

Problem statement

Master plans serve as crucial tools for guiding, controlling, and managing urban growth and development in a structured manner. However, the existence of a master plan alone does not guarantee its effective implementation. For successful urban planning, a comprehensive assessment of the master plan's implementation is essential, as failures in execution are significant obstacles to achieving planned outcomes. Despite the importance of the Kigali City Master Plan, no studies have evaluated its actual implementation or its impact on urban dwellers' living conditions. This gap in evaluation leaves uncertainty about whether the objectives of the master plan align with the current living conditions in Kigali.

Objectives:

The aim of this study was to address this gap by evaluating the implementation of the Kigali City Master Plan and assessing its impact on the living conditions of urban dwellers in Nyarugenge District. The specific objectives were as follows:

- 1.** To evaluate the implementation of the Kigali City Master Plan by measuring the degree of conformity between the planned and actual land uses in Nyarugenge District. This was assessed through three indicators of conformity: accordance, fulfillment, and deviation. Using ArcGIS software, the study compared actual land uses on the ground to the master plan's designated land uses through GIS overlay analysis.
- 2.** To assess the impact of the master plan's implementation on the living conditions of urban dwellers by focusing on indicators of urban quality of life. These indicators, directly related to the master plan's goals, were used to evaluate residents' living conditions before and after the plan's adoption. Using paired sample test analysis in SPSS, the study assessed changes in the availability and accessibility of quality-of-life indicators to determine the influence of the master plan. The results showed varying levels of conformity across land use categories, with high conformance for public facilities, medium conformance for infrastructure and commercial and natural areas, low conformance for agriculture, and very low conformance for industries, residential areas, and open spaces. Paired sample t-test results suggested that while the master plan has contributed to improved living conditions in some respects, other essential quality-of-life indicators have not shown significant improvement. The low level of overall implementation is attributed, in part, to zoning categories and regulations that are not feasible for low-income residents.

Keywords:

Kigali City Master Plan, implementation assessment, urban development, living conditions, land use conformity, urban quality of life, Nyarugenge District, GIS overlay analysis, ArcGIS, SPSS

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LIST OF ABBREVIATIONS

GoR: Government of Rwanda

NISR: National Institute of Statistics of Rwanda

SPSS: Statistical Package for Social Sciences

C1: Mixed Use Commercial District

C2: Neighborhood Level Commercial District

C3: City Level Commercial District,

C3A: City Level Commercial District

C3B: City Level Commercial District

C3C: City Level Commercial District

C4: Regional Level Commercial District

C4A: Regional Level Commercial District

C5: Retail Warehouse District

CBD: Central Business District

CGIS: Centre for Geographic information System

CIP: Capital Improvement Program

Df: Degree of freedom

DLUP: District Land Use Plan

ELU: Existing Land Use

GIS: Geographical Information System

I1: Light Industrial District

I2: General Industrial District

KCMP: Kigali Conceptual Master Plan

MP: Master plan

NISR: National Institute of Statistics of Rwanda

NLUDMP: National Land Use Development Master Plan

P1: Passive Recreational District

P2: Active Recreational District

P3: Agricultural Area

P4: Protected Area

PCT: Percentage

R1: Single Family Residential District

R1A: Mixed Single-Family Residential District

R1B: Rural Residential District

R2: Low Rise Residential District

R2A: Low Rise Residential District

R3: Medium Rise Residential District

R4: High Rise Residential District, See

REMA: Rwanda Environmental Management Authority

RTDA: Rwanda Transport Development Agency

RLMUA: Rwanda Land Management and Use Authority

Sig: Significant

SPSS: Statistical Package for the Social Sciences

CHAPTER I: GENERAL INTRODUCTION

1.1. Introduction to the study

This project is about the impacts of Kigali master plan implementation on living conditions of urban dwellers. Case study: Kinyinya sector in Gasabo district (2008-2018). Under this chapter, the researcher presents the background of the study, statement of the problem, purpose of the study, objective of the study, research questions, research hypotheses, and scope of the study, significance of the study and lastly the structure of the study.

1.2. Background of the study

A master plan is a dynamic long-term planning document that provides a conceptual layout to guide future growth and development of city or country (Nikuze et al., 2019). Through comprehensive studies, Master Plan determines the City's growing needs and provides clear goals and strategies to direct future growth of City (Dowling & McGuirk, 2006). A Master Plan is a document and policy guide designed to help communities create a vision of what they want their city to look like in the future. A master plan is an important tool which guides, controls and manages an urban growth and development in a planned manner (Of et al., 2023).

Implementation of master plan means the process by which the provided sufficient level of details in master plan are put in action to promote improvements as required for full city or rural development while considering environment protection (Bassett, 2017). The Implementation strategies provides a roadmap for action. It outlines what the city must do to implement the master plan. It provides an approach especially customized to the unique. This part of the master plan is the implementation plan and recommended actions. It sets out the potential projects, programs, policies and strategies to move the master plan towards fruition (Haar, 2015). With an emphasis on governance, the planning and regulatory framework, incentives and financial tools, capital improvements, as well as other recommended strategies, this document addresses the current conditions of downtown in defining the necessary actions that will advance the long-term vision presented in the guiding framework (City of Kigali, 2013)

According to (Nyiransabimana et al., 2019), there are two types of master plan implementation evaluation approaches: performance and conformance. The performance approach is often applied

when plans are considered as visions, and it focuses on the role of plans in decision-making. The conformance approach however, considers plans as blueprints, with their provisions eventually reflected in actual spatial development. Therefore, the conformance approach assumes that plans are successfully implemented if their outcomes on ground correspond to plan provisions.

Mabaso, Shekede, Chirisa, Zanamwe, Gwitira, and Bandaiko, (2029) used GIS overlay analysis to evaluate the degree of conformance of physical developments in the City of Mutare in Zimbabwe. (Butuner, 2020), also evaluated the implementation of the Guangzhou Urban Master Plan in China using GIS overlay analysis, based on three categories of implementation indicators: accordancy, unfulfillment and deviation. (Of et al., 2023) evaluated the implementation of the physical development strategy in Iskandar Malaysia using the three indices: accordancy, unfulfillment and deviation (Nyiransabimana et al., 2019).

In Rwanda, Attracted by the economic opportunities, a large number of people are moving from rural area to Kigali City (The City of Kigali, 2010b). The increasing population and inadequate planning resulted in poor social infrastructures in Kigali City. This resulting in the creation of informal settlements in the city and tend to have major impacts on the environment and human health such as unplanned buildings, poor social infrastructure, open drains, poor sanitation and environmental degradation due to high urban population growth (REMA, 2017). Therefore, such growth needs to be guided by careful and timely planning to ensure that Kigali is able to address the increasing real estate demand in an organized and controlled manner. For this reason, as response, the Kigali City authority adopted the Kigali City Master Plan (KCMP) to guide the urban development and the City of Kigali has adopted a legal framework which guides and regulates urban planning and development in the City of Kigali. One of the constituents of this legal framework, is the Kigali Conceptual Master Plan (KCMP) which was approved by the Ministry of Infrastructure in 2008 (Nyiransabimana et al., 2019).

The KCMP stipulates the broad range development vision for the City of Kigali and the need to develop detailed master plans for each of its three Districts (The City of Kigali, 2010b). Therefore, the approval of KCMP has been followed by the approval of the detailed master plan of Gasabo District in 2010. Later, in 2013, the detailed master plans for the other two constituent Districts of Kigali City and the whole master plan for the entire City were approved. The objectives of the Kigali City master plan and that of the detailed Master Plan for Gasabo District are related to each

other. Some of those objectives are the following: to ensure adequate allocation of land uses; to provide modern and comprehensive housing solutions for all groups of people; to develop efficient transportation, infrastructures and public facilities; and to create and conserve alluring recreational features (Republic of Rwanda/Kigali city, 2020)

These objectives are expected to be achieved through the implementation of this master plan. Apart from the general land uses allocation, the developments proposed by the master plan of Gasabo District are expected to be implemented in phases. Some developments priorities were planned to be completed by 2020, while other developments was implemented in long term. This study evaluated the status of the implementation of the detailed master plan of Gasabo District and evaluated the achieved outcomes of those developments priorities whose implementation was expected to be completed by 2020. In addition, this study will assess the impact of master plan implementation on the living condition of urban dwellers (Colony of Singapore, 2019).

In this study, the impact of master plan implementation on the living condition of urban dwellers was evaluated based on the indicators of urban quality of life which are related to the objectives of the master plan and to the living condition of the urban dwellers. By comparing the current situation and the situation before the adoption of the master plan, this study will evaluate the level of availability and accessibility of these indicators of urban quality of life in the study area.

To assess the impact of the Kigali City Master Plan implementation on urban dwellers, researcher will propose a framework which guides the assessment. The framework will have the following five dimensions: Adequate allocation of land use; affordable housing; efficient transportation infrastructures and public facilities; recreational areas and employment opportunities. These dimensions are the previously mentioned objectives of the Kigali City Master Plan which are related the improvement of living conditions of urban dwellers (Government of Rwanda, 2016).

1.3.Problem statement

The rapid urbanization of Kigali City has led to significant demographic shifts, as many individuals migrate from rural areas in search of economic opportunities (Butuner, 2020). This influx of population, coupled with inadequate urban planning, has resulted in the emergence of informal settlements and deteriorating social infrastructure, manifesting as unplanned buildings, poor sanitation, open drains, and environmental degradation. Such conditions pose severe challenges to public health and overall living standards, emphasizing the urgent need for organized urban development (City of Kigali, 2020).

In response to these challenges, the Kigali City planning authority established a legal framework, encompassing detailed Master Plans for Gasabo, Nyarugenge, and Kicukiro Districts, which were subsequently integrated into a comprehensive Kigali City Master Plan approved in 2013 (Willmer, 2008). While this Master Plan outlines various objectives aimed at enhancing the living conditions of urban dwellers—such as equitable land use, modern housing solutions, efficient transportation infrastructure, recreational space conservation, and local employment opportunities (Of et al., 2023)—the effectiveness of its implementation remains largely unexamined.

To date, there is a notable absence of comprehensive evaluations regarding the impact of the Kigali City Master Plan on the living conditions of its urban residents. The mere existence of a planning document does not guarantee its effective execution; therefore, a robust method for evaluating the implementation of the Master Plan is crucial. This study aims to bridge this gap by systematically evaluating the implementation of the Kigali City Master Plan and its subsequent effects on the living conditions of urban dwellers in the Kinyinya sector of Gasabo District.

1.4.Purpose of the study

The purpose of this study is to assess the impacts of Kigali master plan implementation on living conditions of urban dwellers. Case study: Kinyinya sector in Gasabo district in Kigali city (2013-2023). In addition, this study is carried out in partial fulfilment of the requirements for the award of advanced diploma in land surveying.

1.5.Objective of the study

1.5.1. Main objective

The main objective of this study was to examine the impacts of Kigali master plan implementation on living conditions of urban dwellers. Case study: Kinyinya sector in Gasabo district in Kigali city (2008-2018).

1.5.2. Specific objectives

This project's specific objectives were as follows:

1. To document the process of master plan implementation in Kinyinya sector;
2. To assess the level of conformance of master plan of Kinyinya sector to the current situation on the ground,
3. To determine how the implementation of master plan of Kinyinya sector is impacting on the living condition of the dwellers,
4. Result on research land use and land cover change of Kinyinya sector from 2008 to 2018

1.6. Research questions

Based on the project's serviceability and functionality, answers to the following research questions was offered in order to fulfil the above particular objectives.

1. What is the process of master plan implementation in Kinyinya sector?
2. To which extent do the current land uses conform to the master plan of Kinyinya sector?
3. How is the implementation of the master plan of Kinyinya sector impacting on the living conditions of the urban dwellers?
4. How implementation of master plan of kinyinya sector impacts land use and land cover from 2008 to 2018?

1.7. Scope of study

This study was delimited in terms of space, time, content and domain. Geographically, this study was limited to Gasabo district, because the researcher believes that he will get relevant information concerning the topic. In addition, the study covers a time scope from 2008 to 2018, this time scope of eighty years is adequate to help the researcher to answer research questions, achieve specific objectives and come up with suitable conclusion. In terms of domain, this research was delimited in domain of land surveying. In terms of content, this research will assess the impacts of Kigali master plan implementation on living conditions of urban dwellers.

1.8. Significance of the study

The following are the significance of this study: This section deals with motives which pushed the researcher to choose and be interested in this topic. The study was important to the researcher, to ULK Polytechnic Institute and to the Rwandan society in general also Government, and to the other researchers.

This study will help to shift from theory to practice; above all, it will contribute to the successful completion of advanced diploma in construction technology. Thereafter it will help to improve the knowledge and skills of researcher about the impacts of Kigali master plan implementation on living conditions of urban dwellers. The results of this research was beneficial to the City of Kigali since the authority of the City was aware of the area where the master plan is not yet well implemented. Thus, urban planners may work toward achieving better implementation of the master plan.

Again, this research would be beneficial to the Kigali City since through the identification of challenges of master plan implementation, Kigali City may work toward overcoming these challenges. In addition, this research may be used by Kigali City authority for the improvement of implementation measures by adopting the identified strategies of overcoming the challenges of master plan implementation. Moreover, this research would enable the City of Kigali to be aware of which elements of urban quality of life are deficient, thus the authority may seek way to provide these elements of urban quality of life in the area where those elements are needed.

Thus, dwellers was nefit from this research since the identification of urban quality of life deficiency may serve as way for the Government to provide these lacking elements by increasing the level of their accessibility. Lastly, this research would serve as reference for further researches relating to the implementation of the master plan and its impact on urban dwellers.

The findings and recommendations of this research was used by Kigali City authorities for the improvement of implementation measures. The last was a need to give a contribution in the enhancement of the living condition of the inhabitants, through the identification of priority areas where the urban quality of life needs to be enhanced and which enhancement is needed.

1.9. Structure of the research

This work consists of five chapters. Chapter one is the general introduction and it includes background of the study, problem statement, purpose of the study, the objectives of the study, research questions, scope of the study, significance of the study and lastly the organisation of the study. The second chapter was the literature review, which was about the general understanding of the reviews of other researchers with the related studies. The third chapter was the research methodology and it will focus on the methods and materials to be used in achieving the objectives of the study. The fourth chapter was the results and discussions and it was the most important one because it will show the presentation of the results acquired. The fifth one, which was the last chapter, will cover the conclusion and recommendations with respect to the predefined objectives.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

This chapter is about the review of literature on master plan implementation evaluation and on the living condition of dwellers evaluation. It also presents the analytical and conceptual frameworks concerning these evaluations. This chapter is presented into nine sections. Section one defines and discusses key terms and concepts that are included in this research. Section two describes steps in preparing a comprehensive plan/master plan. Section three presents an overview of land use planning in Kigali City. Section four describes the tools for Gasabo District Detailed Master Plan implementation where Kinyina sector is located. Section five explain the analytical framework about plan implementation evaluation. Section six discusses the conformance evaluation approach

of urban master plan. Section seven describes how the used indicators of urban quality of life were selected. Section eight describes the conceptual framework for evaluating the impact of master plan implementation in Gasabo District/ Kinyinya sector. The last section is a conclusion of this chapter.

2.2. Definition of key terms

Apart from the terms: quality of life and urban quality of life which was discussed under section seven of this chapter for better and logical connection of arguments, the key terms and concepts relating to this study are defined and discussed under this section, for better understanding of this research. These include for example planning, urban planning and master plan.

2.2.1. Urban planning

Urban planning is the technical and political process concerned with the control of the use of land and design of urban environment, including transportation networks, to guide and ensure the orderly development of settlements and communities (Serag et al., 2015). Additionally, Pinson (2010) defines “urban planning” as a notion that encompasses the whole set of social activities aimed at anticipating, representing and regulating the development of an urban or a regional area. Thus, urban planning articulates intellectual activities of study and prospective, social and economic forecasting with more concrete activities such as infrastructure programming, land reservation and land use regulation (Pinson, 2010).

However, agencies (such as UN-Habitat) argued that in many part of the world, urban planning systems are parts of the problems since they serve to promote social and spatial exclusion by pushing the poor away (Watson, 2009). Normally, in many poorer cities, urban planning is being driven by private sector property developments and increased rental markets; due to this, low-income households are being pushed further out and into marginal locations (Watson, 2009). However, besides these problems, planning plays several roles in the development process such as promoting job opportunities through economic development and enhancing urban amenities of the communities through urban design regulations among others (Myers, 2016). Below is a brief discussion about “master plan”, one of the instruments of urban planning.

2.2.2. Master plan

Different authors have defined the term “master plan” and their definitions are related to each other. For instance, Buch (1987) defines the term “master plan” as one of the important planning documents to facilitate and encourage the optimal growth of dominant functions of urban centres, strengthening the intra-urban linkages and providing an elbow room for spatial growth. This definition is related to that of Hameed & Nadeem (2008), who define the term master plan as a tool to guide and manage the future growth of cities in a planned manner. Thus, the master plan is based on study of existing situation of each and every component of a City comprising land use, socio-economic and other facilities based on analysis of existing situation, forecasting of future trends, and finally making proposals for the growth and management of the city (Hameed & Nadeem, 2008).

In addition, Tiwari (2010), defines the term “master plan” as a long-term plan which provides guidelines for urban growth and guides people in locating their investment in the City in an orderly manner. Moreover, Mishra (2012), defines the master plan approach as a form of spatial planning based on comprehensive land use maps, zoning and planning standards. A master plan is prepared by the planning board of the State. The following section describes steps that are involved in its preparation.

2.2.3. Master plan implementation

Implementation of master plan means the process by which the provided sufficient level of details in master plan are put in action to promote improvements as required for full city or rural development while considering environment protection (Bassett, 2017). The Implementation strategies provides a roadmap for action. It outlines what the city must do to implement the master plan. It provides an approach especially customized to the unique. This part of the master plan is the implementation plan and recommended actions. It sets out the potential projects, programs, policies and strategies to move the master plan towards fruition (Haar, 2015). With an emphasis on governance, the planning and regulatory framework, incentives and financial tools, capital improvements, as well as other recommended strategies, this document addresses the current conditions of downtown in defining the necessary actions that will advance the long-term vision presented in the guiding framework

2.3. Steps in preparing a comprehensive plan/master plan

According to Chandler (2000), there is a sequence of ten steps that can be followed in developing a comprehensive plan/a master plan. These are discussed hereafter as follow:

Plan to Plan; the key factors associated with this step include the allocation of time, human resources, money, and energy to the effort. When planners mistakenly think that they will deal with these issues as problems arise, this logic is faulty and potentially fatal to the planning process.

Structure and schedule the process; this step involves featuring discrete planning activities, the party(s) responsible for each activity, and the due date as well as the key stakeholders. **Gather and analyze the data.** The master plan must address both issues and concerns of the present and what will likely face the community in the future. Therefore, there is a need to gather and analyze a wide array of data that will help in accomplishing this task appropriately.

Identify problems, issues, and concerns as well as opportunities. In fact, it is crucial to identify the significant problems, issues, and concerns facing the community as well as the opportunities. It is during this step that planning commissions engage the public through community meetings, surveys, focus groups, or advisory committees. This helps in ensuring the plan's decisive adoption and implementation.

Develop a vision for the plan. Once community problems and opportunities have been identified, planning commissions prepare a vision statement which shows what the community intends or wishes to become at some point in the future. This gives direction to the development of plan goals and objectives.

Develop plan goals and objectives. Once the plan's vision statement is completed, the next step is to establish specific plan goals and objectives.

Generate and evaluate plan options.

This step involves the development of a draft plan which contain a series of chapters or elements by focusing on selected topics. Elements to be included on a draft plan are for example, the community's natural environment, transportation system, public facilities, and residential, commercial, and industrial uses.

Select and develop a preferred Plan. Once the various plan options have been reviewed and studied, the planning commission will need to select a preferred option or approach. The final draft

plan can then be prepared and formally received and considered for adoption by the planning commission.

Adopt the plan and set an implementation schedule. Once the plan is adopted by the commission, the plan is forwarded to the governing body for consideration and final adoption. This should be accompanied by setting plan implementation strategy and schedule. The plan development process is considered incomplete if plan implementation strategy and schedule are not included in the document. This is critical since a plan will make a difference only if it is implemented.

Monitor for results and impact. Generally, plans must be written in a manner that allows people to measure the impact of these plans on the life of a community. In addition, plans need to be regularly reviewed and updated. In Virginia for example, comprehensive plan for a locality, must be reviewed at least every five years (Chandler, 2000). Similarly, in Rwanda, master plan of Kigali City is reviewed every five years. The following section gives an overview of the historical evolution of land use planning in Kigali City.

2.4. Process of master plan implementation

The process of master plan implementation is based on 5 stages which are priorities, phasing, proposal for land resource mobilization, investment strategy and institutional set up (Tian & Shen, 2011).

1. Priorities

In this stage master plan implementation is classified according to priorities stating which project comes first and then arrange them in sequence order (Szuster & Dietrich 2014). Classify various projects identified as a part of development proposals by priority as under: essentials (Top priority), necessary (2nd priority), acceptable and desirable (3rd priority), deferrable (4th priority) (Haar, 2015).

2. Phasing

Master plan should advisably be in phases of 5 years to coincide with the state five-year plans. The targets set for each phase can be assessed as the mid-term review against the achievements at the end of each phase. For greenfield area phasing could include a 'zero' period for approvals, institutional set-up, initial land pooling and revisiting any strategy (Todes et al., 2010).

3. Proposal for Land Resource Mobilization

Implementation mechanism in which proposal of how land resources was used to achieve master plan target is drafted. It is detailing approaches for land polling and development in lines with the suggested mechanism in the master plan perspective plan (Nguyen et al., 2021).

4. Investment Strategy

In this stage the master plan stakeholders sit together with the private sector and other investors willing to invest in the master plan projects then make the investment strategy. The Proposals for fiscal resource mobilization including (Spence, 2019)

5. Institutional Setup

In this stage all stakeholders are assigned role and responsibility to perform in according with master plan implementation. In addition, clearly provide Stakeholders' role and responsibility and organization chart (Hossain et al., 2015).

2.5. Land use planning in Kigali City

In 2008, the Rwanda's Ministry of Infrastructure has developed and approved the KCMP (The City of Kigali, 2010b). The KCMP specifies the need to develop Detailed Master Plans for each of the three Districts as well as the key areas of Kigali City. In addition, in 2010 the Kigali City has developed an urban design for the Central Business District (CBD) areas (The City of Kigali, 2010a) and a Detailed Master Plan for Gasabo District (The City of Kigali, 2010b). Later, in 2013, the Detailed Master Plans for the other two constituent Districts of Kigali City namely Kicukiro and Gasabo were approved (The City of Kigali, 2013c). After the approval of the Detailed Master Plans for the three Districts, the whole master plan for the entire Kigali City was also approved in 2013. In order to implement the Detailed Master Plan for Gasabo District, various zoning categories have been proposed into the following zoning Districts (The City of Kigali, 2013a):

❖ Seven Residential Districts

The residential district is made of Single-Family Residential District (R1), Mixed Single Family Residential District (R1A), Rural Residential District (R1B), Low Rise Residential District (R2), Low Rise Residential District (R2A), Medium Rise Residential District (R3) and High-Rise Residential District (R4).

❖ **Nine Commercial Districts**

The commercial district is made of the Mixed-Use Commercial District (C1), Neighborhood Level Commercial District (C2), City Level Commercial District (C3), City Level Commercial District (C3A), City Level Commercial District (C3B), City Level Commercial District (C3C), Regional Level Commercial District (C4), Regional Level Commercial District (C4A) and Retail Warehouse District (C5).

❖ **Two Industrial Districts**

The industrial district is made of Light Industrial District (I1) and General Industrial District (I2).

❖ **Four Parks and Open Space Districts**

The parks and open space District is made of Passive Recreational District (P1), Active Recreational District (P2), Agricultural District (P3) and Protected Area (P4). The description for each zoning category is presented in appendix B. The following section describes the tools for the implementation of the detailed master plan for Gasabo District.

2.6. Tools and strategies for Kigali City master plan implementation in Gasabo District.

A master plan preparation alone does not ensure the implementation of what proposed (Hameed & Nadeem, 2008). For a successful implementation of a plan, it requires comprehensive implementation tools. According to Bahtti (1993), the general tools for implementing the master plan include legal protection of the plan, Capital Improvement Program (CIP), zoning regulations, land sub-division regulations, building regulations, and urban renewal program. For the implementation of the Detailed Master Plan of Gasabo District, the key tools and strategies proposed are the following: the implementation of the Zoning Plan, the Capital Improvement Plan, and the development of Special Projects (The City of Kigali, 2010b).

❖ **Zoning Plan**

The Zoning Plan is composed of a zoning map and a set of zoning regulations. The zoning map identifies specific zoning districts within the planning area, it also identifies the desired intensity and building height for that area (The City of Kigali, 2013a). The implementation of Zoning Plan is expected to regulate the development in different parts of the District and the development or redevelopment of prioritized areas.

❖ **Capital improvement plan**

The capital improvement plan is proposed for the development of Gasabo District, by focusing on the development of infrastructures and providing essential public facilities required to support the proposed land use plans.

2.7. Conformance evaluation of urban master plan

Different studies evaluated the implementation of urban master plans based on the conformance approach using GIS as a tool for evaluation. Normally, GIS is a very useful tool for assessing the conformance, especially in land use planning and implementation (Loh, 2011). Mabaso et al. (2015), used GIS to evaluate the degree of conformance of physical developments in the City of Mutare in Zimbabwe. They used the overlay analysis to assess whether land use proposals conform to the existing developments in the City. The results of their study showed that there was a high overall conformance, although some proposed land uses did not conform to the master plan. In addition, Tian & Shen, (2011) evaluated the implementation of the Guangzhou Urban Master Plan in China, using the overlay analysis to identify the level of conformance.

Their evaluation identified three categories of implementation indicators. Those are type of accordance, type of unfulfillment and type of deviation. They compared the planned land uses to the actual land developments for each piece of land. Then, they calculated the percentage of land in which the actual uses followed the plan. Their findings showed that while the actual land uses were very different from what was in the plan and from what was preexisting, several main roads area were built as planned.

Moreover, Johar, et al., (2013) evaluated the implementation of the physical development strategy in Iskandar Malaysia. Their study compared the original physical development strategies with subsequent development activity using the overlay analysis. They also applied three indices: accordance, unfulfillment and deviation to measure the level of conformance between the plan and actual land use of five major land uses: residential, commercial, public facilities, industrial and open space. Their findings showed that the accordance level was relatively high for industry and open space while relatively low for residential and public facilities. Referring to these previously

discussed studies, this study evaluated the implementation of Kigali City master plan in Gasabo District, based on conformance approach using the overlay analysis by GIS software.

Additionally, this study evaluated the impact of such implementation on the living condition of urban dwellers. This impact was conceptualized as a change which can be attributed to urban quality of life through the availability and accessibility of urban quality of life indicators. The following section presents the description of how urban quality of life indicators were selected based on the case study.

2.8. The selection of urban quality of life indicators

The term “quality of life” represents the concept with broader meaning and consists of many different aspects of human being which indicates its multidimensional character (Nováková & Šoltés, 2016). There is no universally accepted definition of this term; however, it overlaps with several terms, including "well-being," "social indicators," and "way of life" among others (Andrews as cited in Gilhooly & Gilhooly, 2005). The concept of quality of life is usually both objective and subjective (Eckersley, 1999 as cited in Georgiou, 2009). Objective indicators of quality of life involve tangible objects such as finances, employment, place of residence, education and one’s social or physical environment (Bowling, 2005 as cited in Georgiou, 2009).

However subjective quality of life is further influenced by events in one’s life and how one reacts to life’s events. so its measurement should include how people think about their lives (Glicksman, 2000 as cited in Georgiou, 2009), and it is measured by personal opinions. Feneri, Vagiona, & Karanikolas (2013) evaluated urban quality of life, focusing on subjective dimension. This was done through satisfaction measurements by asking a categorical question and rating the responses on a point scale. The purpose was to identify satisfaction with the respondent’s wellbeing, social, environmental aspects, as well as infrastructure facilities. In addition, Czapiński (2013) assessed objective and subjective quality of life in Poland with emphasis on Poles’ living conditions.

The quality of life can be measured in both rural and urban areas. In fact, urban quality of life is the human satisfaction with different urban attributes such as transportation, quality of public spaces, recreational opportunities, land use patterns, population and building densities, ease of

access of all to basic goods, services and public amenities (Serag et al., 2015). Garau & Pavan, (2018) evaluated urban quality of life in Italian Cities, using both subjective and objective quality of life indicators. Normally, various indicators of urban quality of life exist. However, depending on the case study, purpose and the available data, researchers select indicators differently. In this study, I used the indicators which are related to the living condition of urban dwellers and to the main objectives of the detailed master plan for Gasabo District. Below are the selected indicators of urban quality of life. They are presented in a table to relate those indicators to the objectives of the detailed master plan for Gasabo District.

Table 1: Selected urban quality of life indicators

Dimension/master plan objectives	Indicators	Means of measuring indicator	Source of indicator
1. Provision of efficient transportation infrastructure and public facilities	Safe traffic availability and accessibility	Satisfaction with availability of pedestrian infrastructures, streets and traffic lights in the neighborhood.	(Garau & Pavan, 2018)
		Satisfaction with appropriate accessibility of bus stops (in terms of time taken).	
	Access to waste management facilities	Satisfaction with the system of garbage collection	(Khaef & Zebardast, 2016; (Shoeibi et al., 2015); Stein, 2001)
		Satisfaction with the condition of the City's sewage system.	
	Access to educational services	Satisfaction with accessibility of kindergarten and primary school (in terms of time taken).	(Khaef & Zebardast, 2016; (Shoeibi et al., 2015); Stein, 2001)
	Health facilities accessibility.	Satisfaction with accessibility of health facilities (in terms of time taken to health Centre)	
Accessibility of power of electricity	Satisfaction with the availability of power of electricity	(UNHabitat, 2004)	

	Access to clean water	Satisfaction with accessibility of daily useful clean water (in terms of time taken to the water tap)	
Dimension/master plan objectives	Indicators	Means of measuring indicator	Source of indicator
1. Adequate allocation of land	Access to governmental administrative office	Satisfaction with accessibility of local government administration office (in terms of time taken)	(Ali et al., 2014)
	Access to commercial centres	Satisfaction with accessibility of commercial facilities (in terms of time taken)	
2. Provision of modern and comprehensive housing solution for all groups of people	Affordable housing and accessibility	Satisfaction with rental cost/house price compared to household income	(Garau & Pavan, 2018; Shoeibi et al., 2015)
5. Creation of alluring recreational features	Access to recreational area	Satisfaction with the availability and accessibility of recreational facilities (whether accessed free of charge or payment fees.)	
6. Creation of local employment opportunities	Availability of employment opportunities	Satisfaction with one's occupational status	(Garau & Pavan, 2018; Shoeibi et al., 2015)

As previously mentioned, the selected indicators of urban quality of life are those related to the main objectives of the master plan of Gasabo District to evaluate the level to which master plan is impacting on the living condition of the urban dwellers. The following section presents the conceptual framework for this evaluation.

2.9. Conceptual Framework

To ensure a sustainable development in urban areas, not only the plan implementation is necessary to be evaluated, but also the impact of the implementation to the living condition of urban dwellers. To evaluate the impacts of master plan of Kigali City on the living condition of the dwellers in the study area, the author of this study proposed a framework to guide the evaluation. The framework has the following five dimensions according to the objectives of master plan of Gasabo District: adequate allocation of land use; creation of attractive recreational features; provision of efficient transportation, infrastructure and public facilities; creation of employment opportunities and provision of comprehensive housing solution for all groups of people. The selection of these five dimensions was based on the main objectives of the detailed master plan for Gasabo District that have a direct impact on urban quality of life. The following figure is an illustration of this framework.

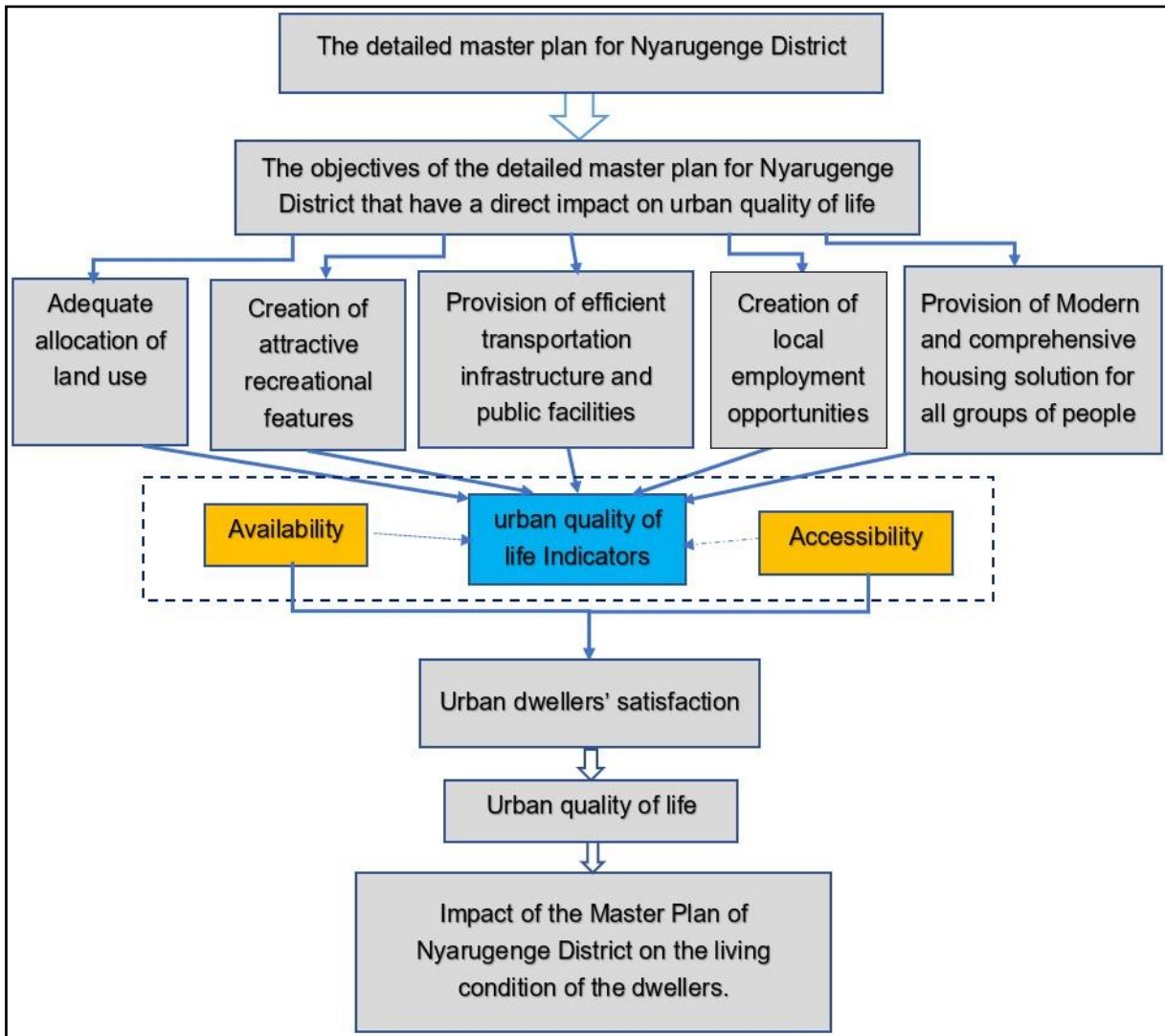


Figure 1: Conceptual Framework

Source: M J Nyiransabimana et al 2019 IOP Conf. Ser.: Earth Environ. Sci. 389 012018

The figure above is a conceptual framework which has been proposed in order to evaluate the level to which master plan is impacting on the living condition of the dwellers. For this evaluation, indicators of urban quality of life which are at the same time related to the living condition of the urban dwellers and to the objectives of the Detailed Master Plan for Gasabo District were analyzed. The selected indicators are shown in table 1 above.

The level to which those indicators are available in the neighborhoods and accessible by dwellers, were assessed. In addition, the peoples' level of satisfaction with such availability and accessibility of those indicators in neighborhoods was also assessed. The availability and accessibility of the selected indicators as well as people's satisfaction help in the identification of urban quality of life and the living condition of urban dwellers in the study area. In fact, the quality of life correlates with the general living condition (UBC Environment and Sustainable Development, 2011).

CHAPTER 3: RESEARCH METHODOLOGY

3.0. Introduction

This section contains the following: description of the study, methodology, data processing, data analysis and material that was used in research.

3.1. Description of the study area

This study was carried in Kinyinya Sector which is one of the 10 administrative sectors of Gasabo district in Kigali, Rwanda. This sector is composed with 4 cells including Kagugu, Gacuriro, Murama, and Gasharu. This sector has 57,846 populations; 2,391 /km² population density and 24.20 km² area (NISR, 2012). The geographical coordinates of Kinyinya sector are: 1° 52' 17" south as Latitude and 30° 31' 17" east as Longitude. In Kinyinya sector, it is a good example to show the impacts of master plan implementation where the master plan has been started to be implemented.

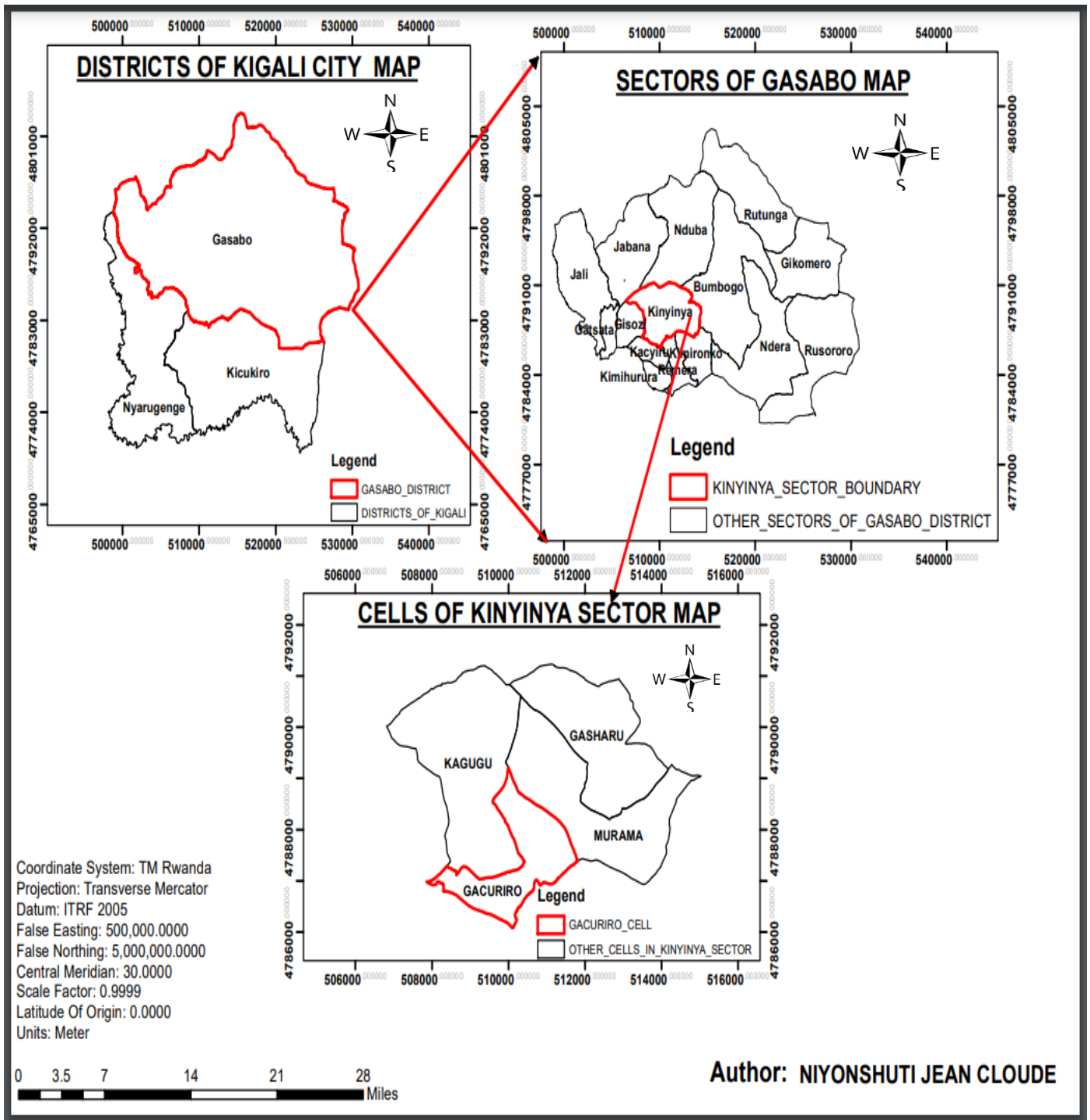


Figure 2: Administrative map of study area

3.2. Data description

Data is soul of any information system. Any kind of analysis or results mainly depends upon reliability and accuracy of data. The efficiency and performance of any information system highly depends on nature, quality and availability of data.

Table 2: Types of Data and data sources

Data	Type of Data	Source of data	Description	Resolution
DEM	Raster	(http://vertex.daac.asf.alaska.edu/)	Topographic map	12.5m
Very-High Resolution images (Aerial Images)	Raster	Google Earth/ SAS Planet	Used to classify satellite image of before and after (current) the introduction of Kigali City master plan. Here, researcher used two very-high resolution images (2008 with resolution of 25cm, 2018 with resolution of 50cm) accessed from National Land Authority.	25 cm for 2008 and 50 cm for 2018
Administrative boundary	Vector	Downloaded from Rwanda Geo-portal (http://geoportal.rlma.rw)	Used for Extracting study area or boundary describing the area of study.	N/A
Information on Master plan, 2018 (zoning plan of 2018)	Raster	NLA		

3.3. Data collection method

In this study, only secondary data was utilized to achieve the results. Spatial data was collected online, including Google Maps and institutional websites that published spatial information, which was then downloaded. Essential data for the study included satellite images from before and after the implementation of the Kigali Master Plan, topographic maps, actual land uses in Kinyinya sector, planned land uses, Rwanda's administrative boundaries, and settlement patterns. To analyze changes, Landsat images from 2008 and 2018 for Kinyinya sector were downloaded from the USGS GLOVIS website, utilizing ERDAS Imagine 9.2 software. The downloaded files, initially in compressed format, were extracted and converted to TIFF format for pre-processing. A Digital Elevation Model (DEM) was also obtained from USGS to assist with topographic mapping.

For satellite image classification, Landsat 8 OLI & TIRS and Landsat 7 TM images were downloaded from USGS, enabling a comparative analysis of images from before and after the Kigali Master Plan's introduction. ERDAS Imagine 9.2 software was employed to process DEM data, create color composites, and classify these satellite images.

The primary satellite imagery sources, covering the years 2008 through 2020, included Landsat 7 ETM+ (2010) and Landsat 8 OLI/TIRS (2020), all accessed from the USGS geo-information portal (www.usgs.gov).

Finally, the study evaluated the impact of the Master Plan on the living conditions of urban residents through change detection analysis. This method assessed whether informal settlements decreased by comparing current data with data from before the Master Plan's adoption, using ArcGIS or ERDAS Imagine 9.2 software for geospatial analysis.

3.4. Software used

Erdas Imagine 9.2 software was initially used to classify images related to the introduction of the master plan. Currently, it is being used to detect changes in the living conditions of urban dwellers, with further analysis planned to identify specific changes. ArcGIS 10.8.1 software was utilized to prepare the administrative map of the study area and the map of the output of the research; Microsoft Word and Excel 2016 was used to write the report.

3.5. Image Classification and Accuracy Assessment

The collection of ground truth data in Kinyinya Sector involved a multi-faceted approach that combined field surveys, remote sensing, government records, and community engagement

For classification data to effectively support change analysis, it is crucial to conduct an accuracy assessment for each classification. This assessment is vital for studying image classification and detecting land use and land cover changes (LULCC), as it allows for an accurate understanding and estimation of changes. It indicates how well the classification results correspond to actual conditions on the ground. Accurately deriving values for individual classifications is essential for their utility in change detection analysis. In this study, we performed an accuracy assessment for the Landsat 7 ETM+ satellite image, using ground truth data for comparison. Overall accuracy was determined by dividing the number of correctly classified sample units by the total number of sample units. Additionally, GIS software played a significant role in finalizing maps, including layout design, and the incorporation of elements such as legends, titles, scales, and north arrows.

3.6. Change detection

In the study area, maximum likelihood supervised classification and post-classification change detection techniques were applied to Landsat images acquired in 2008 and 2018, to map land cover changes in Kinyinya Sector. A supervised classification was conducted on the twelve reflective bands of the six images individually, aided by very high-resolution images. The post-classification change detection technique helped produce change images through cross-tabulation (**means a statistical tool used to analyze the relationship between two or more categorical variables. It involves creating a matrix (table) that displays the frequency distribution of variables, allowing for the comparison of the relationships among them**), allowing for the assessment of changes among different land cover classes in Kinyinya Sector. Regardless of the technique used, the effectiveness of imagery depends on both the nature of the changes involved and the success of the image pre-processing and classification procedures.

This chapter explains all the methods and materials adopted in this study to achieve the main objective of the project. Specifically, maximum likelihood supervised classification and post-classification change detection were applied to Landsat 7 and Landsat 8 images from 2008 and 2018. A supervised classification was performed on the eight reflective bands for Landsat 7 and the eleven reflective bands for Landsat 8, using very high-resolution images for reference.

The post-classification change detection technique produced change images through cross-tabulation, enabling the assessment of changes among different land cover classes in Kinyinya Sector. The success of change detection from imagery relies on both the nature of the changes involved and the effectiveness of the image pre-processing and classification procedures. If the nature of change within a particular scene is either abrupt or at a scale appropriate to the collected imagery, detection should be relatively straightforward; however, problems arise when spatial

changes are subtly distributed and thus not obvious within any image pixel (Yirsaw et al., 2016). In Kinyinya Sector, significant changes occurred between 2008 and 2018.

3.7. Data processing and analysis

3.7.1. Image pre-processing

✓ Radiometric correction

This technique was used for removal of atmospheric noise, it accurately represents ground conditions improve image visually (Lu & Weng, 2007).

✓ Geometric correction/registration

In image geometric correction, Landsat 8 image was transformed into one coordinate system with the same of study area Shape file to reduce the size of the images file to include only the area of interest. The Geometric image registration was performed in order to minimize all geometric distortion inherent to the image. The Landsat 8 OLI image was registered to a common universal Transversal Mercator (UTM) WSG84 Datum, administrative boundaries area of the study has projected 36S Zone coordinate as system. By reducing large amount of the geometric errors a pear in raw data.

✓ Layer stack

This step was used to combine separated bands into one multispectral image. The combinations bands of Landsat 8 OLI are band 2, 3, 4, 5, 6, 7. This band enable researcher to extract the needed information relating their desire.

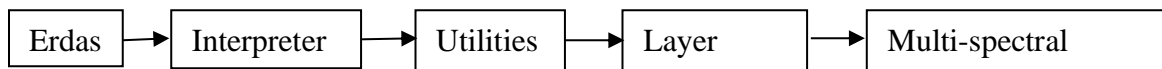


Figure 3: Layer stack procedures

✓ Resolution Merge.

This step was applied to combine the multispectral bands with a panchromatic band in order to get an image of a 15-meter resolution to enhance and increase the visibility of images. Landsat 8 OLI data are acquired at two different resolutions which are the

multispectral bands (bands 2 to 7) collected at 30 meters' resolution and the panchromatic band (band 8) is collected at 15meters resolution (Li, & Cheng, 2019)

✓ **Pan sharpening**

This step is to combine the multispectral bands with panchromatic band in order to get an image of 15-meter resolution. Landsat 8 OLI data are acquired at two different resolutions which are the multispectral bands (band 1 to 7) collected at 30 m resolution and panchromatic band is (band 8) is collected at 15 m resolution, Multispectral image is produced by sensors that measure reflected energy within several specific bands of the electromagnetic spectrum and it's indicates that the sensor has the capability to accept signal in various narrower bands separately while a panchromatic band is essentially a black and white band and it's have very high signal compared to multispectral bands whose capability that enable to see a smaller portion and still get a strong signal. Hence panchromatic often resembles one wide band with lower spatial resolution (often 50% less than multi spectral band) which helps us to see finer details.

✓ **Image sub-setting**

The area of interest (AOI) was prepared for Gasabo district to extract required study area from Landsat image. The Landsat tile is much larger than a project study area. In this case, it was beneficial to reduce the size of the images file to include only the area of interest, the study area shape file was projected to be given the same projection as the one of satellite image. Then it was used to subset that satellite image using ERDAS imagine 9.2.

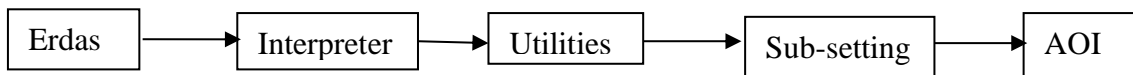


Figure 4: Sub setting image's procedures

3.8. Data processing.

This section involves two steps, one is Satellite data processing in ERDAS imagine 9.2 and another is data processing in ArcGIS 10.8.1. Classification of land use/land cover of Kinyinya sector was done in ERDAS imagine 9.2 software by using unsupervised classification method with Landsat

8 OLI image data, then through accuracy assessment with random reference points was calculated to clarify if the classification made was in conformance with what was on the ground. Slope and elevation was processed in Arc map 10.3 software using DEM Data through arc tool box and raster calculator tool.

✓ **Visual image interpretation**

Image enhancement techniques was used to improve the quality of an image as perceived by a human. These techniques are most useful because many satellite image when examined on colour, it gives inadequate information for image interpretation. False Colour Composite (FCC) of band combination of (band 5, 3 and 2 for Landsat 8 OLI) and true colour composite was used to visualize the Satellite images of Kinyinya sector before and after (current) the introduction of Kigali city master plan.

✓ **Recording**

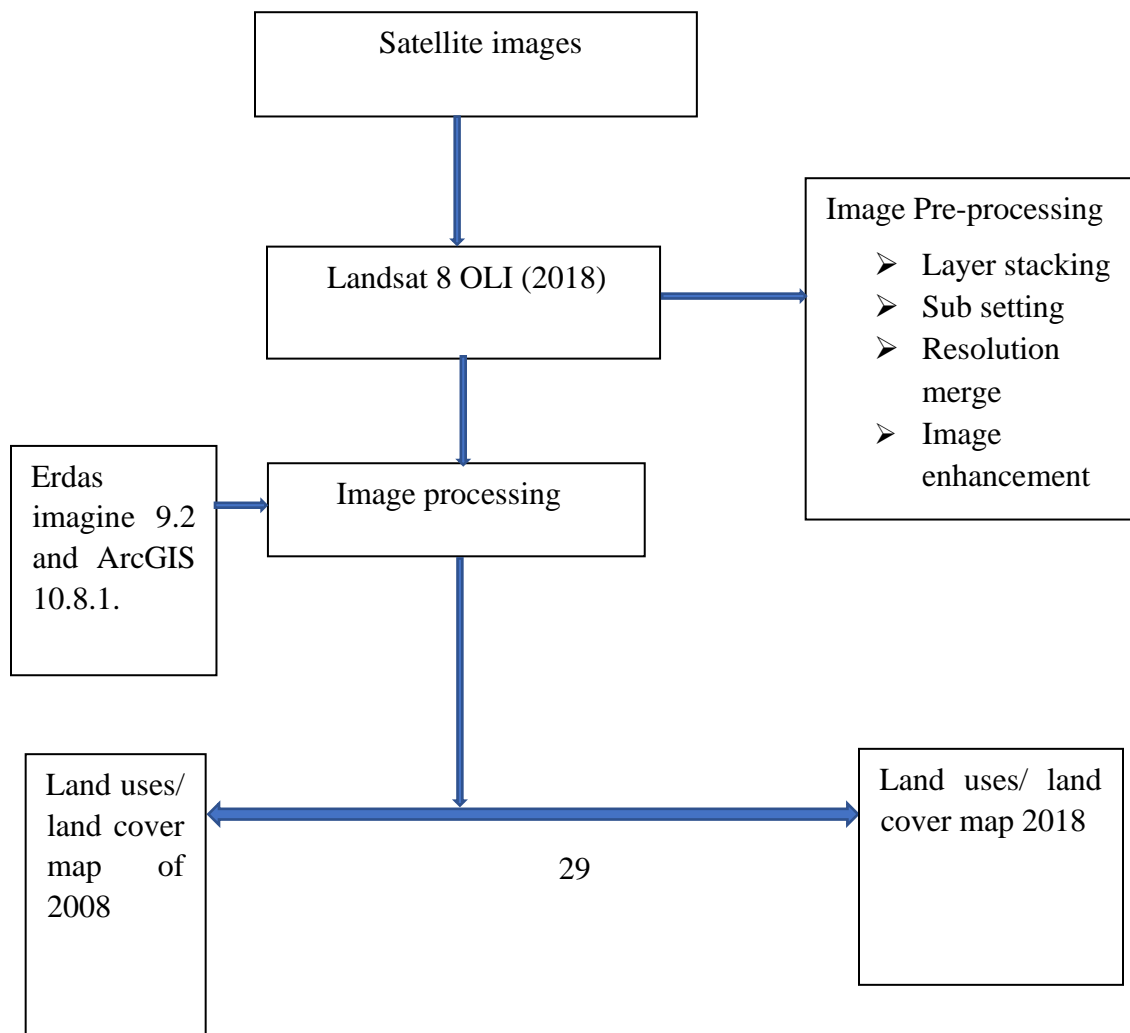
After the classification process, all signature sample point was grouped as class by record function according to the determined land cover classification type in study area. Recording was involved the assignment of new values to one or more classes and was used to reduce the number of classes and combine classes.

✓ **Accuracy assessment report**

In this research, each of land use / land cover map was compared to the reference data to assess accuracy of the classification. The Reference Data was prepared by considering the ground control point, the field knowledge and Google earth image. During this classification in accuracy assessment, the actual land uses that exist on ground was compared to the planned land uses on the master plan using GIS overlay tools. Change detection is described as a process that measures how the attributes of a particular area have changed between two or more periods, in this study it is also applied for comparing the satellite images of the study area taken between 2008 and 2018.

3.9. Flowchart of Methodology.

The methodological flowchart indicates the summary of the data, software and their tool that was used from data collection process to the final results of this study in order to achieve the specific objectives.



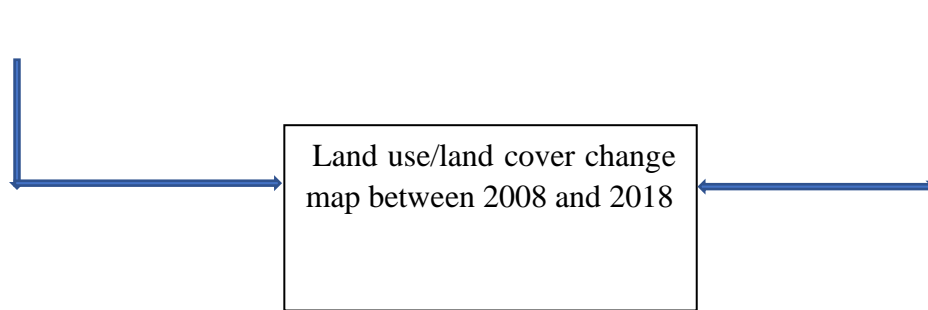


Figure 5: Flowchart of Methodology

CHAPTER IV: RESULTS AND DISCUSSION

4.0. Introduction

This chapter defines the results, findings, and discussions that were founded. The intention of the results and discussions is to investigate the contribution of master plan implementation in improvement of living conditions of urban dwellers This study was going to emphasis precisely in Kinyinya sector where it's going to document the process of master plan implementation in Kinyinya sector; to assess the level of conformance of master plan of Kinyinya sector to the current situation on the ground, and to determine how the implementation of master plan of Kinyinya sector is impacting on the living condition of the dwellers.

4.1. The process of master plan implementation in Kinyinya sector

According to the research findings, the process of master plan implementation in Kinyinya sector are priorities, phasing, and proposal for land resource mobilization, investment strategy and institutional set up. The chart below has been formed in order to present well the gathered information as discussed above.

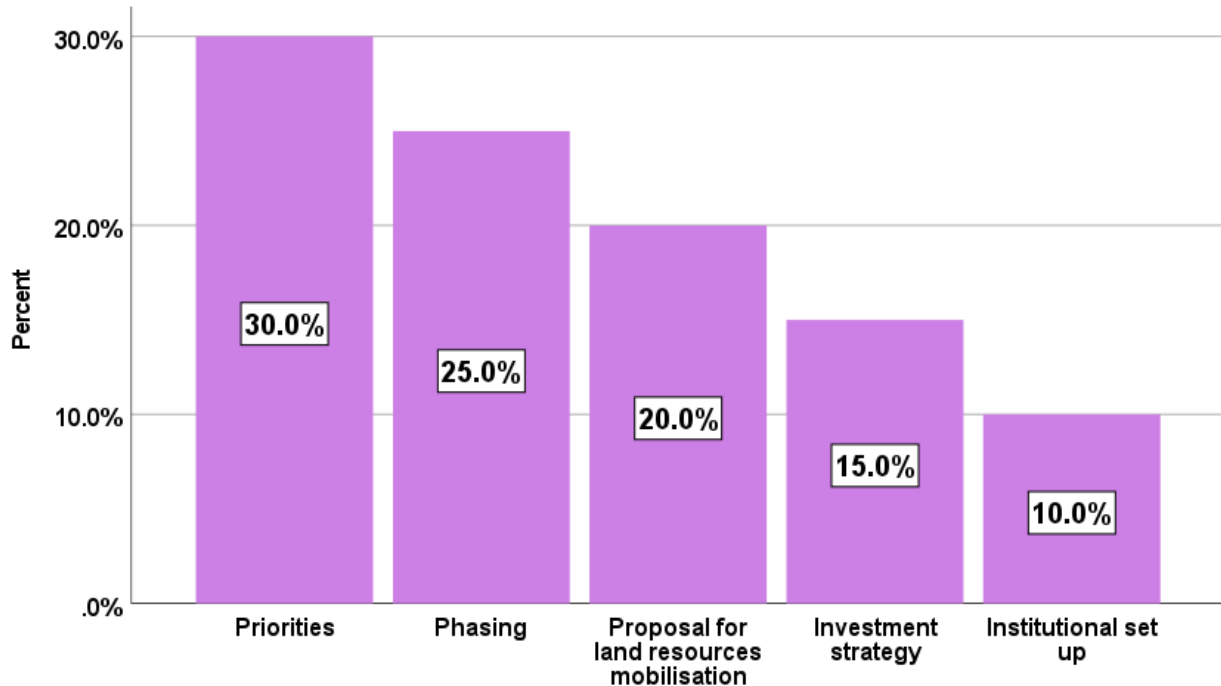


Figure 6: Process of master plan implementation in Kinyinya sector

As shown in figure 1, 30% of respondents reported priorities as one of the process of master plan implementation, they said that during this step, master plan implementation is classified according to priorities stating which project comes first and then arrange them in sequence order. 25% of respondents reported that phasing is step in master plan implementation whereby Master plan implementation projects are put into phases which coincide with the state phase plans. 20% of respondents reported that the next step in master plan implementation is proposal for land resources mobilization whereby proposal of how land resources will be used to achieve master plan target is drafted. 15% of respondents reported investment strategy, they said that in this stage ;the master plan stakeholders sit together with the private sector and other investors willing to invest in the master plan projects then make the investment strategy. 10% of respondents reported institutional set up where by all stakeholders are assigned role and responsibility to perform in according with master plan implementation.

The obtained results are like those of Bassett (2017) who demonstrated that during master plan implementation, the first phase is priorities in which master plan implementation is classified according to priorities stating which project comes first and then arrange them in sequence order. In line with this, Todes and others (2010) noted that during master plan implementation, in the

stage of phasing, master plan should advisably be in phases of 5 years to coincide with the state five-year plans.

The targets set for each phase can be assessed as the mid-term review against the achievements at the end of each phase. For Greenfield area phasing could include a 'zero' period for approvals, institutional set-up, initial land pooling and revisiting any strategy. Nguyen and others (2021) stated that in the 3rd phase of master plan implementation, the implementation mechanism in which proposal of how land resources will be used to achieve master plan target is drafted. Spence (2019) stated that in the 4th phase of master plan implementation, the implementation mechanism in which proposal of how land resources will be used to achieve master plan target is drafted. Hossain and others (2015) noted that in the 5th stage of master implementation, all stakeholders are assigned role and responsibility to perform in according with master plan implementation. In addition, clearly provide Stakeholders' role and responsibility and organization chart.

4.2. The land use and land cover change of Kinyinya sector from 2008 to 2018.

To get relevant results, the maps presenting land use/land cover of Kinyinya sector from 2008 - 2018 were created using the spatial tools in the Erdas imagine 9.2 software.

4.2.1. Land use/land cover of Kinyinya sector in 2008

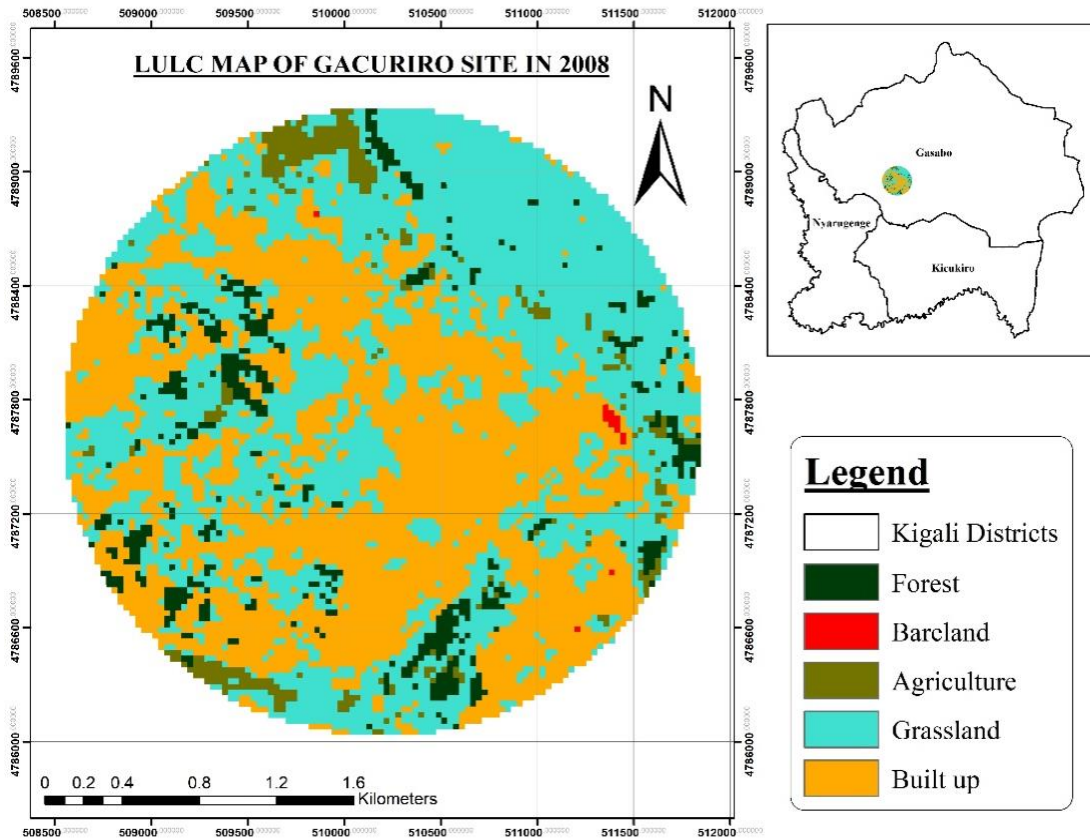


Figure 7: Map of land use /land cover of Gacuriro Sector in 2008

According to the land use/land cover map of Gacuriro sector in 2008 as presented above, green colour stands for forest covered 50.67 ha, Bare land as represented by red colour covered 1.26 ha, Agriculture as represented by light green colour covered 33.75 ha, Grassland area as represented by right blue colour covered 391.86 ha, built up place represented by yellow colour covered 382.77 ha.

Table 3: Land use and land cover of Gacuriro Sector in 2008

LULC Types	2008	
	Area(ha)	Area (%)

Built up	382.77	44.5
Grassland	391.86	45.6
Agriculture	33.75	3.9
Forest	50.67	5.8
Bare land	1.26	0.2
Total	860.31	100

Table 4: Accuracy assessment of Gacuriro Site of 2008 classified image

Classified Pixels	Ground Truth						Grand Total	User accuracy(%)
	LULC Types	Built up	Grassland	Agriculture	Forest	Bareland		
Built up	60	1	2	1	2	66	90.9	
Grassland	0	40	1	3	1	45	88.8	
Agriculture	2	1	33	1	1	38	86.8	
Forest	1	0	3	47	0	51	92.15	
Bareland	3	2	1	0	38	44	86.36	
Grand Total	66	44	40	52	42	244		
Producers Accuracy(%)	90.9	90.9	88.89	90.38	90.47			
Overall accuracy	89.34%							

4.2.2. Land use/land cover of Kinyinya Sector in 2018

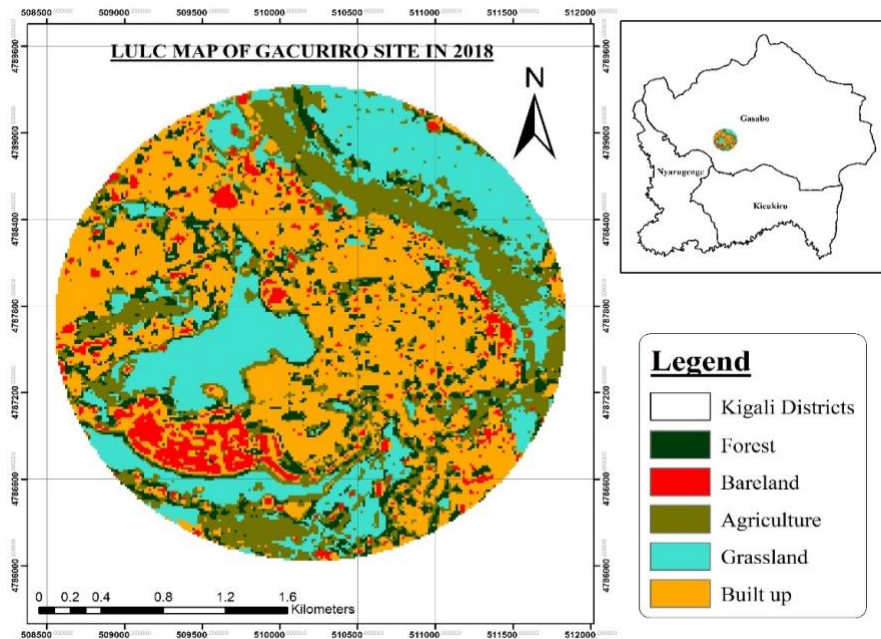


Figure 8: Map of land use /land cover of Gacuriro Sector in 2018

According to the land use / land cover map of Gacuriro sector in 2018 as presented above, Green colour stand for forest covered 98.5 ha, Bare land as represented by red colour covered 60.25 ha, Agriculture as represented by light green colour covered 170.12 ha, Grassland area as represented by right blue colour covered 210.1 ha, built up place represented by yellow colour covered 321.34 ha.

Table 5: Table showing the land use/ land cover of Gacuriro Sector in 2018

LULC Types	2018	
	Area(ha)	Area (%)
Built up	321.34	37.4
Grassland	210.1	24.4
Agriculture	170.12	19.8
Forest	98.5	11.4
Bare land	60.25	7
Total	860.31	100

Table 6: Accuracy assessment of Gacuriro Site of 2018 classified image

Classified Pixels	Ground Truth							User accuracy(%)
	LULC Types	Built up	Grassland	Agriculture	Forest	Bareland	Grand Total	
Built up	42	3	2	0	0	47	89.36	
Grassland	1	51	2	1	2	57	89.5	
Agriculture	2	0	33	2	1	38	86.8	
Forest	0	2	0	30	3	35	85.7	
Bareland	1	1	0	3	45	50	90	
Grand Total	46	57	37	36	51	227		
Producers Accuracy(%)	91.30	89.47	89.19	83.3	88.25			
Overall accuracy	88.54%							

4.2.3. Change detection in land use and land cover of Gacuriro sector from 2008 to 2018.

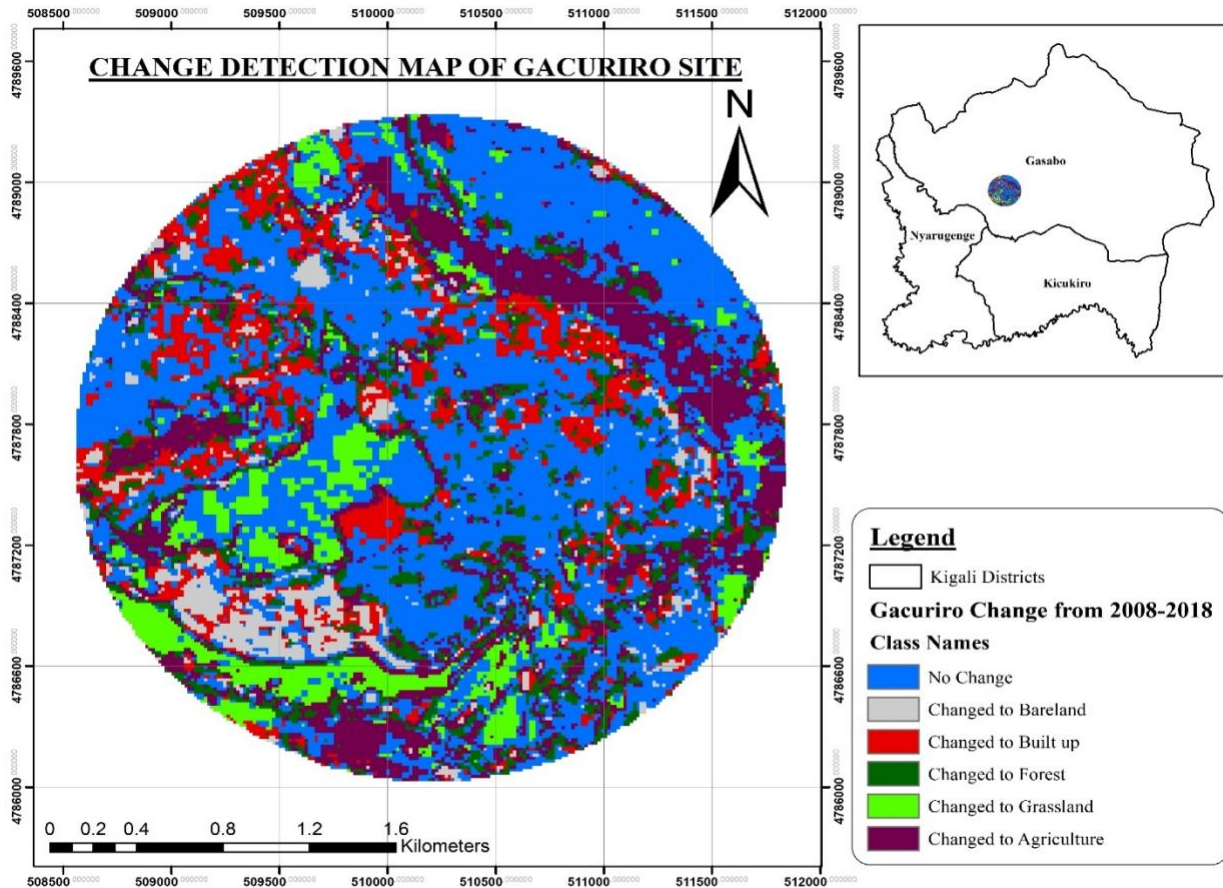


Figure 9: Change detection map of Gacuriro sector from 2008 to 2018

Based on the above map, Gacuriro sector undergoes with a lot of changes on the land use/land cover. Built up areas decreased from 382.77 ha in 2008 to 321.34 ha in 2018, Bare land area increased from 1.26 ha in 2008 to 60.25 ha in 2018, Forest area increased from 50.67 ha to 98.5 ha in 2018. Grassland area decreased from 391.86 in 2008 ha to 210.1 ha in 2018 and Agriculture area decreased from 33.75 ha to 170.12 ha in 2018.

Table 7: Change detection map of Gacuriro sector from 2008 to 2018

LULC Types	2008		2018	
	Area(ha)	Area (%)	Area(ha)	Area (%)
Built up	382.77	44.5	321.34	37.4
Grassland	391.86	45.6	210.1	24.4
Agriculture	33.75	3.9	170.12	19.8
Forest	50.67	5.8	98.5	11.4
Bare land	1.26	0.2	60.25	7
Total	860.31	100	860.31	100



LULC Types	2008	2018
	Area(ha)	Area(ha)
Built up	382.77	321.34
Grassland	391.86	210.1
Agriculture	33.75	170.12
Forest	50.67	98.5
Bare land	1.26	60.25

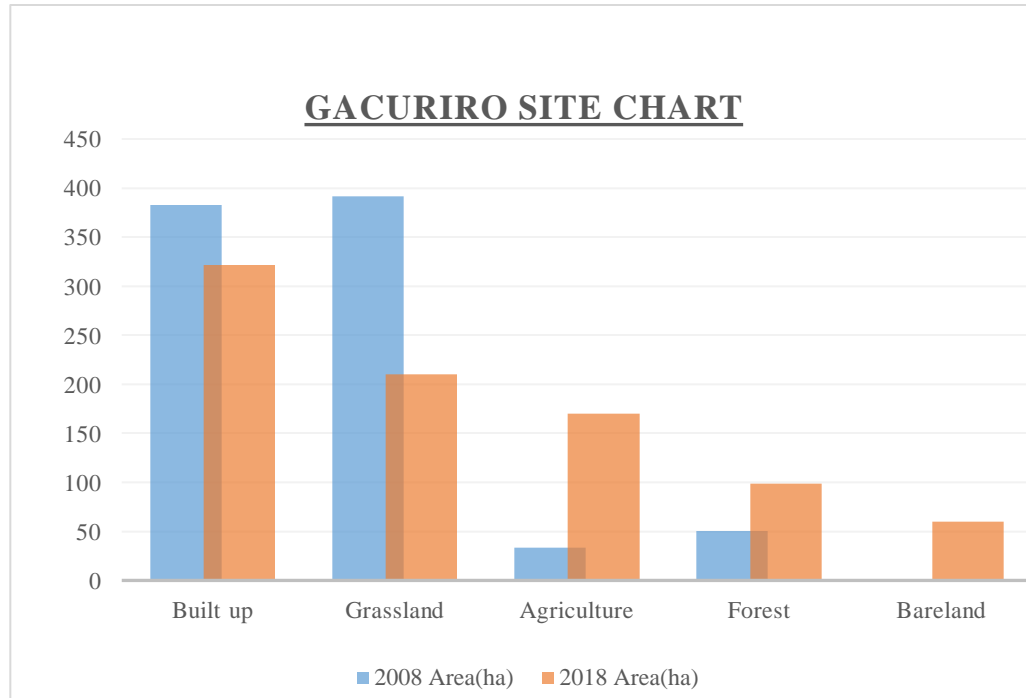


Figure 10: Gacuriro site chart

4.3. Status of the master plan implementation in Kinyinya sector from 2008 to 2018

The maps showing the status of the master plan implementation in Kinyinya sector from 2008 to 2018 was created using the spatial tools in Erdas imagine 9.2 software.

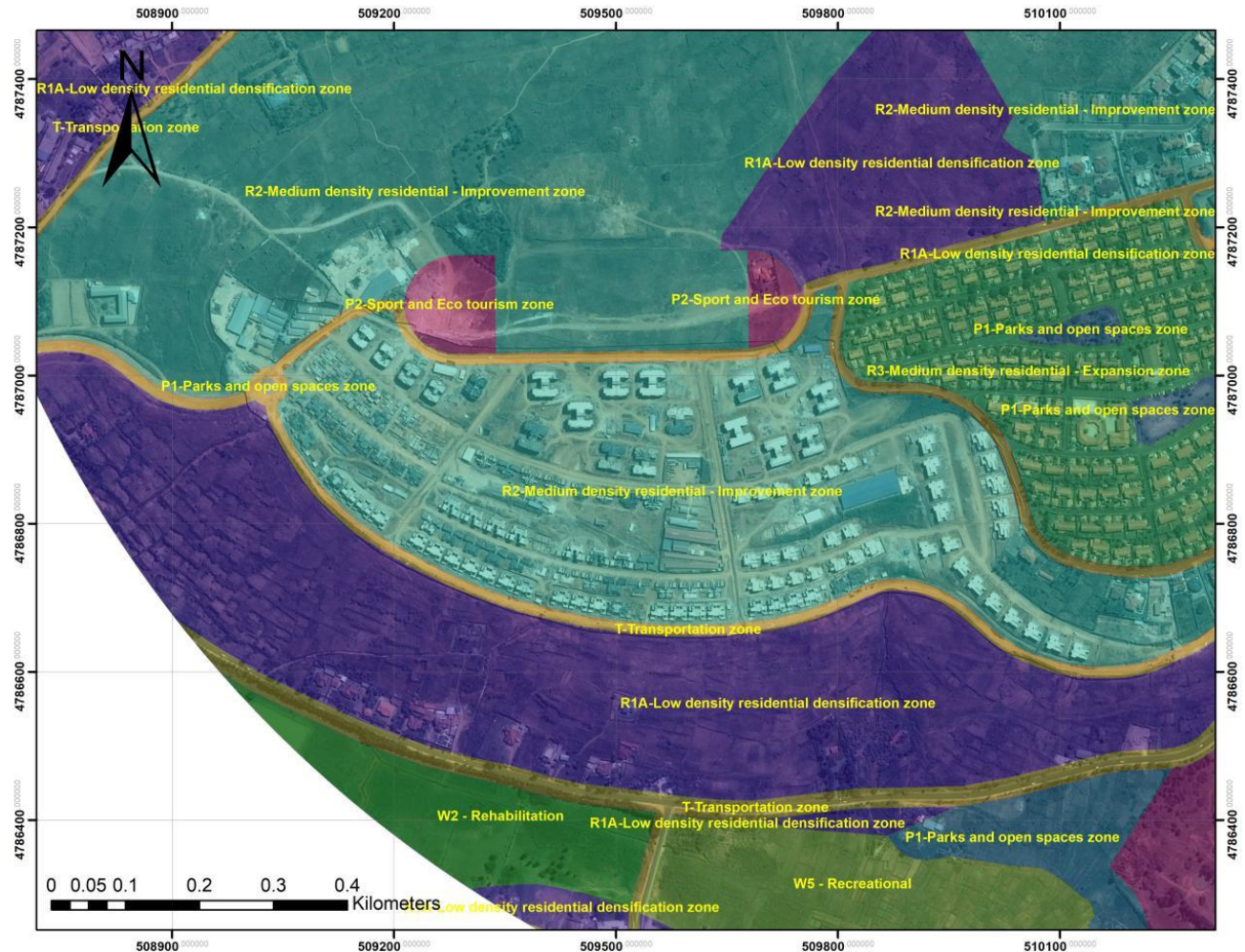


Figure 11: Status of the master plan implementation in Kinyinya Sector

From the map above it is clearly visible that Gacuriro sector did a lot in implementing the master plan and in reduction of informal settlements as roads and other public facilities were well zoned. Affordable residential zones were developed and city commercial zones were improved. Below is the table to show the level of Conformance of the master plan implementation to the status of the informal settlement in Gacuriro Sector.

Table 8: Conformance of master plan implementation to the zoning types in Gacuriro sector in 2018

S/N	Zoning type	Accordance		Unfulfillment		Deviation		Total area proposed	
		Area (m ²)	PCT (%)	Area (m ²)	PCT (%)	Area (m ²)	PCT (%)	Area (m ²)	PCT (%)
1	PF3 - Religious facilities	1.6	69.57	0.7	30.43	-	-	2.3	100
2	R- 4 High density residential zone	19.4	68.57	5.1	18.03	3.79	13.4	28.29	100
3	R-2 Medium density residential zone	89.1	76.82	19.1	16.47	7.79	6.71	115.99	100
4	T-Transport zone	3.6	62.07	2	34.48	0.2	3.45	5.8	100
5	R1A- Low density residential densification zone	87.7	79.23	18	16.26	4.99	4.51	110.69	100
6	P2- Sport and eco-tourism zone	5	70.42	1.6	22.54	0.5	7.04	7.1	100
7	P1- Parks and open space zone	2.92	59.35	1.1	22.18	0.94	18.95	4.96	100
8	C3-City commercial zone	23	76.16	5	16.56	2.2	7.28	30.2	100
9	W2- Rehabilitation	5.1	54.84	3.31	35.59	0.89	9.57	9.3	100
10	W5- Recreational	4.9	73.14	1.2	17.91	0.5	7.46	6.7	100

Table 9: Conformance of master plan implementation to the zoning types in Gacuriro sector in 2018

S/N	Zoning type	Area in conformance with the master plan		Total area proposed	
		(m ²)	PCT (%)	Area (m ²)	PCT (%)
1	PF3 - Religious facilities	1.6	69.57	2.3	100
2	R- 4 High density residential zone	19.4	68.58	28.29	100
3	R-2 Medium density residential zone	89.1	76.82	115.99	100
4	T-Transport zone	3.6	63.07	5.8	100
5	R1A- Low density residential densification zone	87.7	79.23	110.69	100
6	P2- Sport and eco-tourism zone	5	70.42	7.1	100
7	P1- Parks and open space zone	2.92	41.13	4.97	100
8	C3-City commercial zone	23	76.15	30.2	100

9	W2- Rehabilitation	5.1	54.84	9.3	100
10	W5- Recreational	4.9	73.13	6.7	100

From the above tables show the summarized result from the overlay analysis on Gacuriro site 2018. The percentages were calculated based on the total existing areas for each zone type among the ten analysed zone type. A high level of accordance indicates a good conformance between the master plan and the current existing zone. However, when the total existing area for a certain zone is much smaller than the total area proposed for such zone type, a high percentage of accordance level calculated based on the total area proposed for a certain zone does not necessarily means the high conformance. In steady, it means that most of the land occupied by such zone type is consistent with the master plan. However, it may happen that a huge area of land is still missing to be implemented as proposed. Therefore, for better interpretation of the result, it was necessary to consider how much is such conformance level with respect to the total area proposed for such

4.3 Summary of conformance of the master plan implementation to the status of the informal settlement in Kigali city.

This study revealed that among ten major zones proposed in Kigali with reference from Gacuriro site, R-2 Medium density residential zone is the highest zone that conforms to the master plan with a high level of conformance. Religious zones and recreational have a medium level of conformance since more than a half of each of them is located in accordance with the master plan. However, these three zones are not significantly sufficient where they are proposed to be located. None of them occupies more than a half of the total area proposed.

The level of master plan implementation for agriculture and industries is very little. Most of the existing commercial activities need to be replaced by residential and the majority of recreational need to be relocated from the study area. The level of master plan implementation for residential

is also low since the required buildings to be constructed are not affordable by the majority of people. The level of master plan implementation for parks and open spaces is also low most of the land proposed for open spaces is currently occupied by other zone such as commercial and residential among others. In fact, the level of Kigali City Master Plan implementation is low with only high implementation level for residential zone, medium implementation for commercial, natural area and infrastructure and a very low implementation for religious and open spaces.

4.4. Impacts of master plan implementation on the living condition of the dwellers



Figure 12: Gacuriro image 2008

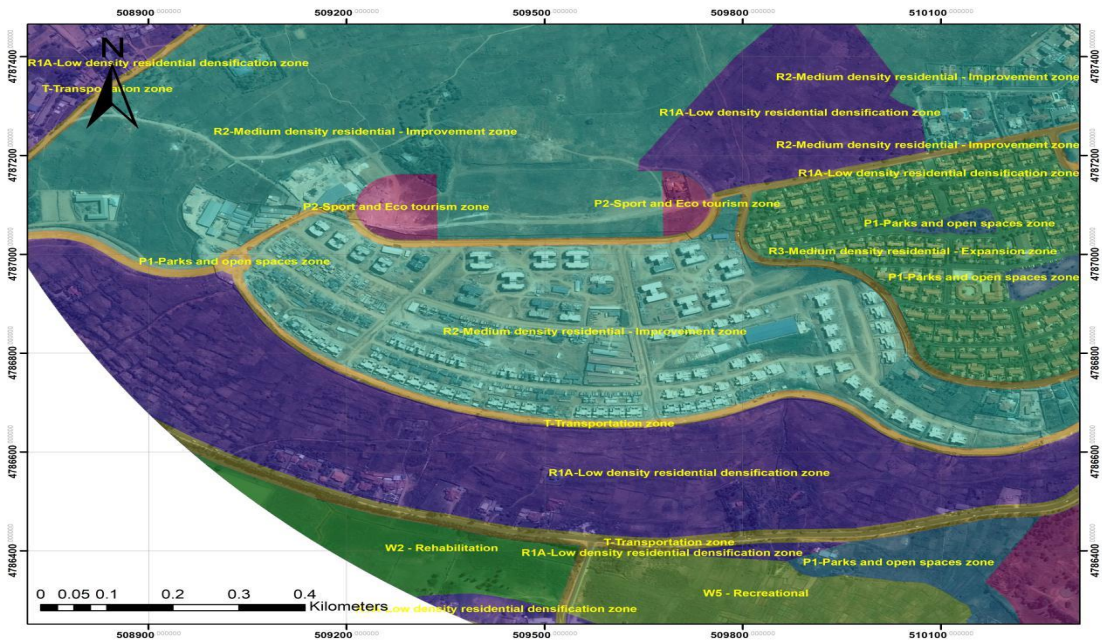


Figure 13: Gacuriro zoning 2018

Based on the map above, Formal settlement, affordable housing, and access to basic infrastructure are the impacts of implementation of master plan on living condition of the dwellers.

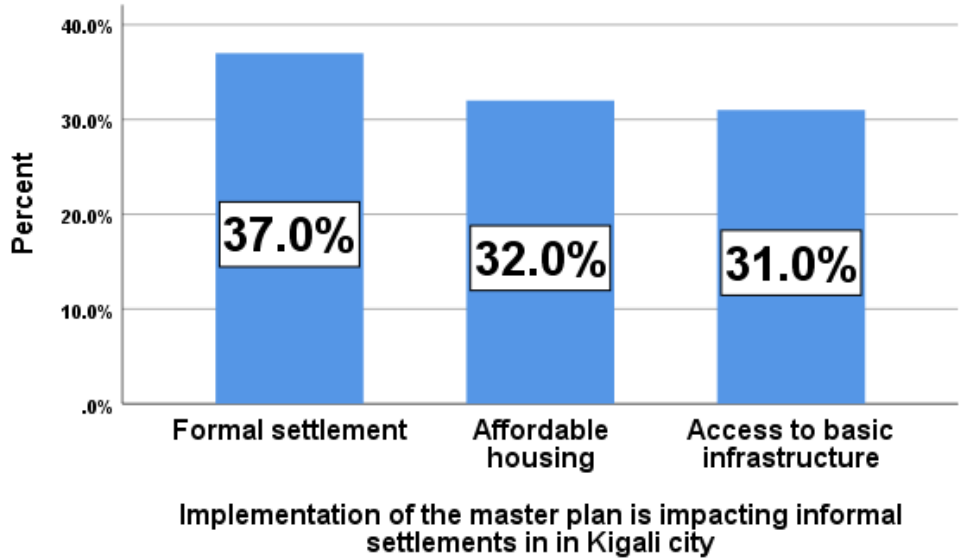


Figure 14: Implementation of the master plan is impacting implementation of master plan in Kigali, Rwanda

Chart above shows respondents' view about implementation of the master plan impacting implementation of master plan in Kigali city, 37% of master plan stakeholders reported formal settlement, because Same of Master plan policy are to reduce informal settlements and slums, though ensuring adequate allocation of land use, and with respect to formal urban standard. 32% respondents reported affordable housing because master plan has several objectives related to the improvement of living conditions of urban residents, it provide modern affordable housing solutions for all groups of people, while 31 % access to basic infrastructure because masterplan develop efficient transportation and public infrastructures facilities, also create and conserve attractive recreational features, which create local employment opportunities.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.0. Introduction

This section provides the conclusion and recommendations of this research, which have been formulated referring to the obtained results found in the study area. Also, this chapter discusses the general conclusion and recommendations based on research process and research findings. Firstly, it relates the research findings with the research objectives and their corresponding research questions. Secondary, it suggests recommendations for achieving strategic interventions for sustainable implementation of Kigali City Master Plan, for enhancing the living condition of the inhabitants and for further researches relating to the implementation of the master plan and its impact on living condition of the dwellers.

5.1. Conclusion

Kigali adopted the Master Plan (KCMP) to address social infrastructure challenges caused by rapid population growth and inadequate planning. This study evaluated KCMP implementation using GIS analysis and a paired sample t-test to assess its impact on residents' living conditions. Findings revealed low implementation levels due to zoning and construction standards that are unaffordable for low-income residents, though some improvements in quality of life were noted. Revising the KCMP to enhance affordability and conducting further research on its potential negative impacts are recommended

5.2. Recommendations

Recommendations for Sustainable Implementation of the Kigali City Master Plan

1. Enhance Citizen Participation: The lack of citizen engagement, particularly among low-income groups, has created challenges in compliance with zoning regulations. It is recommended to review the master plan, incorporating feedback from all income groups, ensuring that proposed zoning regulations are feasible and inclusive. Increased citizen participation may enhance compliance with the master plan

2. Increase Public Awareness: Many citizens are unaware of the master plan and its impact on their living conditions. The City of Kigali should conduct public awareness campaigns, including meetings, news broadcasts, and community engagements, to educate the public on the master plan's significance.

3. Establish a Coordinating Institution for Urban Planning: The City of Kigali should create an additional institution dedicated to coordinating urban planning and development. Furthermore, strengthening institutional capacity by increasing staff and providing international training opportunities could improve the handling of urban planning issues.

4. Seek Partnerships for Financial Support: Limited budgets hinder the completion of prioritized projects. To address this, the City of Kigali should collaborate with private financial institutions and NGOs, focusing on phased project implementation aligned with available funds.

5. Revise Zoning Regulations and Provide Support for Low-Income Groups: Implementation levels for agricultural and residential land use are low due to unaffordable development requirements. Reviewing these regulations and offering financial or technical support to low-income groups would facilitate compliance and equitable development.

6. Develop Recreational Spaces in Wetlands: Open space and recreational area development, especially in designated wetlands, is insufficient. Efforts should focus on transforming these areas into recreational facilities for the community.

7. Improve Urban Quality of Life: The study identified deficiencies in elements crucial to urban quality of life, such as traffic infrastructure, affordable housing, recreational areas, and employment. It is recommended that Kigali City prioritize these elements to improve residents' living conditions.

8. Future Research Directions: Further studies should evaluate both the positive and negative impacts of the master plan on residents' living conditions. This balanced approach would provide a more comprehensive understanding of the plan's effects.

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