MASTER OF SCIENCE (MSC) IN URBAN AND REGIONAL PLANNING

THESIS

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MZUZU UNIVERSITY

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ASSESSING THE IMPACT OF RAPID GROWTH OF LOW-INCOME SETTLEMENTS ON SERVICE DELIVERY IN LILONGWE CITY, MALAWI

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A THESIS SUBMITTED TO THE FACULTY OF ENVIRONMENTAL SCIENCES, DEPARTMENT OF THE BUILT ENVIRONMENT, IN FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE (MSc) IN URBAN AND REGIONAL PLANNING

MZUZU UNIVERSITY

DECLARATION

I hereby declare that this thesis titled "Assessing the Impact of Rapid Growth of Low-Income Settlements on Service Delivery in Lilongwe City, Malawi" has been written by me and is a record of my research work. All citations, references, and borrowed ideas have been duly acknowledged and submitted to meet the requirements of the Master of Urban and Regional Planning award of Mzuzu University. None of the present work has been submitted previously for any degree or examination in any other University.

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Name of Student: OBVIOUS NYIRENDA

Signature_____ Date: 15 DECEMBER 2025

CERTIFICATE OF COMPLETION

The undersigned certify that this thesis is a result of the author's own work and that to the best of our knowledge, it has not been submitted for any other academic qualification within the Mzuzu University or elsewhere. The thesis is acceptable in form and content, and the candidate demonstrated sufficient knowledge of the field covered by the thesis through an oral examination held on **10th December 2025**.

Supervisor — 15 DECEMBER 2025

Associate Prof. Mtafu Chinguwa Manda, PhD) — Date

ABSTRACT

As urban populations grow, the demand for public services rises. This situation also obtains in Lilongwe City, the capital of Malawi. This study assessed the impacts of rapid growth in low-income settlements on delivery of water, electricity, and solid waste management. Using both quantitative and qualitative methods, primary data were collected from households and key informants through interviews using questionnaires and checklists. Spatial analysis of Landsat images from 2010 and 2023 were performed using the Normalized Difference Build-Up Index (NDBI) to assess land-use changes. The study showed that over a 13-year period, the population in low-income settlements nearly doubled from 166,132 to 301,567 and an increase in households from 37,757 to 68,538. The built-up areas expanded by 3,028.54 hectares, while vegetation decreased by 1,723 hectares, and bare land declined by 490 hectares. Logistic regression analysis identified annual income, land cost perceptions, and agricultural land preferences as key drivers of low-income settlement growth, explaining 63.7% of the variability (Nagelkerke $R^2 = 0.637$). Strong correlation was noted between increased household numbers and increased service demand for water ($r = 1.0$), electricity ($r = 0.983$), and waste collection ($r = 0.915$). Statistical analyses showed significant impacts of rapid urban growth on service delivery (ANOVA F-statistic = 231.24, $p = 0.000$). Approximately 65.6% of respondents in areas 25, 36, 38, 45, 49, and 53 reported an increase in lack of access to services. The study concludes that the spatial expansion of low-income settlements significantly affects service delivery. It is recommended that Lilongwe Council should adopt participatory planning and strengthen local governance systems to formalise customary land, expand water supply infrastructure, enforce zoning and development control to mitigate uncontrolled rapid spatial urban growth.

Key Words: low-income settlements, service delivery, urban growth, land use change.

DEDICATION

I dedicate this thesis to my mother Ama Face NyaLongwe and my late dad, Ada Wadi Wasuzgu Mtaja Nyirenda, my ever-loving siblings, my supportive wife Evelyn Kabulunge, my daughter Lunjika and son Mutaski.

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ACRONYMS AND ABBREVIATIONS

APA	American Planning Association
ESCOM	Electricity Supply Commission of Malawi
GIS	Geographic Information System
HUD	Department of Housing and Urban Development
ICT	Information Communication Technology
LIS	Low-Income Settlements
LCC	Lilongwe City Council
LULC	Land Use and Land Change
MHC	Malawi Housing Corporation
NDBI	Normalized Difference Built Up Index
NIR	Near Infrared Band
NPDP	National Physical Development Plan
NUP	National Urban Policy
OECD	Organization for Economic Cooperation and Development
RA	Roads Authority
RFA	Road Funds Administration
RS	Remote Sensing
SANDAG	San Diego Association of Governments

SDG	Sustainable Development Goals
SPSS	Statistical Package for Social Sciences
SWIR	Shortwave Infrared Band
TOD	Transit-Oriented Development
UGB	Urban Growth Boundaries
UN	United Nations
USP	Urban Structure Plan

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CHAPTER ONE: INTRODUCTION

1.1 Introduction

This chapter presents the background of the study, problem statement, main and specific objectives, research questions, justification of the study, ethical consideration, and chapter conclusion.

1.2 Study Background

Rapid urban growth in sub-Saharan Africa has accelerated significantly in recent decades, with many cities experiencing rapid population growth that outpaces service delivery (Aliyu and Amadu, 2017). Lilongwe, the capital city of Malawi, is no exception with the population growing from ten times in the last 40 years from 24,000 to an estimated population of 989,318 in 2018 (NSO, 2019). Originally designed as an administrative center with a low-density urban structure, Lilongwe has undergone rapid urban expansion, leading to the proliferation of informal and low-income settlements. The population density has increased from 43 persons/km² in 1966 to 1,702 persons/km² in 2008 (Lilongwe City Council, 2010). The low income-settlement areas are typically characterized by inadequate housing, limited access to basic services, insecure land tenure, and poor environmental conditions (JICA, 2010).

Low-income settlements, often referred to as informal settlements or slums, emerge as a result of the mismatch between housing demand and supply, driven by rural-urban migration, poverty, and insufficient urban planning mechanisms (Angel, 2023). In Lilongwe, such settlements have grown substantially in both size and number, particularly in areas such as Area 25 (Dzenza), Area 36 (Western by-pass), Area 38 (Kaphiri), Area 45 (Western by-pass road), Area 49 (Air-Wing) and Area 53 (Lumbadzi). The inhabitants of these communities typically experience inadequate access to essential public services such as water supply, electricity supply and waste management.

The rapid growth of these low-income settlements poses complex challenges to urban service delivery. Overstretched infrastructure systems, unplanned housing, and insufficient municipal resources often hinder the effective provision of services (Bah et. al., 2018). For instance, water

and electricity may be under pressure from overuse, waste collection may be inconsistent or entirely lacking. Furthermore, informal status of these settlements may lead to marginalization in official planning and budgeting processes, exacerbating the cycle of underdevelopment and inequality (Audirac, 2002). According to Baye (2025), there is a systemic exclusion of informal settlements from formal infrastructure planning and investment, perpetuating socio-economic inequalities. Local authorities tend to prioritize planned urban areas, while informal residents rely on alternative, often costlier, and lower-quality services, such as informal water vendors and shared electricity connections.

Assessing the impact of low-income settlements on service delivery is crucial for sustainable urban management in Lilongwe. It helps stakeholders, including policymakers, urban planners, NGOs, and donor agencies to understand the extent to which these low-income settlements affect infrastructure provision and the need to balance rapid urban growth and service delivery. By examining this relationship, it becomes possible to identify service gaps, inefficiencies, and opportunities for inclusive development strategies that integrate the service delivery needs of low-income communities.

The main objective of this study is to analyse the impact of rapid urban growth of low-income settlements on service delivery in Lilongwe City focusing on water, electricity and waste management. The study also assesses the spatial land changes between 2010 and 2023 and identifies the drivers which lead to rapid expansion of low-income settlements.

1.3 Problem Statement

Low-income settlements in Lilongwe are home to more than 70% of the city's population and are facing a convergence of crises that have reshaped their socioeconomic landscape (Zidana & Luka, 2023). Residents of low-income settlements lack access to services such as water, electricity and solid waste collection which is beyond the expectation and current capacity of the service providers. Low-income settlements are areas where a large number of residents have limited financial resources, often resulting in informal housing, poor access to basic services like water and sanitation, and a high population density (Carruthers and Ulfarsson, 2007). Much of the population growth in Lilongwe is projected to occur in the low-income settlements (JICA,

2010). While the city as a whole is expected to grow at 4-5% per year, population growth in informal settlements is projected at over 8% (LUPPEN, 2014). As the city grows the demand for services such as water, electricity and waste collection will exponential grow hence the failure by the service providers to meet the demand in rapidly growing low income settlements. Eakin, et al (2022) suggests that there is need for research to gain an understanding of the threats and opportunities associated with rapid growth of low-income settlements, in order to design policies and programs for sustainable urban spatial growth and equitable distribution of services. Shao et al (2020) suggested that a combination of remote sensing, social sensing, and population data were useful as an inference for interpreting urban rapid growth, access to urban services and infrastructure in Morogoro. Rapid growth of low-income settlements has a significant impact on service delivery within the Lilongwe city (JICA, 2010). While service providers are struggling to provide services, low-income settlements continue to grow hence affecting service delivery such as sewer, water, and solid waste management (Lilongwe City Council, 2010). Despite the growing body of literature on the impact of rapid growth of low-income settlements there is need to assess its impact on service delivery in Lilongwe city. Limited research on the impact of rapid urban growth on low-income settlements in Lilongwe city will continue to have adverse effect on provision of essential services.

1.4 Study Objectives

1.4.1 Main Objective

The main objective of the study was to assess the impact of rapid growth of low-income settlements on service delivery in the City of Lilongwe with a focus on water, electricity and solid waste management.

1.4.2 Specific Objectives

The specific objectives of the study were:

1. To assess the drivers of rapid growth of low-income settlements in Lilongwe City.
2. To analyse the impact of rapid growth of low-income settlements on delivery of water, electricity and solid waste management services in Lilongwe City.

3. To assess spatial land use change between 2010 and 2023 in low-income settlements.

1.4.3 Research Questions

1. What are the drivers of rapid growth of low-income settlements in Lilongwe City?
2. What are the impacts of rapid growth in low-income settlements on water, electricity and solid waste management service delivery in Lilongwe?
3. What spatial changes have taken place between 2010 and 2023 in low-income settlements?

1.5 Justification of the Study

This study contributes to the Sustainable Development Goals (SDG 11) objective on making cities inclusive, safe, resilient and sustainable. The study is also in harmony with National Urban Policy (2019) priority area three (3) which calls for integrated urban planning as a key to the development of compact built forms that optimise use of limited resources and equitable service delivery. The study is in line with Malawi 2063 which states that 'our cities are not well planned and do not adequately provide services such as water supply, electricity supply, waste management, education, health and transport.' (NPC, 2020, p. 20). National Urban Policy (2019) priority area three (3) emphasises integrated urban planning as a key to the development of compact built forms that optimise use of limited resources and equitable service delivery. While the MW2063 Pillar No. 3 advocates for world class urban centers with requisite modern socio amenities. The Water Policy (2005) promoted provision of water of acceptable quality and of sufficient quantities to satisfy the basic requirements of every Malawian. Environmental Management Act (2017) protects management of the environment and sustainable utilization of natural resources. On the other hand, the National Energy Policy (2018) supports the increase to access affordable, reliable, sustainable, efficient and modern energy for every person in the country.

1.6 Ethical Consideration

The Mzuzu University Research Ethics Committee (MZUNIREC) granted permission for the study (Appendix 4). Research participants signed a consent form before interviews and

participation in the study (See Appendix 5). Privacy and confidentiality were ensured by using codes to reflect the respondents without revealing their actual names.

1.7 Structure of the Thesis

Chapter 1: Introduction

The introduction section provides overview of the background content of the study, the research problems, research objectives and questions and theoretical framework.

Chapter 2: Literature Review

The literature review section discusses the theoretical framework, conceptual framework, drivers of rapid growth of low-income settlements, impact of rapid growth of low-income settlements on service delivery, effectiveness of planning frameworks in managing rapid growth of low-income settlements and spatial land changes in low-income settlements.

Chapter 3: Methodology

The methodology section describes the study area, research design, sampling framework and methods, sampling method and sample size, data collection methods and instruments and data analysis.

Chapter 4: Study Results

The results section presents the main research findings in line with the research questions posed for each objective.

Chapter 5: Discussion

The implications of the research study based on the results and how the results relate to literature are covered in this section.

Chapter 6: Conclusion and Recommendations

The conclusion summarises the significant outcomes of the study as they relate to research aim, objectives and questions. Recommendations are presented that give insight into the possible solutions or measures that can be implemented based on the research findings.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

This chapter presents the theoretical framework, conceptual framework, empirical review, drivers of rapid growth of low-income settlements, impact of rapid growth of low-income settlements on service delivery and spatial land changes in low-income settlements

2.2 Theoretical Framework

This research study is informed by the Smart Growth Theory which emerged in the 1990s. As several large institutional actors in urban development began to promote an alternative growth paradigm they came to call Smart Growth in the United States of America (Kushner, 2002). A combined effort of the American Planning Association (APA), the U.S. Department of Housing and Urban Development (HUD), and the Henry M. Jackson Foundation aimed at updating local land use controls to emphasize more compact development patterns to promote service delivery. This led to APA's "Growing Smarter" document, released in 1997. The Smart Growth theory is based on the idea that the design and use of urban space has a significant impact on people's quality of life and ability to provide services.

Policies such as 'new urbanism' and 'smart growth' in North America, and 'compact city' and 'multifunctional land use' policies in Europe, though difficult to implement, have the potential to curb haphazard urban growth of low-income settlements as the cases of Portland, Oregon and Randstad Holland in The Netherlands (Dieleman & Wegener, 2004). The main purpose of the smart growth theory was to limit the haphazard growth of urban centres and ensure that services were easily accessible and distributed. Smart growth theory is also a planning and development approach that emphasizes sustainable, efficient use of land, resources and infrastructure (Daniels, 2001). Smart Growth theory is a product of modernist criticism and was based on traditional suburban development patterns, which relied on unsustainable rapid growth of low-density neighbourhoods and a reliance on cars (Qian, et al., 2021).

Bevilacqua (2014) contends that Smart Growth theory is one of the contemporary urban theories that developed in response to rapid urban growth of cities and suburbs in the mid-twentieth

century crises which led to new planning concepts and approaches meant to rectify the situation. It was also meant to be a solution to rapid urban growth towards the peripheries of cities. Figure 1 is a schematic progression of connected issues in the process of controlling rapid urban growth through the Smart Growth theory.

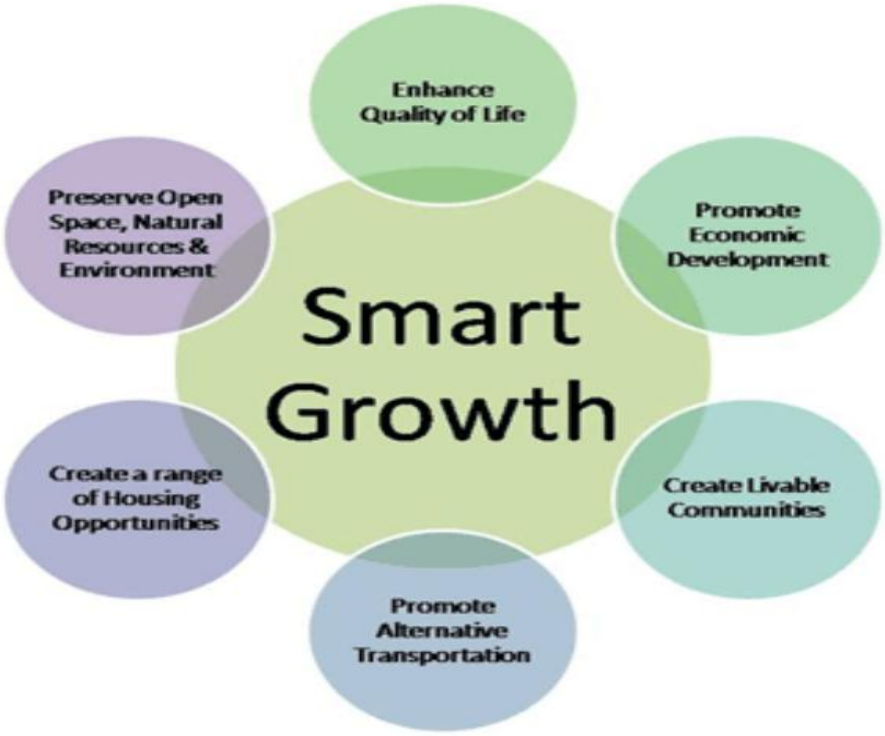


Figure 1: Smart Growth Principles

Source: Bevilacqua (2014, p. 182)

Although smart growth has received tributes for encouraging sustainable development and raising quality of life, it has also come under fire from some who claim it is overly prescriptive and limits economic progress (Ding, et al., 2009). In general, smart growth is a comprehensive planning and development strategy that strikes a balance between social, environmental, and economic issues to build communities that are sustainable, liveable, and economically competitive. Litman (2009) asserts that by limiting the supply of land and constraining development patterns, smart growth hinders economic growth. This results in rising cost of services such as water, sewer and electricity particularly in low-income households.

Despite these objections, a lot of planners, decision-makers, and academics and the researcher are of the view that smart growth theory represents a promising strategy for affordable service delivery. The researcher contends that most theories were developed to find solutions to a solution to curb rapid urban growth and to ensure adequate provision of services.

2.2.1 Theories related to Smart Growth Theory

Over several decades, many theories and planners have emerged around rapid urban growth and urban planning in general. These theories were brought by geographers, planners, economists, and transportation engineers. The literature and theory on urban growth is substantial and already provides a good explanation of its nature, causes and consequences (Couch, Leontidou and Petschel-Held, 2007). The research has selected a number of theories which relate to urban growth, urban expansion and containment of rapid growth of settlements.

2.2.1.1 Compact City Theory

This theory advocates for dense, mixed-use urban development to reduce rapid urban growth and improve service delivery through more efficient use of resources and infrastructure. Compact City theory refers to a design and planning approach that seeks to promote sustainable urban development. Theorists like Anabtawi, (2023) believe that compact city theory is one of the leading paradigms of sustainable urbanism. Compact city planning and development has been the preferred response to the challenges of sustainable service delivery. It is strongly promoted by global and local policies due to its positive outcomes in terms of contributing to the economic, environmental, and social goals of sustainability (Bibri, et al., 2020). It proposes that cities should be developed in a dense, compact, and integrated form that maximizes the efficient use of land and other resources, minimizes the need for transportation and reduces energy consumption. This theory suggests that cities should be compact and compactness should be the goal of urban planning and proper distribution of services.

Burchell, et al. (2002) is of the view tha compact city theory is based on the idea that compact development is a more sustainable form of urban development than rapid urban growth, which is characterized by low-density, dispersed development patterns. Compact cities are thought to offer several benefits, including:

1. Reduced service delivery costs: By promoting dense development patterns, compact cities can reduce the cost of service delivery and the associated consumption.

2. Improved quality of life: Compact cities promote walkability, cycling, and public transit use, which can improve quality of life by reducing dependence on personal vehicles and increasing access to green spaces and cultural facilities.

3. Enhanced environmental sustainability: Compact cities can minimize the use of land and other resources, reduce energy consumption, and promote sustainable development practices.

Compact city theory is often associated with the New Urbanism movement, which seeks to promote sustainable urban design principles, including mixed-use development, pedestrian-friendly streets, and compact, transit-oriented development patterns (Neuman, 2005).

In relation to service delivery, a compact city is designed to provide a range of services and amenities within close proximity to its residents (Neuman, 2005). This makes it easier for people to access services and amenities such as water, sewer, electricity, roads, health care, education, recreation, and transportation (Dieleman & Wegener, 2004). Compact cities also provide a more efficient and cost-effective means of service delivery, as services can be centrally located and easily provided by service providers to residents (Bibri, et al., 2020). This can lead to better quality services, as well as reduced costs for both service providers and users. In addition, the proximity of services and amenities can also reduce social and economic inequalities by making essential services accessible regardless of their income or social status (Bibri, et al., 2020). Compact cities promote sustainable, efficient, and equitable service delivery, making urban life easier, healthier, and more enjoyable for all residents (Katz, 1994).

Despite its popularity as a solution to rapid urban growth, compact city development has faced criticism from various perspectives. Critics argue that compact city development can lead to social exclusion, particularly for low-income families, who may not be able to afford to live in the more densely populated and expensive areas (Lees, 2008). Some argue that compact city development can lead to increased pressure on local resources, including water, energy, and land,

this can result in environmental degradation and increased carbon emissions. They further argue that the high-density nature of compact cities can lead to overcrowding, noise pollution, and a lack of personal space. Additionally, limited parking and increased traffic congestion can impact the quality of life for residents.

Despite these criticisms (Brueckner, 2000), many urban planners and policy-makers believe that the benefits of compact city development, including reduced traffic congestion, increased access to public transportation, and improved environmental sustainability, outweigh the costs of service provision. The challenge lies in finding ways to address the criticisms while still maintaining the principles of compact city development.

2.2.1.2 Accessibility Theory

The theory was developed by David M. Levinson, an American transportation engineer and researcher. It asserts that the proximity and ease of access to goods, services, and opportunities is a key determinant of land use patterns and urban form. Improving accessibility can reduce rapid urban growth and improve service delivery (Banister & Hickman, 2006). Accessibility theory is a branch of transportation planning and geography that deals with the ease of access to services and destinations. Morris, et al., (2009) are of the view that the theory is based on the idea that accessibility is a key factor in shaping human behaviour and the urban environment.

The theory argues that accessibility to services, employment opportunities, and other destinations is an important determinant of human activity and the structure of urban areas. Currie and Stanley (2008) research shows that a high level of accessibility provides greater opportunities for people to participate in a range of activities, such as work, education, and social interaction.

Morris, et al., (2019) observes that there are two main components of accessibility theory: physical accessibility and perceived accessibility. Physical accessibility refers to the actual distance and time required to reach a destination, while perceived accessibility takes into account an individual's subjective perception of the ease or difficulty of reaching a destination. This relates to the study being carried out to analyse the distribution of services in low-income areas.

Accessibility theory has important implications for transportation planning and urban design, as it suggests that improving access to destinations can increase economic opportunities, reduce poverty and inequality, and enhance social and environmental sustainability (Li, et al., 2019). To improve accessibility, transportation planners and urban designers may use a variety of strategies, such as improving public transportation systems, designing walkable and bike-friendly communities, and promoting mixed-use development that combines residential, commercial, and employment uses (Banister & Hickman, 2006).

A study by Rahman, et al., (2022) concludes that accessibility theory is related to the concept of transit-oriented development (TOD), which emphasizes the importance of public transportation and its role in shaping the urban environment and improving accessibility. By focusing on improving access to destinations, accessibility theory and TOD can help to create vibrant and sustainable urban areas that support a high quality of life for residents.

2.3 Conceptual Framework

The researcher developed a conceptual framework of rapid growth of low-income settlements. It is envisaged that political, social and economic factors such as migration, lifestyle preferences, affordable cost of land, rapid population growth, absence of city rates will trigger demand for land and subsequently lead to rapid growth of low-income settlements. Institutional factors such as inadequate enforcement of laws and adherence to rules by developers also contribute to low-income settlements. However, rapid growth of low-income settlements has the potential to generate both positive and negative consequences for local households (Amponsah, 2022). The positive consequences include availability of cash income jobs, opportunities for the cultivation of various crops. On the other hand, rapid growth of low-income settlements could lead to loss of farmlands, food insecurity, breakdown of traditional family system and above all lack of services such as water, electricity and solid waste management (Aljoufie et al, 2011).

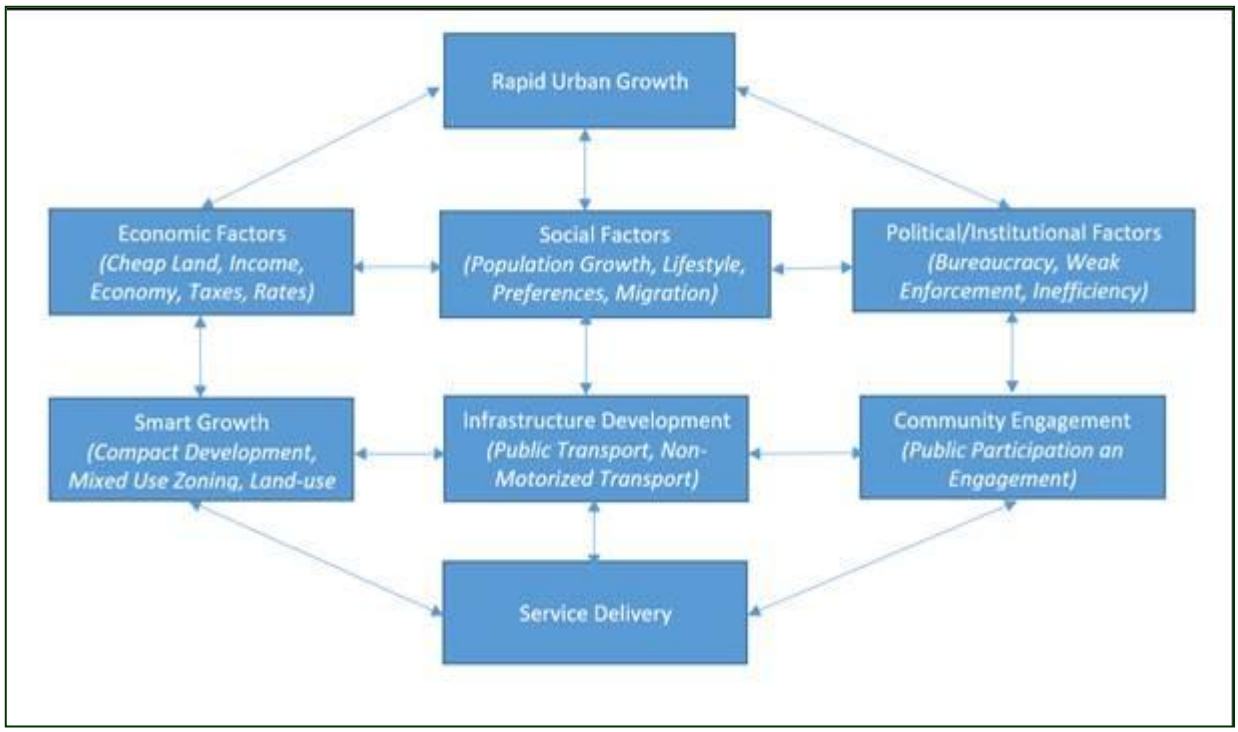


Figure 2: Conceptual Framework.

Source: Adapted from Polyzos et al., (2023), Page 10.

The conceptual framework for how rapid growth impacts delivery of water, electricity and solid waste management services includes the following key components:

Rapid Urban Growth which is the steady increase in the number of people living in cities or urban centres. Rapid urban growth evolves in terms of spatial, economic, social, and functional composition (Ziwoni and Mwange, 2025). The criteria used for rapid growth were high density, high population growth rate, high building coverage ratio, high demand of services.

Socio-economic factors are characteristics of residents living in areas affected by rapid urban growth, such as income, education level, and age. These factors can influence access to services.

Smart growth, infrastructure development, and community engagements are interventions and strategies that can be implemented to improve the delivery of services. This can include

infrastructure improvements, public participation programs, and land use policies that promote mixed-use and compact development.

Service delivery refers to the availability and accessibility of services, such water, electricity and solid waste management. This can be measured by indicators such as travel time to services, service availability, and service quality.

Low-income settlement refers to a community where many residents have low incomes, lack basic services and often live in poor housing conditions.

Bare land refers to land that is uninhabited, uncultivated, and without trees. It can also refer to land that has no dominant vegetation cover.

Built-up Area refers a continuous expanse of land primarily occupied by buildings and other developed structures, including residential, commercial, industrial zones, roads, and associated infrastructure.

Wetland refers to a type of ecosystem that is characterized by water-saturated land, either permanently or seasonally.

2.4 Empirical and Literature Review

The impact of low-income settlements on service delivery in rapidly urbanizing cities like Lilongwe, Malawi's capital, is a critical issue for urban planning, service delivery, and environmental sustainability. This empirical review synthesizes key research findings on the relationship between the growth of low-income settlements and the provision of essential services such as water electricity, and solid waste management in Lilongwe City.

2.4.1 Overview of Low-Income Settlements in Lilongwe

Manda, (2015) noted that Lilongwe, like many other cities in Sub-Saharan Africa, has witnessed rapid urbanization, with a substantial increase in low-income settlements. These settlements, often referred to as informal settlements or slums, are primarily inhabited by migrants from rural areas in search of better economic opportunities. The city's urban growth has outpaced

infrastructure development, leading to a mismatch between population growth and the availability of essential services (JICA, 2010). A notable characteristic of these low-income settlements in Lilongwe is that they are located on the periphery of the city, where land is cheaper and often unregulated. Weak urban planning and governance exacerbates the challenges associated with providing basic services (Lilongwe City Council, 2010).

2.4.2 Impact of Rapid Growth of Low-Income Settlements on Water Delivery

Access to clean water is a significant challenge in Lilongwe's low-income settlements. Empirical research by Manda (2015) highlights that water access in informal settlements is limited, with many residents relying on unsafe sources such as shallow wells, rivers, or communal taps. According to the study, only a small fraction of these settlements are integrated into the formal city water supply network, and those who do often experience unreliable service. Furthermore, a study by Lilongwe City Council (2020) found that, in informal settlements in Lilongwe, water rationing and erratic supply are common, particularly in settlements far from the city's central infrastructure. The lack of formal land tenure in these areas also complicates water delivery, as authorities hesitate to invest in infrastructure for residents without legal claim to land (Zidana & Luka, 2023).

2.4.3 Impact of Rapid Growth of Low-Income Settlements on Solid Waste Management

Lilongwe has a substantial impact on solid waste management services. As demonstrated in a study by Ndala & Ndala (2022), these informal settlements often lack organized waste collection systems, leading to the accumulation of refuse in open spaces, streets, and drainage channels. The study indicated that 63% of participants lacked waste management skills, while 93% observed that population growth contributes to increased waste generation within their communities.

Muheirwe, *et al*., (2023) found that waste collection services are sporadic, with most settlements relying on self-organized, informal waste disposal methods. The sporadic waste collection is exacerbated by the rapid growth of low-income settlements, which puts additional pressure on an already overstretched waste management infrastructure (Bagheri and Tousi, 2018). The absence of waste management services not only affects public health but also creates environmental problems and contamination of water sources (Hiramatsu, 2014).

Akimanizanye, *et al*., (2020) noted that low-income settlements in Kigali, Rwanda often face challenges in managing waste due to limited financial resources, lack of awareness about proper disposal methods, and insufficient municipal oversight. In the absence of a coordinated approach to waste management, these settlements often turn to informal solutions that are inadequate and harmful in the long run. This combined with weak urban planning and governance, exacerbates the challenges associated with providing basic services.

2.4.4 Impact of Rapid Growth of Low-Income Settlements on Electricity Supply

Chaima, *et al.*, (2023) analyzed electricity distribution in Lilongwe city and concluded that low-income areas face significant challenges in accessing reliable electricity. Francioli (2020) states that many households in low-income settlements rely on informal or illegal connections, which not only increase the risk of accidents and fires but also contribute to power losses.

The study by Chaima, *et al.*, (2023) highlighted that the Malawi Electricity Supply Corporation (ESCOM), which is responsible for electricity provision in Lilongwe city, struggles to extend its grid to informal settlements due to the cost of infrastructure development and the absence of formal land tenure in these areas. As a result, a large portion of residents in informal settlements lack electricity, and many are forced to use alternative sources like kerosene lamps or firewood for lighting and cooking (Winkler, *et al.,* 2011). Falk, et al., (2021) suggests that the low levels of electrification in low-income settlements contribute to social and economic exclusion, as electricity is essential for education, work, and accessing modern communication technologies.

2.4.5 Drivers of Rapid Growth of Low-Income Settlements

Driving forces behind rapid growth of low-income settlements vary between cities, regions and countries and is dependent on the political, social and economic conditions in each city (Tanja & Christiansen, 2011). Rapid urban growth evolves in terms of spatial, economic, social, and functional composition (Ziwoni and Mwange 2025). Different studies have examined the emergence of suburban nodes, emerging patterns of poly-centricity, multi-functionality, as well as economic and functional self-sufficiency (Phelps & Wood, 2011). The drivers of low-income settlements are various and complex. The smart growth theory which is a theory guiding this research emphasizes sustainable urban development by promoting compact, connected, and

efficient land use patterns that integrate housing, transportation, and services delivery to improve quality of life (Shrivastava and Sharma, 2012). This theory offers a conceptual framework highly relevant to assessing the rapid growth of low-income settlements and their impacts on service delivery in Lilongwe city.

2.4.5.1 Economic factors

One of the most significant drivers of low-income settlements is economic growth, particularly the growth of the real estate and construction industries (Brueckner, 2000). On the other hand, the demand for new housing, shopping centres, and office parks drives the development of new residential areas and commercial districts on the outskirts of cities. Economic factors, such as competition between cities, land prices and purchasing power and market failure, are also driving forces behind low-income settlements (Tanja & Christiansen, 2011). For instance, centralization may contribute to increased pressure on housing and housing prices, and they are usually highest in the center. Thus, it is cheaper to purchase apartments that are located in areas characterized by lower density and at the periphery. As it has been pointed out (Bueno-Suárez & Coq-Huelva, 2020), the agglomeration economies are one of the theoretical foundations of urban phenomena. Thus, when densities strongly diminish, some of the key economic forces, which explain the existence of cities are weakened.

Carruthers and Ulfarsson (2007) based their study on U.S. cities and argued that low-income settlements contributes to increased expenditure per capita for service delivery. Solé-Ollé and Hortas-Rico (2008) study in Barcelona, Spain argue that low-density development patterns in low-income settlements lead to greater provision costs of local public services. The influence of economic opportunities in the rural areas is less than half of that in the city core area. The land market factor has the highest influence in rural areas, closely followed by the fringe areas. Lands in rural areas are acquired at cheaper prices for new developments or land businesses (Thapa & Murayama, 2010).

Glaeser and Kahn, (2003) also believe that economic growth can be a driving force behind low-income settlements. This can be true for developed countries and would not apply to most developing countries. Central areas have the highest demand, and prices will be high in such areas. This drives buyers to seek new homes in more peripheral areas due to lower housing prices (Tanja & Christiansen, 2011). (Bertaud, 2004) study shows that there is correlation between density and land prices. The chart below (Figure 3) illustrates that land prices are highest in areas that are dense and closest to the centre of a City. This is also reflected in Lilongwe City where individuals are lured by cheap land prices in the outskirts and the peri-urban of the City.

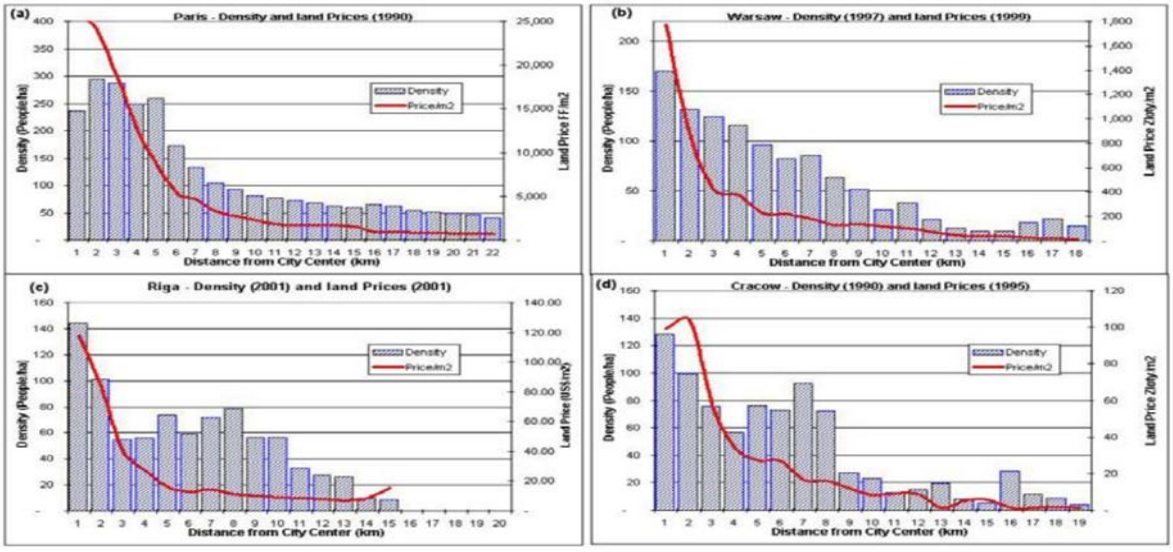


Figure 3: Density and Housing Prices

Source: Bertrand (2004).

2.4.5.2 Rapid population growth

As cities grow, so does the demand for housing. This can lead to rapid growth of low-income settlements as developers build new homes and communities on the outskirts of the city. JICA (2010) confirms the fact that the southern and western part of Lilongwe has seen a considerable population increase and spatial growth. Population growth is a primary cause of rapid physical growth in Europe in recent decades (Glaeser, et al., 2001). The causes of population growth and

influx to the cities are related to economic growth because of industrialization and technological progress (Tanja & Christiansen, 2011).

OECD (2018) study shows that an increase in the urban population increases demand for services and increases the urban footprint. It further alludes to the fact that households demand more floor space as income grows. In turn, the increased demand for floor space leads to an extended city with a lower population density. In most African countries, such as Malawi, the population growth results in the outward expansion of urban areas and sometimes population decline also can be a precursor to rapid urban growth (Carruthers & Ulfarsson, 2007). In Saharanpur (India), population growth is identified as the chief driver of rapid urban growth land development (Wilson & Chkraborty, 2013). This study in particular, acknowledges rapid urban growth as both a cause of negative externalities (i.e., the loss of prime farmland) and the reason for lack of services in settlements close to the boundary of a City.

2.4.5.3 Technological advancements and Transport

Advances in transportation and communication technologies have made it easier for people to live far from the city centre and commute to work (Rodrigue, 2020). This is particularly true with developed countries. For example, the rise of the automobile allowed people to travel greater distances more easily, making it possible to live in the suburbs and work in the city. In Europe and America, unlike in most African countries including Malawi, improved transportation infrastructure, such as highways and public transportation, makes it easier for people to live further from the city centre (Tanja & Christiansen, 2011). In Lilongwe because of lack of public transport system it is difficult to live further away from the City unless you own a vehicle which will also raise the cost of travelling.

In the Global North train, metro, bus and car have provided greater freedom and opportunities with regard to localization of individuals, businesses and industry. Schroten, et al., (2020) believes that technological improvements and falling transport costs have made it possible for businesses and industries to locate away from transport hubs such as railway stations and ports. Handy (2005) asserts that the smart growth theory advocates for connectedness, integrating transportation networks with land use planning. This is critical in Lilongwe city where poorly

planned settlement expansion can isolate residents from employment centers and service hubs, exacerbating socio-economic vulnerabilities. By fostering better connectivity, cities can enhance equitable access to services and reduce informal settlement-related service delivery deficits (Kopecky & Suen, 2010).

Therefore, one can live farther away from the centre or the workplace without increased travel time. Lack of such infrastructure in Malawi has not contributed to low-income settlements but it is because of social and financial factors. Transport and urban growth are strongly related. In fact, there is a reciprocal relationship between transport and urban growth (Aljoufie, et al., 2011).

2.4.5.4 Political factors

Local and state governments often provide incentives for developers to build on the outskirts of cities, such as tax breaks, subsidies, and zoning changes. This can encourage rapid urban growth as developers take advantage of these incentives to build more homes and commercial properties in rural or agricultural areas (Ziwoni and Mwange, 2025). Although there is considerable evidence that rapid urban growth has adverse effects on service delivery, policy frameworks designed to combat rapid urban growth have conflicting interests and political viewpoints (Resnik, 2010).

Evidently, anti-rapid urban growth and compaction policies are by no means purely technical and consensual. The smart growth theory also emphasizes stakeholder participation and inclusive governance, encouraging collaboration among government entities, private sector, and communities in planning processes (Downs, 2001). Given the challenges documented in African cities where low-income settlement populations are often marginalized from formal urban planning and service delivery, smart growth theory emphasises on participatory approaches to improve responsiveness in service provision and infrastructure development. In countries where these policies have been considered at local scales, anti-rapid urban growth and densification policies are highly political (Moore, 2013).

2.4.5.5 Lifestyle choices

This applies particularly to young couples with children. They want to establish themselves in more rural residential areas with large lots and access to green areas. This may partly be because housing prices are lower outside the urban areas, and that families can fulfil their desire for a bigger house than they would be able to afford in the city, as well as access to gardens or green areas in relation to housing (Tanja & Christiansen, 2011). Many people prefer to live in the suburbs, where they can enjoy a more suburban lifestyle with larger homes, bigger yards, and more open space. This demand for suburban living can drive rapid urban growth in low-income settlements as people move out of the city and into the surrounding areas. there is a tendency that people want to move out of the inner city to more rural areas outside of urban areas (Nuisaal and Siedentop, 2021).

2.4.5.6 Land use policies

Zoning and land use policies can encourage rapid urban growth by allowing for low-density development. One hypothesis is precisely that countries with a strong control over land use policy, and with less dispersed and fragmented governance system, have the best potential for managing and planning land developments (Nuissal & Siedentop, 2021). It is also important to point out that cities or municipalities may promote rapid urban growth, because it is in their interest to do so. Some municipalities may facilitate rapid urban growth to attract new inhabitants and increase the population for the sake of development (Tanja & Christiansen, 2011).

Couch and Karecha, (2006) also agree that strong planning controls have been effective in reducing rapid urban growth. Despite the controls still developers often prefer areas outside the cities. The center generally has stringent requirements for planning and environmental aspects, as well as competition with other developers (Williams & Shields, 2000). Thus, smart growth theory serves as both an analytical lens and a planning guide to assess and address the impacts of swelling low-income settlements on service delivery in Lilongwe by advocating for compact, connected, inclusive, and sustainable urban development.

2.5 Impact of Rapid Growth of Low-Income Settlements on Service Delivery

2.5.1 Cost of Service Delivery

Baye (2025) noted in his study that rapid growth low-income settlements in the peri-urban areas of a City leads to increased costs in providing utilities and other public service infrastructure because of the distance and uncoordinated developments. Carruthers and Ulfarsson, (2003) argue that the high service costs incurred through far-flung development patterns serve as a key source of leverage for urban planners and others advocating the use of growth management and `smart growth' programs to promote more compact urban areas. Carruthers and Ulfarsson, (2003) further points out that low-income settlements have come to represent the dominant mode of growth and it continues to generate extensive debate over its desirability as a pattern of land use. Others defend low-income settlements as a fulfilment of consumer preferences whereas detractors fault it for contributing to failure to provide services (Gordon and Richardson, 2001).

Rapid urban growth is regarded as a costly form of urban development due to the spreading out of infrastructure (utilities and related services) (Zhao et. al., 2022). In the context of Lilongwe, a rapidly urbanizing city with expanding low-income settlements, smart growth principles/theory help highlight key challenges and opportunities in managing urban growth sustainably. Rapid influxes into low-income settlements which often overwhelm existing infrastructure and service delivery systems such as water, sanitation and electricity. Spatially expansive development patterns also lead to greater costs because of the larger investments required in extending basic infrastructure (such as water, electricity and waste management) over greater distances to reach relatively fewer numbers of residents (Carruthers, 2002). The empirical literature that examines the impact of rapid urban growth on the provision of services does not exist in Malawi and mostly research focuses on developed countries. When a city expands, its infrastructure together with certain public services need to be increased to maintain a given level of public services for all its residents (Couch, et al., 2007). Consequently, rapid urban growth leads to a marked increase in the provision of costs of local services such as waste collection, water and electricity provision.

The cost of service in relation to rapid urban growth can be significant. Rapid urban growth is the spread of low-density residential development over large areas, often at the edge of cities (Bagheri & Tousi 2018). As a result, the cost of providing services such as public transportation, water and sewage, emergency services, and schools increases. Overall, rapid urban growth increases the cost of service delivery, which is passed on to residents in the form of higher taxes, fees, and charges (Amponsah, 2022). This can put a burden on the residents and create an unequal distribution of services between in low-income settlements and those with more compact development patterns.

2.5.2 Social and Economic Impacts on Service Delivery

Rapid urban growth impacts on social and economic aspects of everyday life and the effects have widely been studied and published. Rogatka and Riberio (2015), state that rapid urban growth has negative effects such as consumption of land, fragmentation of ecosystems, higher cost of public services, social segregation and increased fuel consumption. Couch, Leontidou and Petschel-Held, (2008) are of the same view that rapid urban growth causes economic pressures on a City and may induce a relative fall in demand for land and development in the central city whilst causing a rise in demand for land at the periphery. By spreading people out, low-density suburban development may reduce social interaction, weakening the bonds that underpin a healthy society (Brueckner, 2000).

Rapid urban growth is increasingly damaging to the quality of urban life and brings about major impacts on the environment such as spatial changes in the demand for development and the location of economic activity. Control of rapid urban growth was one of the earliest reasons for the emergence of modern town planning (Couch, Leontidou and Petschel-Held, 2008). The study by Oueslati et. al, (2015) indicate that income growth is by far the most important cause of urban expansion and the spread of settlements.

2.5.3 Environmental Impacts on Service Delivery

Environmental impacts pose a more direct threat to human health than those associated directly with suburban development yet conceivably they are less likely to be remedied in a timely manner than those associated with suburban development (Kahn, 2000). Wilson and Chkraborty,

(2013) contend that after decades of denial, misinformation, and debate, global climate change has emerged as one of the most significant challenges for urban planning and rapid urban growth of informal settlements.

The loss of farmland, open space, forest, and habitat are the most common issues addressed by articles focusing on the impacts on rapid urban growth from a land use perspective. Low-income settlements are characterized by an increase in impervious surfaces, which have extensive and well-documented effects on hydrology including an increase in the volume, rate, and pollutant content of storm water leaving a site (McGrane, 2016).

An alternative viewpoint for environmental impacts of rapid urban growth is that of environmental justice, whereby poor and minority communities suffer disproportionately from urban disinvestment and/or hazardous land uses (Lambin et al, 2001). Both of these outcomes can be viewed as correlates of rapid urban growth, in as much as rapid urban growth incorporates a transfer of people and resources from the inner city and inner-ring suburbs to more distant suburbs, and such transfer is performed with very tight local control over land uses (Nelson, 2012)

2.6 Spatial land cover and land use changes

One of the primary objectives of spatial planning and land-use management is to promote territories that are environmentally sustainable, functional and aesthetically pleasing, ultimately enhancing the population's quality of life (Gomes, et al., 2024). Detecting land use/cover change (LULC) provides a proper background for environmental, planning, and urban management analysis (Gondwe et al., 2021). However, detecting land use/cover is not easy due to various factors such as when the size of pixels in land cover/use map is different and some elements are not being recognized properly due to lack of resolution (Manandhar, et al., 2009).

Land use change is one of the challenges that aggravate service delivery problems. Understanding the scope of land use change, driving forces, and consequences is very crucial for proper management of service delivery. Land cover and land use are fundamentally different concepts of the land surface (Gomes, et al., 2024). Land cover is defined as the physical state of

the land surface, while land use is a description of the spatial aspects of all human activities on the land (Lambin, et al., 2001). Land use change is a process that occurs as a result of human interaction with the physical environment, resulting in the modification and biophysical attribute change of the Earth's terrestrial surface by either shifting to a new type of land use or intensifying use of the existing type (Lambin, et al., 2001). McGrane (2016) is of the view that various land use change models, that have been developed over the past three decades, enable the assessment and simulation of the future role of land use/land cover change in predicting the demand for services.

Land use cover change studies suggest that, in order to use land optimally and ensure proper service delivery, it is necessary to have the information and continuously update the data on existing land use and land cover (Shaghla, et al., 2018). Land cover changes can be determined by statistical assessment by comparing temporal or different dated land cover maps (Choukiker, 2021). It is therefore important to have capability of monitoring the dynamics of land use resulting out of changing demands of an increasing population to ensure adequate provision of services. Smart growth stresses compactness and completeness, meaning neighbourhoods should contain diverse housing types and essential daily services within walkable distances which directly addresses issues of service accessibility for low-income populations (Downs, 2001).

CHAPTER THREE: METHODOLOGY AND METHODS

3.1 Introduction

This chapter describes the study area, research design, sampling framework and methods, sampling method and sample size, data collection methods and instruments and data analysis.

3.2 Description of the Study Area

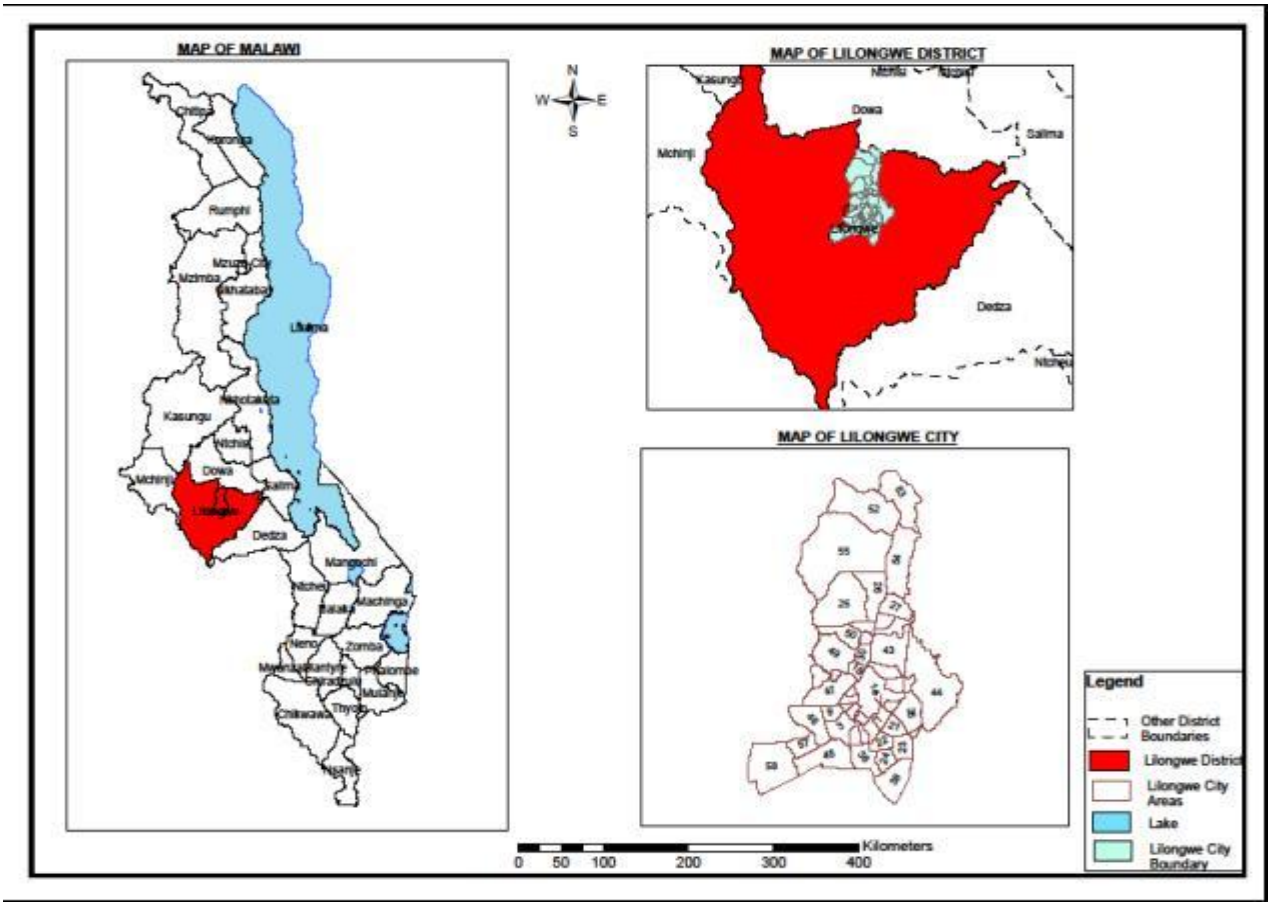


Figure 4: Location of Lilongwe

Source: LCC GIS Office (2022)

The study took place in Lilongwe, the capital city of Malawi. The jurisdictional area of Lilongwe City is 403 km² and has a population of approximately 989,318 according to the 2018 Population and Housing Census (NSO, 2019). The Lilongwe City urban growth has been expanding to the

southern, south-western and western areas of the City haphazardly (Lilongwe City Council, 2010). Because of the rapid growing population and demand for land there are already attempts to annex the sprawled low-income settlements into Lilongwe city jurisdiction (Lilongwe. 2010).

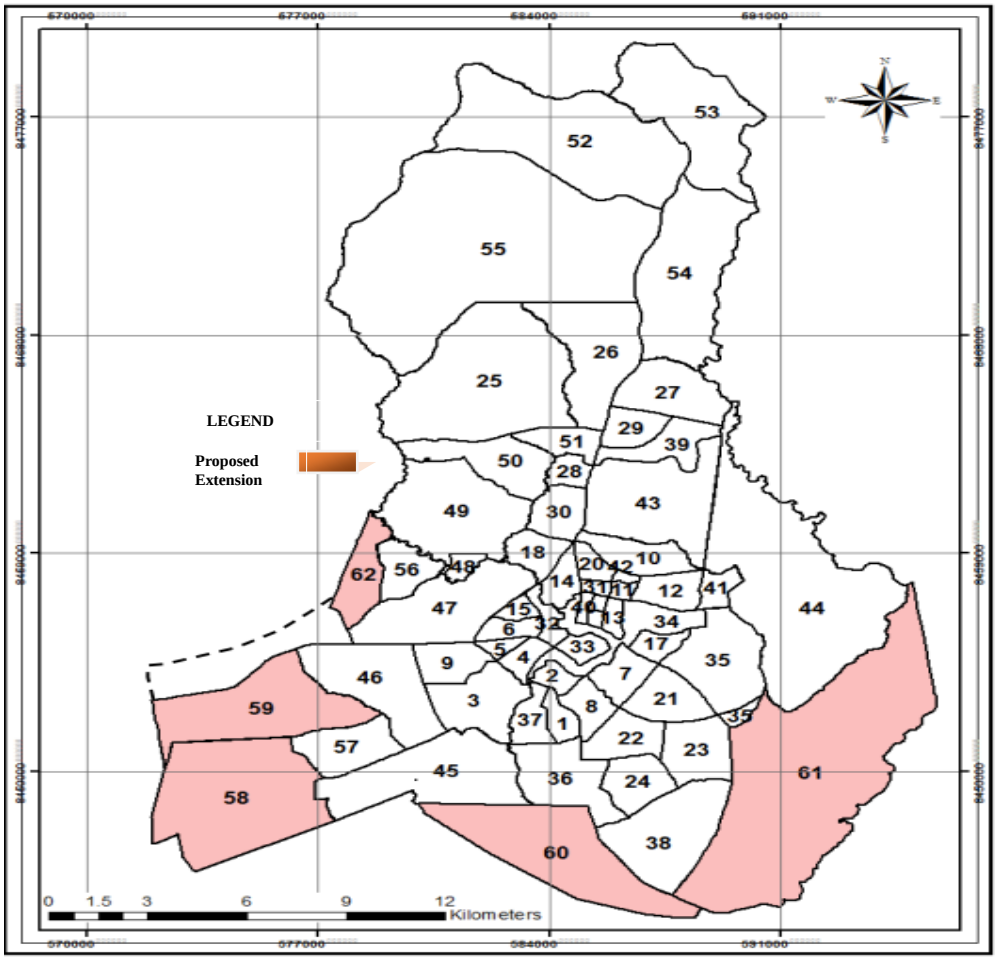


Figure 5: Map of Lilongwe

Source: LCC GIS Office (2022)

The shaded areas are to be converted from Lilongwe District Council to Lilongwe City Council. Area 59: to the north from Area 57 and 58, Area 60 to the south from Area 36 and 45, Area 61 to the east from Area 38, Area 62: to the west from Area 56. The study areas were chosen because they exhibit rapid urban growth, which aligns with the objective of assessing the impacts of urban expansion on service delivery.

Figure 6 shows the areas under study, Area 25 (Dzenza), Area 36 (Western by-pass), Area 38 (Kaphiri), Area 45 (Western by-pass road), Area 49 (Air-Wing) and Area 53 (Lumbadzi). Lilongwe City Council (2010) confirms that rapid urban growth is exceptional in the southern area (Area 36) where population increased by more than 30,000, followed by the southwest (Area 57) and the west (Area 25) with more than 20,000, and then, the southeast (Area 44).

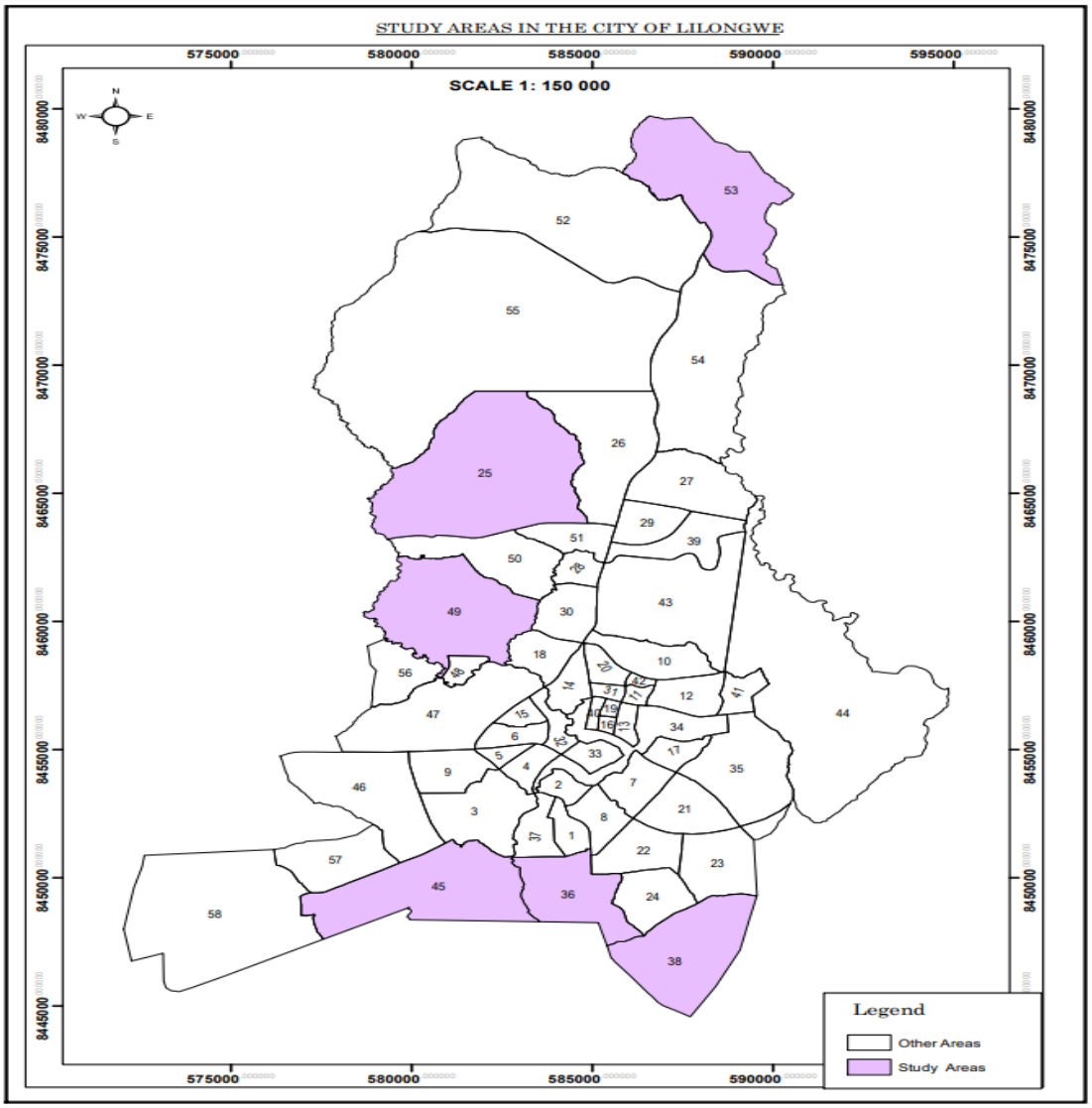


Figure 6: Study Areas

Source: LCC GIS Office (2022)

3.3 Research Design

According to Jahoda, Deutch & Cook "A research design is the arrangement of conditions for the collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy and procedure". Research design is the plan, structure and strategy and investigation concaved so as to obtain search question and control variance" (Borwankar, 1995). Henry Manheim says that research design not only anticipates and specifies the seemingly countless decisions connected with carrying out data collection, processing and analysis but it presents a logical basis for these decisions (Selltiz, 1962).

The study used a mixed-method research design to address the specific objectives. Mixed methods research design integrates quantitative data (numbers, statistics) and qualitative data (words, meanings, experiences) to draw stronger conclusions through triangulation, complementarity, and comprehensiveness. Primary and secondary data were collected and analysed using quantitative and qualitative methods. Primary data was collected from service providers as key informants and from residents in the study areas through interviews using questionnaires. Secondary data was collected from service providers, archival reports, government regulatory documents and peer-reviewed papers.

3.4 Sampling Framework and methods

3.4.1 Target Population

The selected population for this study was 301,567people residing in the study areas of Area 25 (Dzenza), 36 (Western By-pass), 38 (Kaphiri), 45 (Air Wing), 49 and 53 (Lumbadzi) and service providers namely the Lilongwe Water Board, Electricity Supply Commission (ESCOM), and Lilongwe City Council were among key respondents informing the research study.

Table 1: Population of study areas

No.	Study Area	Population
1	Area 25 (Dzenza)	107,316
2	Area 36 (Western By- Pass)	92,733
3	Area 38 (Kaphiri)	22,551
4	Area 45 (Katete Farm)	3,725
5	Area 49 (Air Wing)	52,948
6	Area 53 (Lumbadzi)	22,294
	TOTAL	**301,567**

Source: NSO (2019)

3.4.2 Sampling Method and Sample Size

Simple random sampling was used to select the low-income settlements which are experiencing rapid growth. Key informants were selected based on their official roles in land management, planning control and service delivery to obtain primary data. The following key informants were interviewed as per the list provided in Table 2 below.

Table 2: Key information interviews with officials

No.	Organization	Position	Experience (Yrs.)
1	Lilongwe City Council	Director of Planning and Development	20+
2	Lilongwe Water Board	Wastewater Treatment Manager	10+
3	ESCOM	Chief Engineer (Distribution Planning)	10+
4	Ministry of Local Government	Planning Officer	5+
5	Airport Development Limited	Senior Estates Officer	10+
6	Ministry of Lands	Chief Planning Officer	15+
7	Lilongwe District Council	Director of Planning and Development	20+
8	CCODE	Program Manager	10+
9	Habitat for Humanity Malawi	Advocacy Coordinator	5+

Source: Author (2024)

For quantitative data collection, sample size was determined by using the Yamane formula:

$n = N/ (1+N (e)^2)$

Where:

n = sample size, N = Total population, e = 5% acceptable error or 95% confidence level

Table 3: Summary of Population and Sample Sizes of Study Areas

No.	Study Area	Area Population	Sample Size
1	Area 25 (Dzenza)	107,316	142
2	Area 36 (Western By- Pass)	92,733	123
3	Area 38 (Kaphiri)	22,551	30
4	Area 45 (Katete Farm)	3,725	6
5	Area 49 (Air Wing)	52,948	70
6	Area 53 (Lumbadzi)	22,294	30
	TOTAL	**301,567**	**401**

Source: NSO (2019)

Total Sample Size

$$n = \frac{301567}{1 + 301{,}567\text{x}.\,05\text{x}.\,05)}$$ n = 400.47 Total Sample Size = 401

A sample size of 401 was the acceptable number of respondents for this study to maintain a 95% confidence level and 5% precision. 10% contingency was added to ensure that the sample size was met. Total Questionnaires administered: 441 Questionnaires

3.5 Data Collection Methods and Instruments

Table 4: Data Collection Methods and Instruments

No.	Objectives	Data Collection Method	Variables	Type of Analysis
1.	To assess the drivers of rapid growth of low-income settlements in Lilongwe City.	Semi Structured Questionnaire Interview	Land Preference Access to land Land Sizes Cost of Land	Descriptive Analysis Content Analysis Logistics Regression
2.	To analyse the impact of rapid growth of low-income settlements on service delivery in Lilongwe City.	Semi Structured Questionnaire Interview	Service availability Affordability of services Cost of services	Descriptive Analysis ANOVA Pearson Correlation test Multiple Linear Regression Analysis
3.	To assess spatial land change between 2000 and 2022 in low-income settlements.	Landsat 7 and 8 imageries Google Earth point data	- Built Up Area - Vegetation - Bare Land	Normalised Difference Build-Up Index (NDBI) Land Use Land Cover Change (LULC)

Source: Author (2023)

A semi-structured questionnaire with open and close-ended questions was used as a data collection instrument for quantitative data as described in Table 4 for interviews with the residents. Qualitative data was collected using a checklist through in-depth interviews with key informants (see appendix 6). Satellite images were used to assess the rapid urban growth of low-income settlements.

Secondary material was gathered through the review of archival documents available at Lilongwe City Council and other literature such as standards and guidelines for development, Physical Planning Act (Amendment) 2022, Lilongwe Urban Structure Plan (2010), newspaper reports, journals and internet sources.

3.6 Data Analysis and Instruments

Quantitative data was analysed using statistical tools and procedures. The data was entered into the Excel software and exported into the Statistical Package for the Social Sciences (SPSS) to generate charts and graphs of the various variables. The variables which were used to assess drivers of rapid growth of low-income settlements, included the migration status of residence, Age Category of the household head, Access to land, Land preference, Level of Education, Annual Income and Land Sizes. These were analysed using a Logistic Regression Model and Pearson Correlation Tests. The Logistic Regression Model's accuracy was assessed using Cox and Snell R Square, Nagelkerke R Square and the Omnibus Tests of Model Coefficients.

To examine the impacts of rapid growth of low-income settlements on service delivery in the study area, the population growth and household number increase between 2010 to 2023 was considered together with the associated changes in service demand. The analysis examined changes in demand for services such as water, electricity and waste management, with respect to changes in the number of households. The analysis was performed through descriptive statistics, Pearson Correlation Test, Paired Samples T test and the Multiple Linear Regression analysis. The Multiple Linear Regression Model was assed using the Coefficient of Determination (R^2) and the Standard Error of the Estimate.

Finally, Landsat 7 and 8 images for the years 2010 and 2023 to describe spatial changes for areas 25, 36, 38, 45, 49 and 53, which were downloaded from the Earth Explorer website to analyse impact of rapid growth of low-income settlements on land. The land use and land cover analysis was performed using Normalised Difference Build-Up Index (NDBI) formula. Determining new built-up index was based on understanding that the urban area is a complex ecosystem composed of four main heterogeneous components; impervious surface material, green vegetation, exposed soil or bare soil and water bodies, which exhibt different surface reflectance and spectral signatures (Zha, et al., 2003). The following formula was used to determine vegetation and built up cover;

$$\boldsymbol{NDBI} = \frac{SWIR - NIR}{SWIR + NIR}$$

Where: NIR is Near-Infrared Light

SWIR is Short Wavelength InfraRed

The accuracy of the classification was assessed using a Confusion Matrix by comparing the developed classes to point data collected from 2010 and 2023 Google Earth's base maps. After obtaining results, land use and land cover change detection analysis was run in ArcGIS to compare the changes over the 13-year period.

A document study was used to review and evaluate information from both printed and electronic sources from service providers and public institutions. The documentary data was analysed together with the data from interviews and observations.

Table 5: Secondary Data Documents Analysed

No.	Document	Data Analyzed
1.	Physical Planning Act (2016)	Development control and planning processes
2.	Lilongwe Water Board Annual Data (2024)	Water Demand and Supply
3.	Lilongwe City Council Diagnostic Report (2020)	Existing and planned service infrastructure
4.	Malawi 2063 (2020)	Urbanization and growth of the city
5.	Lilongwe City Wide Sanitation Survey (2020)	Demand and supply of sanitation facilities
6.	Lilongwe Urban Profile (2011)	Challenges in provision of urban services
7.	National Urban Policy (2019)	Sustainable urban development
8	SDGs	Challenges to access basic services

Source: Author (2025)

3.7 Chapter conclusion

This chapter has presented the description of the study area, research design, sampling framework and methods, sampling method and sample size, data collection methods and instruments and data analysis.

CHAPTER FOUR: STUDY RESULTS

4.1 Introduction

This chapter presents results of the study. The results have been presented in the order of the study objectives, which were to assess the drivers of rapid growth of low-income settlements in Lilongwe City, to analyse the impact of rapid growth of low-income settlements on delivery of water, electricity and solid waste management services in Lilongwe City, and to assess spatial land change between 2010 and 2023 in low-income settlements.

4.2 Demography

4.2.1 Sample Size Response rate

Table 6: Response rate from Sample Size

Description	Target	Response received	Response rate %
Questionnaire	401	401	100 %

Source: Field Data (2023).

The researcher added a 10% contingency to ensure that the required questionnaires were completed for the study. Therefore, the researcher administered 441 questionnaires to households to meet a sample size of 401 (see 3.4.2), achieving more than 100% of the required sample. According to Mugenda (2008), a response rate of 95% is sufficient, 60% is good and above, and 70% is rated very highly, 100 % is a good representation of the population. It can therefore be concluded that the research was grounded on a good representative sample of the population

4.2.2 Gender participation of the respondents

The descriptive analysis showed that the gender composition of the respondents in the study area was 77.1% females and 22.9% males. Although this gender distribution could be a reflection of the residents' gender distribution in the study areas, the time (day time) at which the interviews were being conducted could also have an effect on the ratios. The 2018 NSO's report showed that

more men are employed than women in Lilongwe City, a condition which could make most of them being at work during the day.

Table 7: Gender participation of the respondents

		Frequency (n)	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
Valid	**Female**	340	77.1	77.1	77.1
	Male	101	22.9	22.9	100.0
	Total	**441**	**100.0**	**100.0**	

Source: Field Data (2023)

4.2.3 Age distribution of the respondents

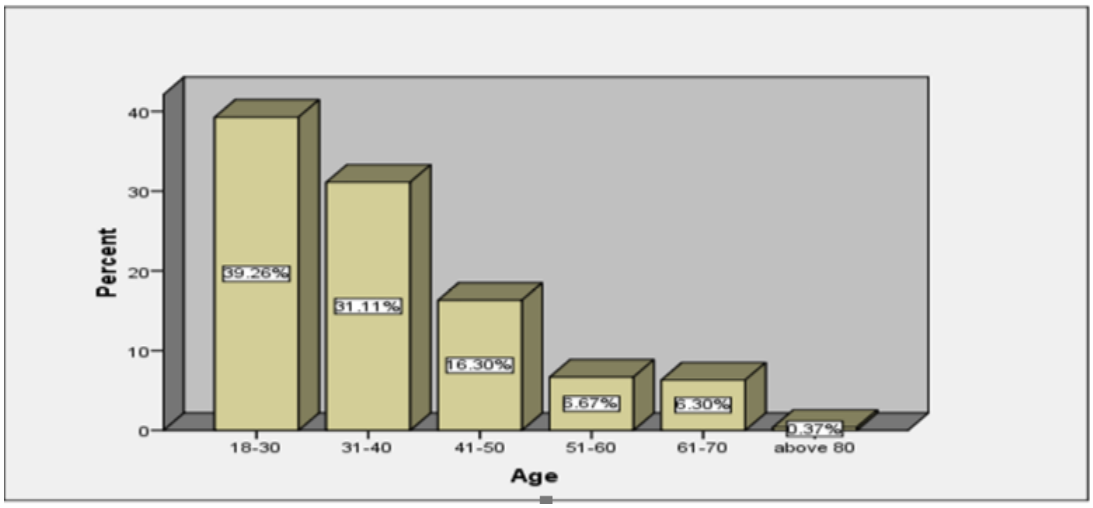


Figure 7: Age distribution of the respondents

Source: Field Data (2023)

The results shown in Figure 7 reveal that more respondents (39.26%) were between the age range of 18 to 30 years; 31.11 % of the respondents were between 31 to 40 years of age, 16.30 % were between 41-50 years, 6.67% were between 51-60 age range and 6.30% were in the age range of

61 -70. The lowest percentage of the respondents were those above 80 with 0.37%. As the results have shown, a majority of the occupants in the study area fall within the active age groups, which could potentially be a signal for business or work related emigration factors into these areas.

4.2.4 Occupation of the Respondents

Table 8: Occupation of the Respondents

		Frequency (n)	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
Valid	Business	155	38.7	38.7	38.7
	Fulltime	64	16.0	16.0	54.6
	Part-time	31	7.7	7.7	62.3
	Retired	16	4.0	4.0	66.3
	Self Employed	18	4.5	4.5	70.8
	Unemployed	117	29.2	29.2	100.0
	10% Contingency	40			
	Total	441	100.0	100.0	

Source: Field Data (2024).

The findings show that majority of the study participants representing 38.7% were engaged in business, followed by those who were unemployed at 29.2%. The study found that 16% of the participants were employed full-time, 7.7% were employed part-time, and 4.5% were self-employed while 4.0% were retired.

4.2.5 Level of education

Educational level of the participants was distributed from none to post graduate. This information is presented in Figure 8 below.

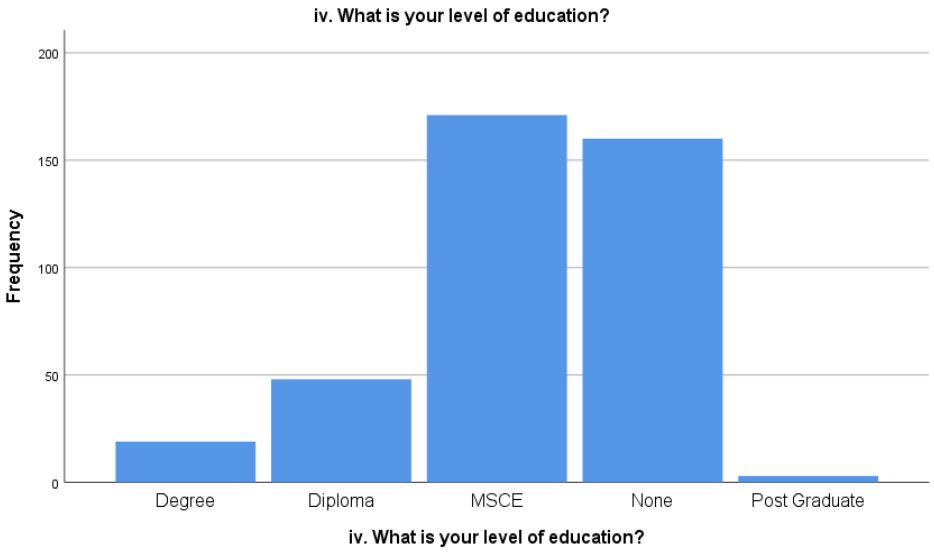


Figure 8: Level of education

Source: Author (2023)

The study revealed that 42.6% of the study participants had MSCE, 39.9% did not reach standard eight, 12.0% had diplomas, 4.7% were degree holders while only 0.7% were postgraduates. Based on these findings it is clear that about 60% of the participants had qualifications equal to and higher than an MSCE, a qualification which is mostly regarded as an entry point for formal employment in Malawi

4.3 Drivers of rapid growth of low-income settlements in Lilongwe

4.3.1 Land Preference

In an attempt to gain an understanding of the drivers of rapid growth of low-income settlements in Lilongwe City the researcher asked the participants why they preferred staying at the periphery of the city and the results are as shown in Figure 9.

	Cheap Land	Agriculture	Available Services	No City Rates	Other
Percentage	12.97	67.33	1.25	11.47	6.98
No. of Respondents	52	270	5	46	28

Figure 9: Land preference.

Source: Author (2023)

The findings reveal that participants preferred staying in low-income settlements for various reasons. Firstly, participants preferred to stay in the low-income settlements areas because there is an opportunity to partake in agricultural activities (67.33%). The second reason was that the land was cheap in the periphery of the city than the inner city (12.97%). Non – payment of city rents was another factor which drove people to move out the inner City (11.97). Other reasons (6.98%) given were that the land belongs to their families hence they do not pay rentals and that it was easy to do business. There was a small percentage of the respondents, which were lured by the available services such as water and electricity (1.25%). As the occupational demographics showed that a majority of the residents in these areas are either doing business or unemployed, the revelation that most of them move to these periphery areas for agriculture and because they find the land cheaper were found to be in line with the initial findings. According to the NSO's 2018 report, 18.7% of Malawians in the city are not fully employed and most of them resort to agricultural activities to earn a living. Therefore, it does not come as a surprise that most of the

respondents in the city move to the areas where land is cheaper, as this is a necessity for both settlement and a factor of agricultural production.

4.3.2 Access to Land

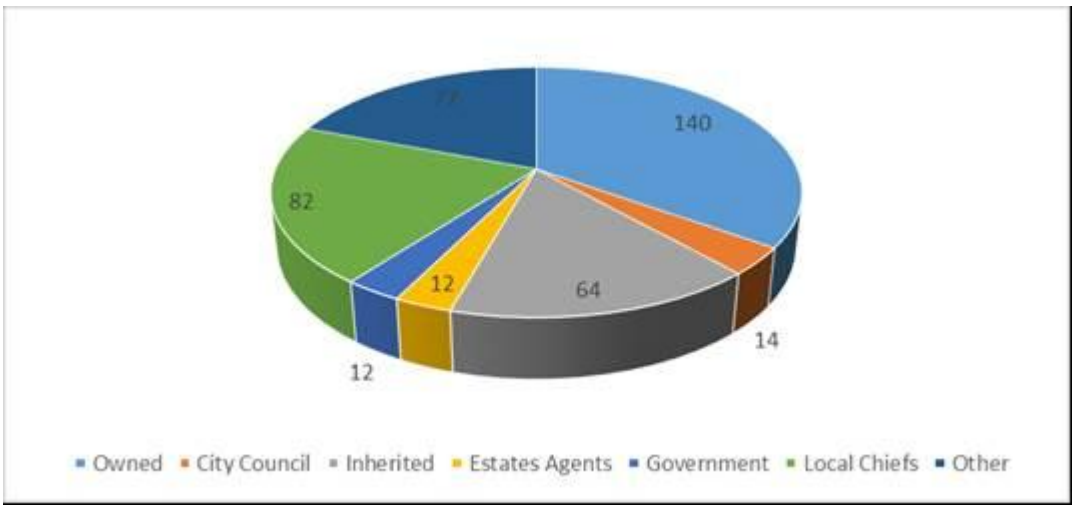


Figure 10: Land Access.

Source: Author (2023)

The study asked how the land was acquired and the following were the results: 34.9 % of the respondents owned the land, 20.4 % allocated by the local chiefs, 16% inherited the land from the parents or forefathers, 3% acquired from Government and Estates Agents (Figure 10). The land in these areas clearly is not under Customary Land control because the Chiefs manage it. Owing to the gender demographic results that 77.1% of the respondents were female, the results that 34.9% owned their land and 16% inherited their land from parents agrees with land customary rights of the central region of Malawi which is matrilineal. The higher percentage of those who were allocated land by chiefs, and government and estate agents was also found to be in tandem with the initial results which showed that a majority of the population is young and active in business which puts them at an advantage of land purchase.

4.3.3 Land Sizes owned

About 34.9% of the respondents own land beyond 3000 square meters followed by 30.7% who own land ranging from 1000 to 2000 square meters. 26.7 percent of the respondents own land in sizes ranging from 2000 – 3000 square meters and the rest are ranging from 500 – 1000 square meters which takes up 1.2 % and 6.5 percent got land of 0 – 500 square meters as illustrated in the Figure 11. As the results have shown, about 92.3% of the residents own land between 1000 to more than 3000 square meters. These results reflect more on the initial findings that most of the residents move to the periphery areas for agricultural purposes as agriculture requires considerable sizes of land to yield good results. This was also found to be an indicator that although the city is expanding to these areas, the expansion could not be entirely as a result of land purchase activities, but as a result of matrilineal inheritance by the large female percentage in the area, as those that have acquired land through customary means are likely to have large sizes as compared to those who make purchases of the same.

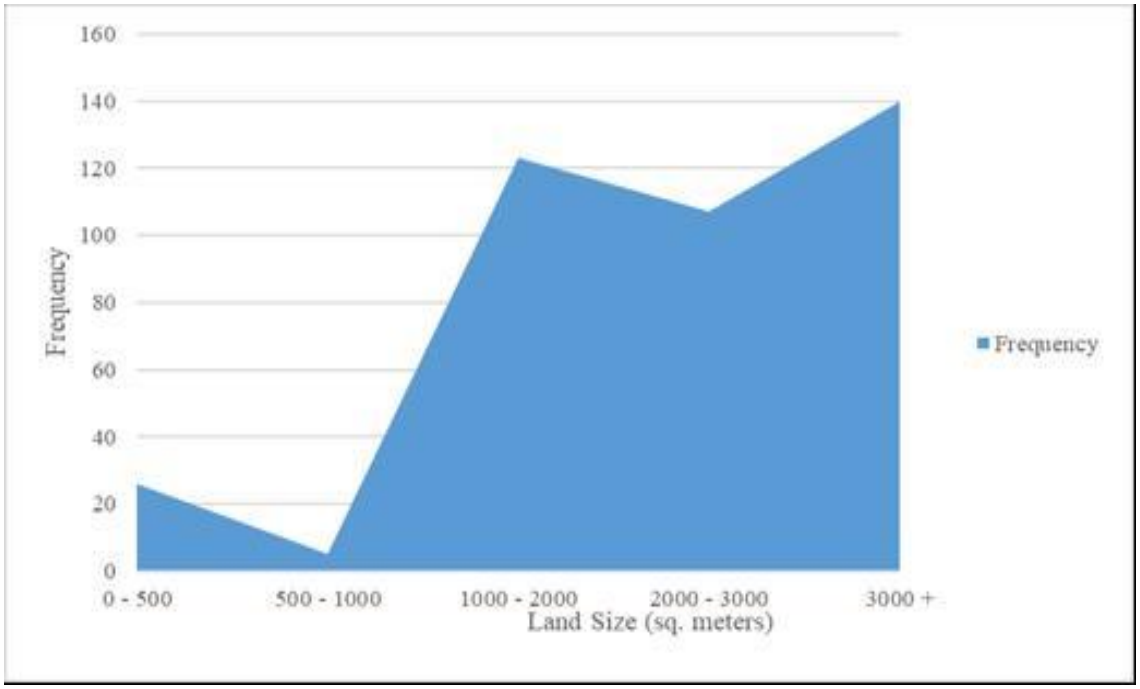


Figure 11: Land Sizes.

Source: Author (2023)

4.3.4 Cost of Land

Figure 12: Cost of Land per Acre

Source: Author (2023)

Figure 12 shows the cost of land in the periphery of the City with 37.16 % of the respondents having acquired the land at less than MK500,000.00/acre, 26.68% at between MK500,000.00/acre to MK1,000,000.0/acre and 28.43% got the land around 1,000,000.00/acre. Less than 10% got the land above MK2, 000,000.00/acre with 1,25% and 6,48% buying the land between MK2,000,000.00/acre to MK3,000.000.00/acre to MK4,000,000.00/acre respectively.

4.3.5 Application of Logistic Regression Model on drivers of rapid growth.

To investigate drivers of rapid growth of low-income settlements, a logistic regression model was run on a household's migration status into the outskirts of the town. The emigration status was given a response of "yes", while for those that have been residents in these areas since birth were given an emigration response of "No". The emigration status was the response variable in the logistic regression, whereas the predictors were Age Category of the household head, Access to land, Land preference, Level of Education, Annual Income and Land Sizes. Before the results of the model were produced, the model was assessed for its fitness.

The logistic regression model was assessed using Cox and Snell R, and Nagelkerke R, whereas the model coefficients were assessed using the Omnibus Test of Model Coefficient, as presented in Tables 10 and 11.

Model Summary

Table 10: Logistic Regression Test of Model Coefficients

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	201.034[a]	.514	.637

Table 11: Logistic Regression Model Summary

		Chi-square	df	Sig.
Step 1	Step	151.050	25	.000
	Block	151.050	25	.000
	Model	151.050	25	.000

The logistic regression model developed to assess the main drivers of rapid growth of low-income settlements in Lilongwe demonstrated a good fit, as evidenced by the model summary statistics in Tables 10,11 and 12. The Cox & Snell R Square value of 0.514 and the Nagelkerke R Square value of 0.637 indicate that the model accounted for a substantial portion of the variance in urban rapid growth of the low-income settlements, with the potential to explain up to 63.7% of the observed variability (Table 10). The omnibus tests in Table 11 also indicated that the model is statistically significant ($p<0.05$) and that the predictors included in the model have a significant effect on the of rapid growth of low-income settlements in Lilongwe City. The model's classification accuracy was further highlighted by its ability to correctly predict 86.5% of cases, with particularly high accuracy (95.5%) in identifying instances of rapid growth of low-income

settlements as shown in Table 12. These results suggested that the included variables provided a robust framework for understanding the dynamics of urban expansion in Lilongwe.

Table 12: Logistic Regression Model Accuracy

Classification Table

Observed			Predicted Rapid Growth		Percentage Correct
			No	Yes	
Step 1	Rapid Urban Growth	No	35	29	54.69
		Yes	15	322	95.5
	Overall Percentage				86.5

a. The cut value is .500

Table 13: Model Results of Drivers of Low Income Settlements

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Age			8.964	5	.111	
	18-30	-22.224	40196.000	.000	1	1.000	.000
	31-40	-21.397	40196.000	.000	1	1.000	.000
	41-50	-21.414	40196.000	.000	1	1.000	.000
	51-60	-20.267	40196.000	.000	1	1.000	.000
	61-70	-20.662	40196.000	.000	1	1.000	.000
	Level Of Education			4.202	4	.379	
	Degree	-39.143	25884.751	.000	1	.999	.000
	Diploma	-36.180	25884.751	.000	1	.999	.000
	MSCE	-38.214	25884.751	.000	1	.999	.000
	None	-38.369	25884.751	.000	1	.999	.000
	Annual Income			4.135	4	.004	
	500,000	-1.234	.671	3.383	1	.007	1.291
	1000,000	-1.014	.714	2.018	1	.016	.363
	1500,000	-.855	.784	1.189	1	.276	.425
	2500,000	-1.650	1.009	2.673	1	.010	1.192
	Land Preference			3.579	4	.005	
	Agriculture	-.573	.760	.569	1	.005	1.564
	Available Services	.089	.799	.012	1	.912	1.093
	Land is Cheap	-1.160	.642	3.261	1	.007	.314
	No City Rates	-.311	16733.656	.000	1	1.000	.733
	Cost of Land			.000	5	.036	
	100,000 - 500,000	.192	6300.733	.000	1	.010	1.212
	1-2 Million	-20.981	5341.495	.000	1	.997	.000
	2-3 Million	-1.189	9055.564	.000	1	.100	.305
	3 Million +	39.009	20530.350	.000	1	.998	8.735E+16
	500,000 - 1 Million	.102	13121.124	.000	1	1.000	1.108
	Land Size			1.611	3	.657	
	0 - 500 m2	-.127	.390	.106	1	.745	.881
	1000 - 2000 m2	-.971	.765	1.611	1	.204	.379
	2000-3000m2	-40.268	12588.021	.000	1	.997	.000
	Constant	82.538	48108.236	.000	1	.999	7.014E+35

a. Variable(s) entered on step 1: i. Age iv. Education Level v. Annual Income, vi. Land Preference, Cost of Land, xii. Land Size.

Source: Field Study (2023).

Having achieved a good fitting model, the logistic regression was able to establish the main drivers of rapid growth of low-income settlements in the study areas as shown in Table 12. The analysis showed that age categories do not significantly affect rapid growth of low-income settlements, as indicated by a Wald chi-square value of 8.964 and a p-value of 0.111. Similarly, the level of education and access to land were found not to be significant predictors of rapid growth of low-income settlements. On the contrary, annual income was found to be a significant predictor of rapid growth of low-income settlements, with a chi-square value of 4.135 and a p-

value of 0.004. Specifically, the analysis showed that households with an annual income of 500,000 have an increased likelihood of moving to the outskirts, with an odds ratio of 1.291. Land preference also yielded a significant impact, especially in a preference for agriculture being positive associated with migration into the peripheral areas (odds ratio = 1.564, p = 0.005). Similarly, the perception that land is cheap had a strong positive association with moving to the outskirts (odds ratio = 0.314, p = 0.007). Land size was found not be significant in influencing migration into the low-income settlements, as indicated by a chi-square value of 1.611 and a p-value of 0.657. These results therefore suggest that economic factors such as income and perceptions of land cost, as well as the need for agricultural land are crucial drivers of rapid urban growth of low-income settlements, while demographic factors like age and education level have less influence.

4.3.6 Impact of land cost on size of land.

Table 14: Land Size – One-Way ANOVA Analysis

	N	*Mean*	*Std. Dev*	*Std. Error*	*Lower Bound*	*Upper Bound*	*Min*	*Max*
1	179	10.62	10.801	.807	9.03	12.21	1	23
2	50	8.16	10.294	1.456	5.23	11.09	1	23
3	15	12.00	10.684	2.759	6.08	17.92	1	23
4	4	18.25	9.500	4.750	3.13	33.37	4	23
5	13	9.23	9.558	2.651	3.45	15.01	3	23
Total	261	10.28	10.648	.659	8.98	11.57	1	23

Table 15: Landsize – Descriptives (95% Confidence Interval for Mean)

Source of Variation	*Sum of Squares*	*Df*	*Mean Square*	*F*	*Sig.*
Between Groups	653.812	4	163.453	1.452	.217
Within Groups	44590.788	396	112.603		
Total	45244.600	400			

Dependent variable – Size of Land/Independent variable – Cost

Source: Author (2024).

A one-way ANOVA was performed to compare the effect of cost on land size. Results from the test, as shown in Table 14 above, suggest that there is no statistically significant difference in the mean size of land across different cost groups (F (4, 396) = 1.452, p = 0.217). The high p-value (p > 0.05) indicates that there are no differences in mean land size based on cost.

4.3.7 Influence of income on choice of location

Table 16: Choice of Location – Descriptives

				95% Confidence Interval for Mean			
	N	*Mean*	*Std. Dev.*	*Std. Error*	*Lower Bound*	*Upper Bound*	*Min*	*Max*
1	180	3.73	1.759	.131	3.47	3.99	1	6
2	104	3.62	1.627	.160	3.30	3.93	1	6
3	44	3.32	1.611	.243	2.83	3.81	1	6
4	23	3.04	1.364	.285	2.45	3.63	1	6
5	50	2.74	1.712	.242	2.25	3.23	1	6
Total	401	3.49	1.709	.085	3.32	3.66	1	6

Source: Author (2024)

Table 37: Choice of Location

	Sum of Squares	*Df*	*Mean Square*	*F*	*Sig.*
Between Groups	45.821	4	11.455	4.042	.003
Within Groups	1122.398	396	2.834		
Total	1168.219	400			

Source: Author (2024)

A one-way ANOVA was performed to compare the influence of income (independent variable) on choice of location (dependent variable). The results revealed that there was a statistically significant mean income difference based on choice of location (F (4,396) = [4.042]. p = 0.003).

4.4 Impacts of Rapid Growth of Low-Income Settlements on Service Delivery

To examine the impacts of rapid growth of low-income settlements on service delivery in the study area, the population growth and household number increase between 2010 to 2023 was considered together with the associated changes in service demand. The analysis examined changes in demand for services such as water, waste collection, and electricity, with respect to changes in the number of households.

4.4.1 Population Changes

Table 18: Population changes between 2010 and 2023

Descriptive Statistics

	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
2010 Population	170	64650	166132	27688.67	23860.758	569335761.867
2010 Households	39	14693	37757	6292.88	5422.899	29407838.939
2023 Population	3725	107316	301567	50261.17	41909.331	1756392052.567
2023 Households	847	24390	68538	11422.99	9524.848	90722729.988
Valid N (listwise)						

Source: Author (2023)

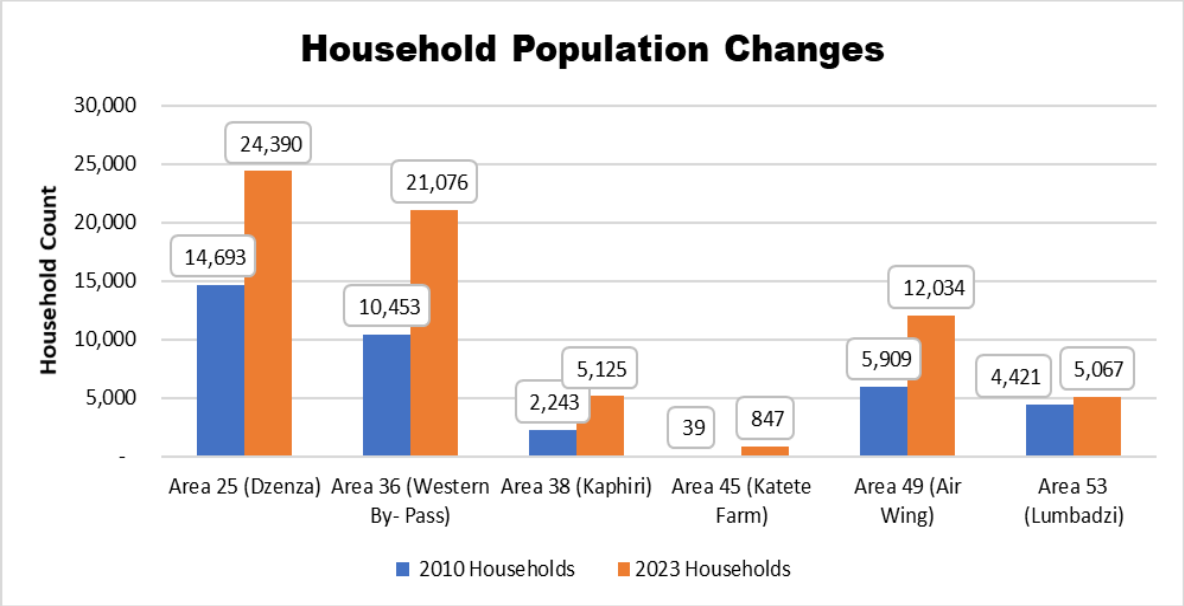


Figure 13: Household Number Changes between 2010 and 2023

Source: Author (2023)

As both Table 17 and Figure 13 shows, the study areas have experienced substantial increase in both population and the number of households settled in these locations. Between 2010 and 2023 the number of people living in these low-income settlements increased from 166132 to 301567, consequently increasing by almost double the number of households from 37757 to 68538 (Table 17). Further analysis as shown in Figure 13, showed that although all areas experienced an increase in the number of households settled, Dzenza and Western By-pass locations expanded more than the rest, from 14693 to 24390, and from 2243 to 5125, respectively, mainly due to the improved road infrastructure over the years and the expanded reach of other services such as electricity and water. Despite housing fewer number of households as compared to Dzenza and Western By-pass, Airwing, Katete Farm and Kaphiri locations were revealed to have grown more than twice the 2010 household numbers. Out of all the study areas, Lumbadzi showed a very little expansion from 4421 to 5067, a condition that can be attributed to limited availability of land for expansion as most of it is owned privately and also protected by the Kamuzu Airport Development Limited (ADL).

4.4.2 Changes in Demand for Services

To understand changes in service demand within the study area, a Paired Samples T-Test was performed on the number of households, water demand, water service connection demand, electricity connection service demand, waste collection service demand, waste generation, electricity consumption, and cases of illegal water connection, as shown in Table 18. Based on the results of the analysis, a significant positive change in the number of households in these low-income settlements was observed (mean = 5130.114, *p=0.035*), indicating an increase in the number of people who are now settling in these areas. In response to the observed significant increase in population, the Paired Samples T-Test also revealed that there has been a significant increase in both water demand within the study's observation period (2010 – 2023) by a mean of 1353.833 m^3 per day (p=0.035). This increase in consumption pattern was found to be in tandem with an increase in water connection service demand, as a positive significant increase was also observed (mean=2831.833, p=0.022).

Table 19: Paired Samples T-Test for Changes in Demand

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	2023 Households - 2010 Households	5130.114	4378.561	1787.540	535.096	9725.131	2.870	5	.035
Pair 2	2023 Water Demand (m³/day) - 2010 Water Demand (m³/day)	1353.833	1155.730	471.825	140.969	2566.697	2.869	5	.035
Pair 3	2023 Water Service Connections - 2010 Water Service Connections	2831.833	2106.016	859.778	621.705	5041.962	3.294	5	.022
Pair 4	2023 Electricity Service Connections - 2010 Electricity Service Connections	1551.667	1478.841	603.734	-.282	3103.615	2.570	5	.050
Pair 5	2023 Waste Service Connections - 2010 Waste Service Connections	823.667	488.265	199.333	311.264	1336.069	4.132	5	.009
Pair 6	2023 Waste Generation/tonnes/day - 2010 Waste Generation/tonnes/day	3.20000	1.98008	.80836	1.12203	5.27797	3.959	5	.011
Pair 7	2023 Electricity (MVA) Consumption/day - 2010 Electricity (MVA) Consumption/day	88.07000	54.38740	22.20356	30.99392	145.14608	3.966	5	.011
Pair 8	2023 Illegal Water Connections - 2010 Illegal Water Connections	18850.000	2728.919	1114.077	15986.175	21713.825	16.920	5	<.001

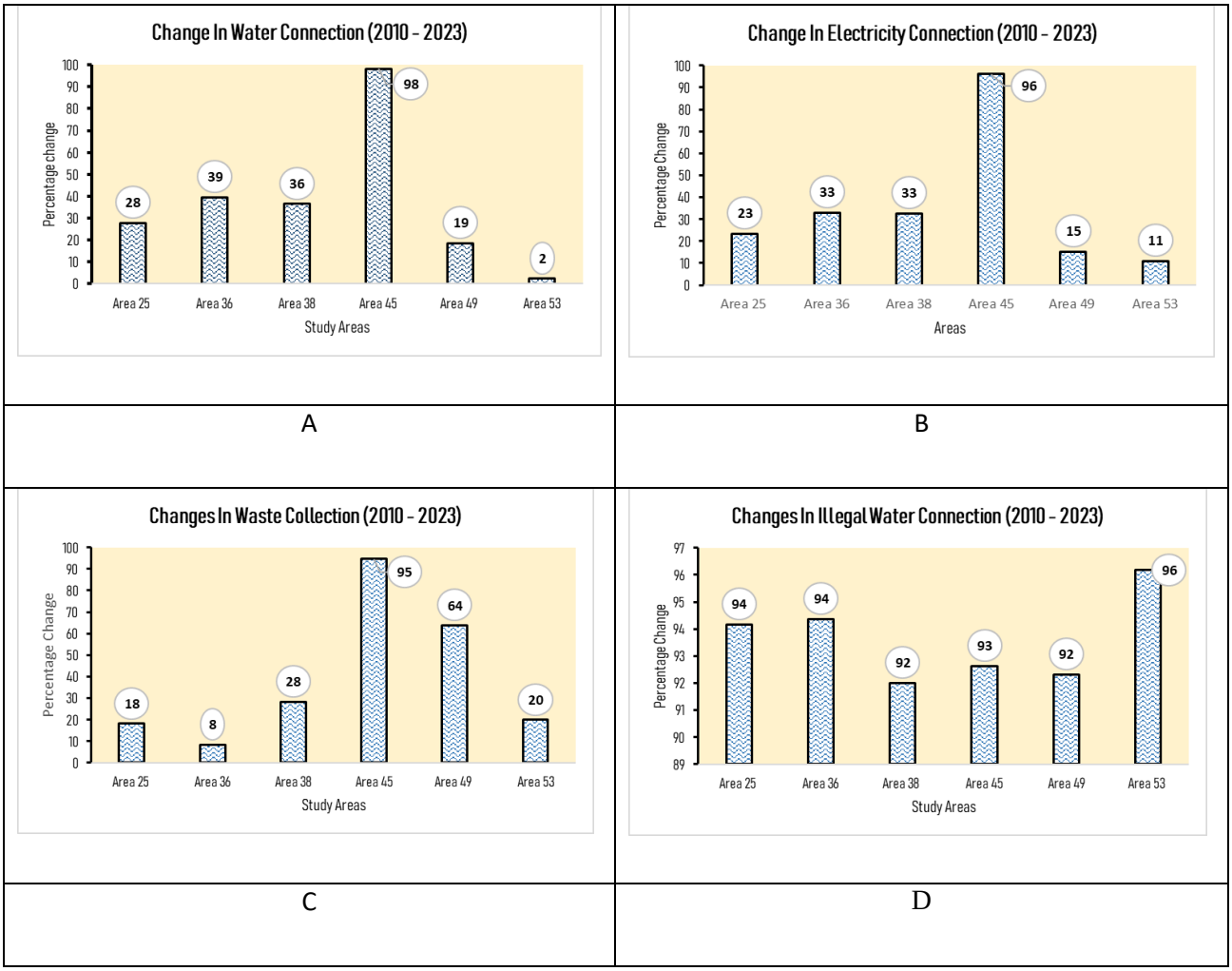


Figure 14:14a, b, c, d: Changes in service demand

Source: Author (2024)

A further descriptive analysis on the change in water connection service demand as shown in Figure 14a, indicated that, despite Katete Farm (Area 45) having few households as compared to the rest of other areas, demand for water connection service has increased drastically by 98 percent. This can be attributed to the rapid increase in the number of households within this area, as earlier observed. In agreement with the observed little change in the number of households in Lumbadzi (Area 53), the descriptive analysis also shows a very minimal increase of 2 percent in water connection service demand in this area. However, despite the overall illegal water connection incidences seeming to have increased significantly in all low-income settlements by a

mean of 18850 (p<0.001), the descriptive analysis as shown in Figure 14d, revealed a concerned situation. While the initial result showed a minimal water connection service demand in Lumbadzi, the descriptive analysis shows that this area experiences increased (96 percent) illegal water connection cases, a condition that further explains the minimal water connection service demand.

Despite the electricity consumption exhibiting a significant positive increase (mean =88.070, p= 0.01) between 2010 and 2013, the analysis showed that there has not been a significant increase in electricity connection services demand in the study area (p=.0.050). Nonetheless, Katete Farm was found to have a rapid increase of 96 percent (Figure 14b), and the least was also Lumbadzi, probably due to the same reasons as in water connection service demand. The analysis of waste generation, and waste collection service demand was also observed to have increased significantly. As Table 17 shows, the overall mean of waste generation per year positively increased by 3.2 tonnes (p=0.011), corresponding to a consequential increase in the number of households seeking waste collection services (mean= 823.667, p=0.009). Further analysis as shown in Figure 14c reveals that Katete Farm which has high percentage change in number of household established between 2010 and 2023 has also a high 95 percentage positive change in the number of households seeking for waste collection services, followed by Air-wing (Area 49), which has also seen a substantial increase in the number of households.

4.4.3 Number of Households and Service Demand

Having established the changes that have taken place between 2010 and 2023 in the study area, the study further examined the relationship between changes in the number of households settled in these low-income areas, and changes in demand for basic services using the Pearson Correlation test. The analysis results revealed a strong and statistically significant positive correlation between the increase in the number of households and the increase in demand for basic services, such as water, electricity, and waste collection. As Table 18 shows, the correlation coefficients for water demand (r = 1.000, p < 0.01), water services connection demand (r = 0.951, p < 0.01), electricity service connections demand (r = 0.983, p < 0.01), and waste collection services demand (r = 0.915, p < 0.01) indicate a nearly perfect linear relationship. This suggests

that as the number of households grew in these low-income settlements between 2010 and 2023, the corresponding demand for these essential services increased proportionally. Similarly, population change within the same specified period was also found to having very significant and positive relationships with these service demands. The high significance of these correlations suggests the existence of potential direct impact of population growth on demand for various essential services within the study area.

The correlation analysis also revealed that the relationship between the growth of the number of household and changes in services demand such as the number of water kiosks and demand for private waste collectors, was weaker and not statistically significant (r = 0.295 and r = 0.299, respectively, $p > 0.05$). In addition, the analysis also revealed weaker relationships between population growth and the demand for these alternative services (number of water kiosks: r = 0.295, $p > 0.05$; demand for private waste collectors: r = 0.299, $p > 0.05$). This suggest that although the positive change in the number of households and population of the area might be relate to the changes in the number of water kiosks established, as well as the demand for private waste collectors, the established relationship between this period was not strong and significant. On the contrary, a significant moderate and positive correlation between the change in the number of households, settled in these areas, with incidences of illegal water connections ($r = 0.507$, $p < 0.05$), was established. Similarly, a positive and statistically significant correlation was found between population growth and illegal water connections ($r = 0.507$, $p < 0.05$). These results suggest that inadequacies in formal service provision, as a result of the expansion of these low-income settlements, may drive residents to seek alternative, unregulated solutions.

Table 20: The Pearson Correlation Test between Population growth changes in demand for services.

										Water Kiosks	Pvt. Wate Collectors	Illegal Water Connections
Population	Pearson Correlation	--										
Households	Pearson Correlation	1.000**	--									
	Sig. (1-tailed)	.000										
Water Demand (m³/day)	Pearson Correlation	1.000**	1.000**	--								
	Sig. (1-tailed)	<.001	<.001									
Water Service Connections	Pearson Correlation	.951**	.951**	.951**	--							
	Sig. (1-tailed)	<.001	<.001	<.001								
Electricity Service Connections	Pearson Correlation	.983**	.983**	.983**	.975**	--						
	Sig. (1-tailed)	<.001	<.001	<.001	<.001							
Waste Service Connections	Pearson Correlation	.915**	.915**	.915**	.890**	.908**	--					
	Sig. (1-tailed)	<.001	<.001	<.001	<.001	<.001						
Waste Generation/tonnes/day	Pearson Correlation	.960**	.960**	.960**	.951**	.960**	.892**	--				
	Sig. (1-tailed)	<.001	<.001	<.001	<.001	<.001	<.001					
Electricity (MVA) Consumption/day	Pearson Correlation	.960**	.960**	.960**	.952**	.960**	.892**	1.000**	--			
	Sig. (1-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001				
Water Kiosks	Pearson Correlation	.295	.295	.295	.411	.301	.210	.393	.392	--		
	Sig. (1-tailed)	.176	.176	.176	.092	.171	.257	.103	.104			
Pvt. Wate Collectors	Pearson Correlation	.299	.299	.298	.413	.303	.215	.397	.397	1.000**	--	
	Sig. (1-tailed)	.173	.173	.173	.091	.169	.252	.101	.101	<.001		
Illegal Water Connections	Pearson Correlation	.392	.392	.391	.507*	.375	.314	.477	.477	.939**	.941**	--
	Sig. (1-tailed)	.104	.104	.104	.046	.115	.161	.058	.058	<.001	<.001	
												12

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

Source: Author (2024)

4.4.3.1 Multiple Linear Regressions Analysis

Finally, to assess the impacts of rapid growth of low-income settlements on service delivery in the city, multiple linear regression analyses were run. The impact of the expansion of the number of households established in these low-income areas was assessed on the changes in electricity services demand, water demand, waste collection services demand, and the presence of other alternative services between 2010 and 2023.

4.4.3.1.1 Models Summary

To achieve the best fitting models for the analysis, the linear regression models were assed using the Coefficient of Determination (R^2) and the Standard Error of the Estimate as shown in Table 19

Table 21: Linear Regression Models Summary

Model Summary

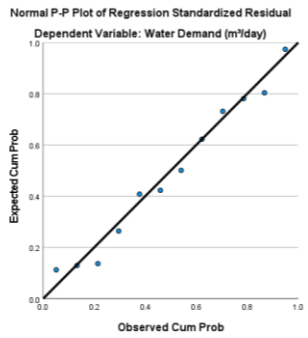
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1[b]	.987[a]	.980	.976	.305
1[c]	.951[a]	.904	.895	1004.648
1[d]	.983[a]	.967	.964	459.282
1[e]	.915[a]	.838	.822	639.934
1[f]	.960[a]	.922	.914	1.09214
1[g]	.960[a]	.922	.914	29.99525
1[h]	.295	.087	-.005	5406.404
1[i]	.299	.089	-.002	5468.359
1[j]	.392	.153	.069	9684.382

a. Predictors: (Constant), Households, Dependent Variables: b. Water Demand (m^3/day); c Water Service Connections; d. Electricity Service Connections; e. Waste Service Connections; f. Waste Generation/tonnes/day; g. Electricity (MVA) Consumption/day; h. Water Kiosks; i. Pvt. Waste Collectors; j. Illegal Water Connections

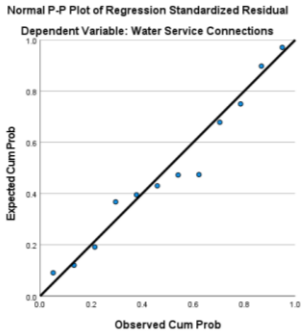
Source: Author (2024)

The results as shown in the model summary table indicate that the predictors used in the models strongly accounted for the variance in the core urban services such as water demand, electricity service connections, and waste service connections. For instance, the linear model analyzing water demand demonstrated a near perfect fit with an R^2 of 0.980 and an adjusted R^2 of 0.976, alongside a minimal standard error of 0.305. Similarly, the model for electricity service connections exhibited a high accuracy, with an R^2 of 0.967, an adjusted R^2 of 0.964, and a standard error of 459.282. Waste service connections model also showed a strong predictive relationship, reflected by an R^2 of 0.838 and an adjusted R^2 of 0.822, with a standard error of 639.934.

The models predicting waste generation and electricity consumption also demonstrated consistent reliability, with both achieving an R^2 of 0.922 and an adjusted R^2 of 0.914, although their standard errors varied at 1.09214 and 29.99525, respectively. On the contrary, the analyses of alternative services, such as water kiosks, private waste collectors, and illegal water connections, revealed weaker predictive strength. These models reported lower R^2 values ranging from 0.087 to 0.153, with adjusted R^2 values as low as -0.005, alongside high standard errors, indicating substantial unexplained variability. Similar to the observed Coefficient of Determination, the P-P plots of the regression models' standardized residuals revealed an almost perfect fitting linear relationship between the predicted and observed water demand, and electricity connection service demand (Figure 15a, c). The P-P plots for the predicted and observed water connection service demand, waste generation, and electricity consumption, as shown in Figures 15b, e, f, also showed a minimal linear relationship. Just as the model precision measurement revealed weaker predictive strength for water kiosks, private waste collectors, and illegal water connections, their relationship between the predicted and the observed standardized residuals for these models was also shown having not to be significant as shown in P-P plots 15f, g and h. Overall, the models provided significant insights into the interpretation of relationship between the expansion of low-income settlements and changes in core service delivery, despite their ability to predict shifts in alternative service systems was more limited.



a



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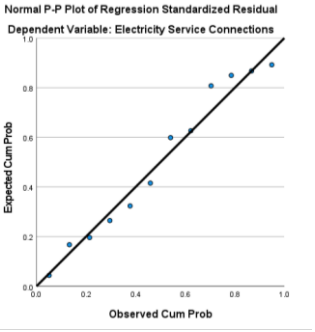

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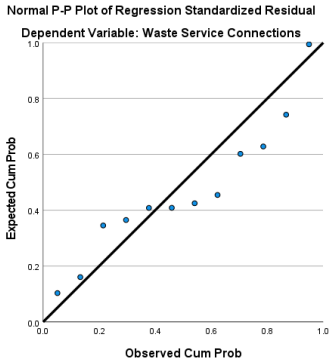

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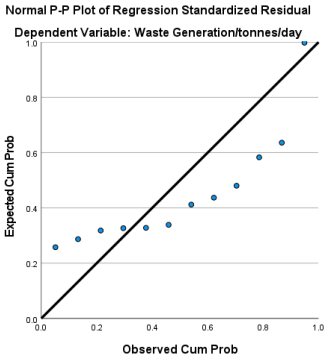

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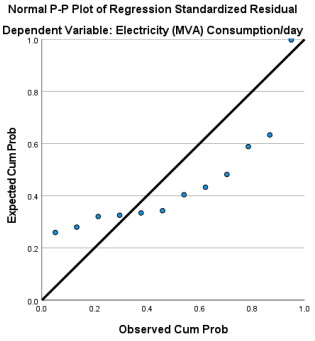
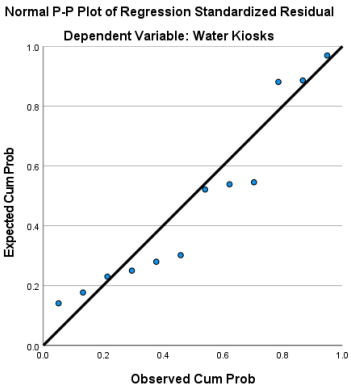
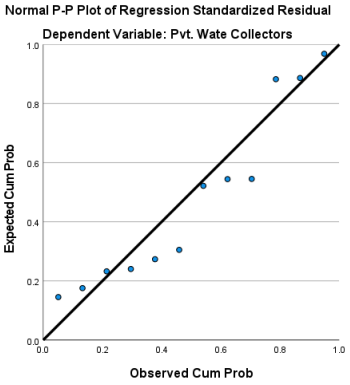


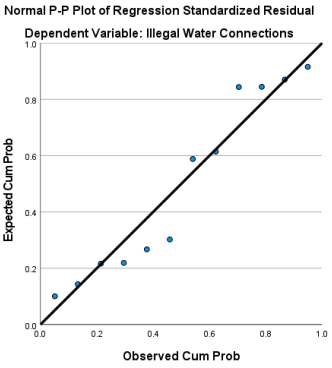
F



f



g



H

Figure 15: 15a, b, c, d, e, f: Linear Regression Models' P-P plots

Source: Author (2024)

4.4.3.1.2 Multiple Linear Regression Models Results

Having evaluated the models' performance, finally the impact of rapid growth of low-income settlements on service delivery in the city was revealed. As Table 22 shows, the results of the multiple linear regression models indicate critical insights into the effects of household growth in low-income settlements on service delivery within the city. For core and basic urban services such as water demand, electricity service connections, and waste collection services, the results indicate statistically significant relationships. The coefficients for households in these models are positive and significant ($p<0.05$, $p < 0.05$, $p<0.05$), suggesting that as the number of households increases, the demand for these services also rises. For example, the model for water demand shows a standardized coefficient of 1.000, indicating a perfect positive relationship between household growth and water demand. Similarly, the coefficient for electricity service connections ($\beta=0.983$, $p<0.05$) and waste collection service demand ($\beta=0.915$, $p<0.05$) reflects strong and significant associations, revealing the impact of expanding low-income settlements on essential urban services. These findings are supported by narrow confidence intervals, which suggest a high level of precision in the estimates.

Table 22: Multiple Linear Regression Models Results

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	T	Sig.	Lower Bound	Upper Bound
1[a]	(Constant)	-.139	.136		-1.024	.330	-.443	.164
	Households	.264	.000	1.000	22538.974	.000	.264	.264
1[b]	(Constant)	1190.694	447.927		2.658	.024	192.650	2188.738
	Households	.375	.039	.951	9.723	.000	.289	.461
1[c]	(Constant)	453.483	204.773		2.215	.051	-2.781	909.746
	Households	.302	.018	.983	17.120	.000	.262	.341
1[d]	(Constant)	229.929	285.318		.806	.439	-405.799	865.657
	Households	.177	.025	.915	7.192	.000	.122	.231
1[e]	(Constant)	.713	.487		1.464	.174	-.372	1.798
	Households	.000	.000	.960	10.870	.000	.000	.001
1[f]	(Constant)	19.398	13.374		1.450	.178	-10.400	49.196
	Households	.013	.001	.960	10.881	.000	.010	.015
1[g]	(Constant)	3450.867	2410.473		1.432	.183	-1920.003	8821.736
	Households	.202	.207	.295	.975	.353	-.260	.664
1[h]	(Constant)	3328.620	2438.096		1.365	.202	-2103.797	8761.038
	Households	.208	.210	.299	.989	.346	-.260	.675
1[i]	(Constant)	5646.967	4317.832		1.308	.220	-3973.762	15267.696
	Households	.500	.371	.392	1.346	.208	-.328	1.328

Source: Author (2024)

On the other hand, services that fall under informal or alternative provisions, such as private waste collection and illegal water connections, showed weaker and statistically insignificant relationships. For instance, the coefficient for private waste collectors ($\beta=0.295$, $p>0.05$) and illegal water connections ($\beta=0.392$, $p>0.05$) indicates minimal and unreliable impacts of household growth on these variables. The wide confidence intervals for these coefficients further suggest substantial variability and lack of precision in the estimates.

In conclusion therefore, these results indicate that rapid urban growth in these low-income settlements leads to significant pressure on formal service delivery systems, such as water and electricity provision, which are highly responsive to household increases. In contrast, informal or unregulated services are less influenced by this growth, possibly due to their dependency on other factors like policy enforcement, or community-level dynamics.

4.5 Spatial Land Changes between 2010 and 2023 in low-income settlements.

To assess the spatial land changes in low-income settlements, 2010 Landsat 7 and 2023 Landsat 8 imagery were used. All collected images had a resolution of 30 meters and were taken in dry season between August and October to reduce the impact of cloud cover on analysis. The six low-income settlement areas which were analysed included 25, 36, 38, 45, 49, and 53. As all areas fall under one imagery scene, the classification of land uses was done on all areas at once. However further analysis was done per area after clipping to settlement areas' extents. Mainly the analysis classified land use changes using the Normalise Difference Build-Up Index into four major categories namely wetlands, vegetation, low-income settlements and bare land, and dense built up. The wetland category combined both surface water bodies and shrubs that grow within these water bodies. Vegetation category combined both trees and grasses, whereas low-income settlements and bare land included all informal and substandard housing areas and bare land which gave a similar spectral signature during analysis due to their light reflectance abilities. To validate the results of the classification process, validation samples were collected from Google Earth imagery for 2010 and 2023. The classification accuracy using the validation samples was done through a confusion matrix.

4.5.1 Normalised Difference Build-Up Index (NDBI)

4.5.1.1 NDBI Accuracy Assessment

The classified image based on the NDBI method for the 2010 imagery achieved an 82 percent accuracy as shown in Table 22. The analysis was able to predict 824 True Positive land use classes samples out of 1000 samples which were collected, which indicated that the NBI correctly predicted the ground conditions. Although the analysis showed very good representation of the ground conditions, the dense built-up classification exhibited a high False Positive condition (52) in the low-income settlements and bare land classes. This was probably due to dust accumulation on building tops in these areas during the time the images were collected (14th October, 2010) which affects the spectral signatures recorded in such areas.

Table 23: NDBI Confusion Matrix for 2010 imagery

Actual	**Predicted**				
	Wetlands	**Vegetation**	**LIS and Bare land**	**Dense Built-up**	**Total**
Wetlands	**220**	10	14	6	250
Vegetation	10	**200**	16	24	250
LIS and Bare land	14	6	**210**	20	250
Dense Built-up	0	4	52	**194**	250
Accuracy is 82%					

Source: Author (2024)

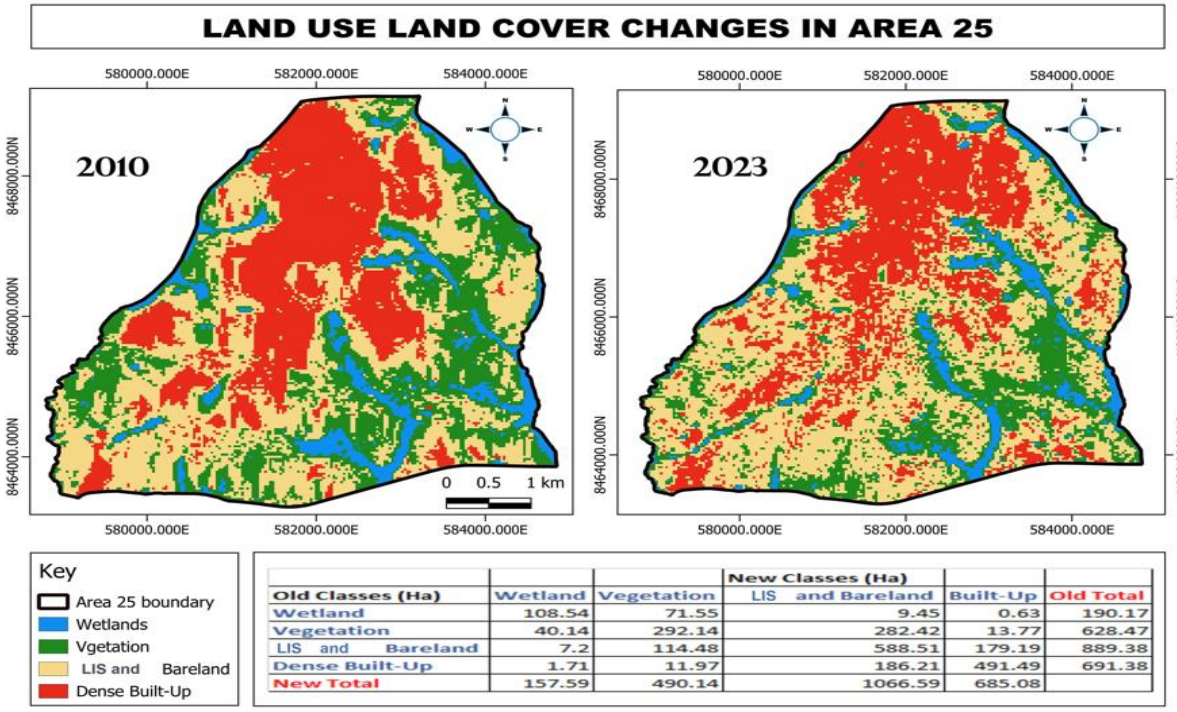
Similar to the confusion matrix for the 2010 imagery's NDBI, the 2023 imagery's NDBI analysis exhibited high accuracy level of 84 percent. Although the analysis showed the index's overall high level of accuracy, more False Positives (36) were also recorded for dense built-up class in the low-income settlements and bare land class as compared to the other classes (Table 23). This was observed to be the case as a result of the same reason as indicated in the 2010's imagery NDBI analysis, since the collected images were also from the same month of October (6th October, 2023) when dust is much visible in the area.

Table 24`: NDBI Confusion Matrix for 2023 imagery

Actual	**Predicted**				
	Wetlands	**Vegetation**	**LIS and Bareland**	**Dense Built-up**	**Total**
Wetlands	**212**	24	14	0	250
Vegetation	26	**192**	22	10	250
LIS and Bareland	8	4	**222**	16	250
Dense Built-up	0	2	36	**212**	250
Accuracy is 84%					

Source: Author (2024)

4.5.2 Land Use Land Cover Changes in Area 25



			New Classes (Ha)		
Old Classes (Ha)	Wetland	Vegetation	LIS and Bareland	Built-Up	Old Total
Wetland	108.54	71.55	9.45	0.63	190.17
Vegetation	40.14	292.14	282.42	13.77	628.47
LIS and Bareland	7.2	114.48	588.51	179.19	889.38
Dense Built-Up	1.71	11.97	186.21	491.49	691.38
New Total	157.59	490.14	1066.59	685.08	

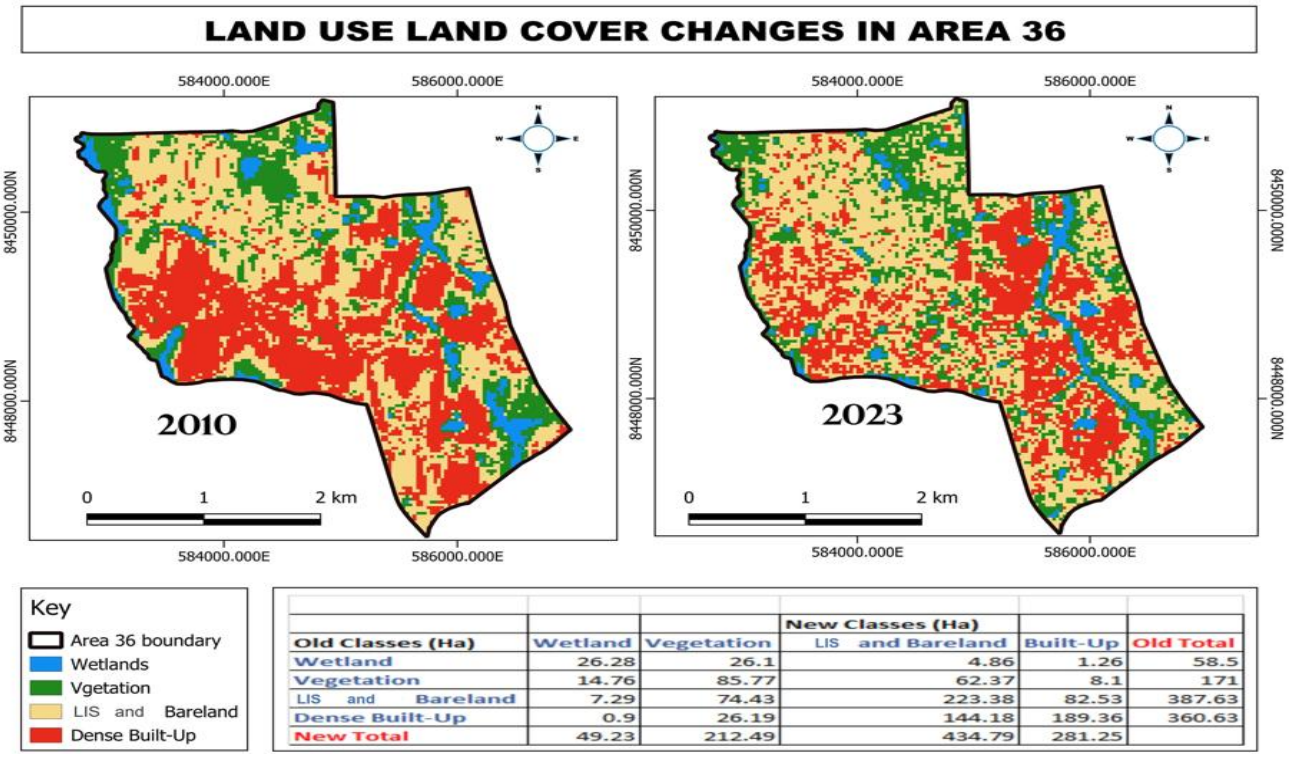
Figure 16: Area 25 Land Cover Maps.

Source: Author (2024)

As Figure 16 shows, between 2010 and 2023, in Area 25 considerable LULC changes occurred. During this period, areas covered by wetlands were reduced from 190.17 hectares to 157.59, while vegetation also declined significantly from a coverage of 628.47 to 490.14 hectares. Although the areas covered by low-income settlements and bare land increased from 889.38 to 1066.39 hectares, a reduction in the dense built up was observed from 691.38 to 685.08. The observed reduction in the dense built-up areas however may not be a true reflection of the dense built-up land use changes as this may be as a result of the influence of misclassification due to dust accumulation on roof tops. As initially revealed in the confusion matrix, moderate misclassification was observed from the dense built-up areas to low-income settlements and bare land. This can also explain the higher increase in the hectarage covered by low-income settlements and bare land. Furthermore, the analysis reveals that the increase in areas covered by low-income settlements and bare land is as a result of more land (282.42 hectares) that has been

converted from vegetation to this class between 2010 and 2023. Overall, the change detection analysis shows that there has been an increase in human settlement in area 25 between 2010 and 2023 as low-income settlements and bare land, as well as dense built up cover a wider area as compared to the other classes.

4.5.3 Land Use Land Cover Changes in Area 36.



Old Classes (Ha)	Wetland	Vegetation	New Classes (Ha) LIS and Bareland	Built-Up	Old Total
Wetland	26.28	26.1	4.86	1.26	58.5
Vegetation	14.76	85.77	62.37	8.1	171
LIS and Bareland	7.29	74.43	223.38	82.53	387.63
Dense Built-Up	0.9	26.19	144.18	189.36	360.63
New Total	49.23	212.49	434.79	281.25	

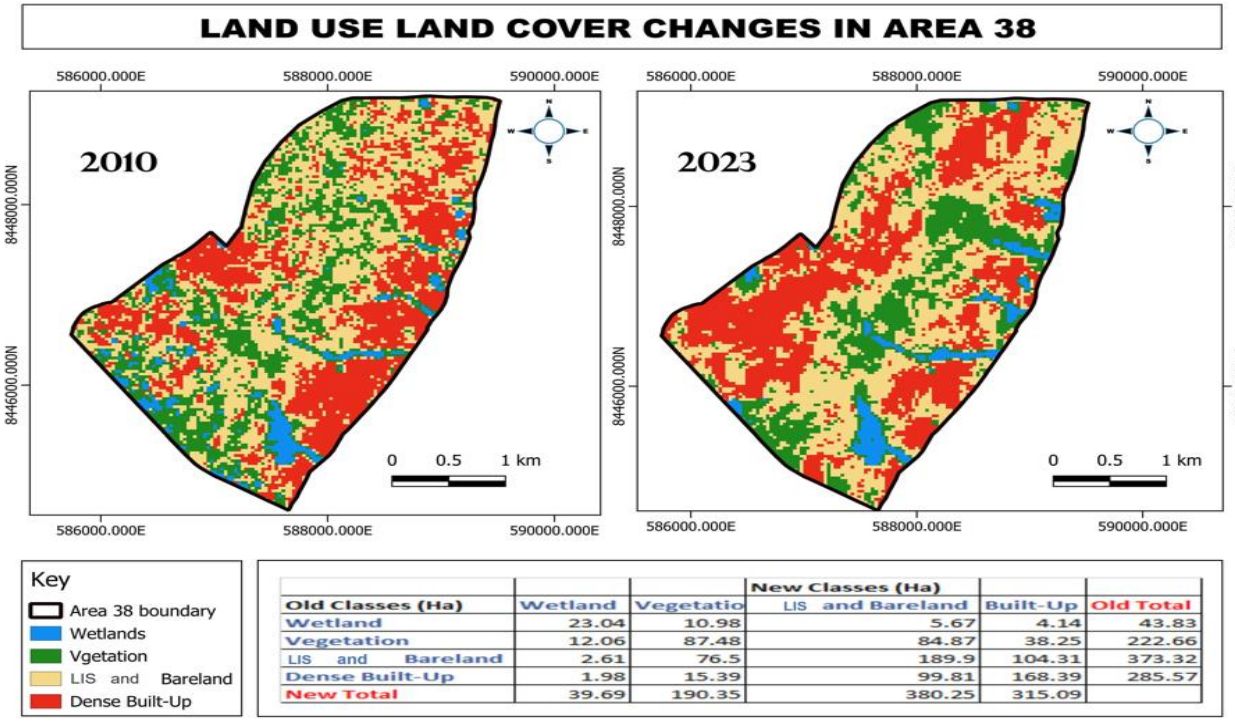
Figure 17: Area 36 Land Cover Maps

Source: Author (2024)

The change detection analysis in Area 36 showed slight different results from the observations in Area 25 (Figure 17). While there was a decrease in vegetation in Area 25, the NDBI shows that vegetated land in Area 36 increased from 171 to 212.49 hectares. The analysis also shows that while vegetation in 2010 was more pronounced in areas around surface water bodies, in 2023 scattered vegetation was observed across the entire area. Despite this increase in vegetation, the analysis also reveals that low-income settlements and bare land have increased more than any other land use in the area from 387.63 to 434.79 hectares, followed by the dense built area which

covers an area of 281.25 hectares. Similar to the results in Area 25, a decrease in the dense built-up area was also observe from 360.63 to 281.25 hectares, mainly due to the same as stipulated in the just preceding section. It is also clear that wetlands in this area have been reduced from 58.5 to 49.23 hectares mainly as a result of their conversion into just vegetated areas (wetland to vegetation was 26.1 hectares). Having looked at the land use change trend in Area 36 therefore, it can be concluded that, between 2010 and 2023 there has been an increase in the areas covered by low-income settlements and bare land, and the dense built-up as compare to any other land use in the area, suggesting an increased rapid urban growth.

4.5.4 Land Use Land Cover Changes in Area 38



			New Classes (Ha)		
Old Classes (Ha)	Wetland	Vegetatio	LIS and Bareland	Built-Up	Old Total
Wetland	23.04	10.98	5.67	4.14	43.83
Vegetation	12.06	87.48	84.87	38.25	222.66
LIS and Bareland	2.61	76.5	189.9	104.31	373.32
Dense Built-Up	1.98	15.39	99.81	168.39	285.57
New Total	39.69	190.35	380.25	315.09	

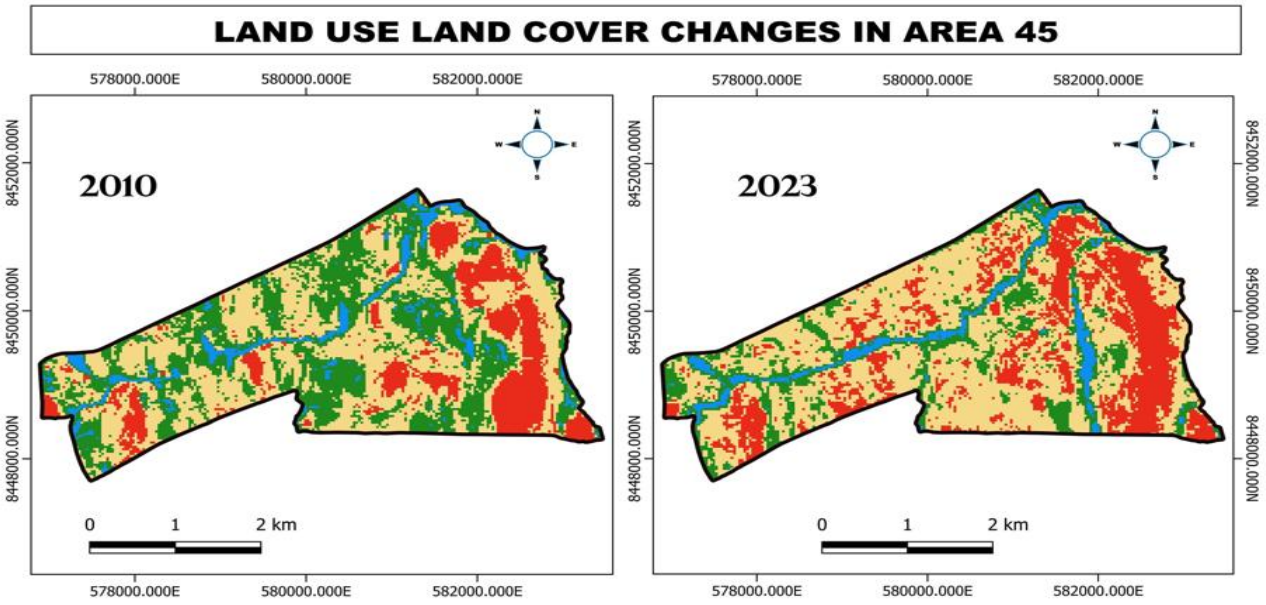
Figure 18: Area 38 Land Cover Maps.

Source: Author (2024)

The land use change detection analysis in Area 38 showed a decrease in both wetlands and vegetation, while an increase was observed in low-income settlements and bare land, as well as dense built-up areas. As shown in Figure 18, areas covered by wetland and vegetation decreased

from 43.83 to 39.69 hectares, and from 222.66 to 190.35 hectares, respectively. The decrease in wetlands was observed to be mainly due to their conversion to general vegetation class (10.98 hectares), whereas the decrease in vegetation was revealed to be mainly as a result of conversion to low-income settlements and bare land class. The analysis reveals that, in general, there has been a sprawl in the area between 2010 and 2023 as low-income settlements and bare land, and built areas have increased from 373.32 to 380.25 hectares, and 285.57 to 315.09 hectares, respectively.

4.5.5 Land Use Land Cover Changes in Area 45



			New Classes (Ha)		
Old Classes (Ha)	Wetland	Vegetatio	LIS and Bareland	Built-Up	Old Total
Wetland	35.82	32.13	14.13	2.25	84.33
Vegetation	28.08	121.77	265.95	42.93	458.73
LIS and Bareland	7.29	78.48	360.27	150.03	596.07
Dense Built-Up	0.09	6.57	61.38	155.97	224.01
New Total	71.28	238.95	701.73	351.18	

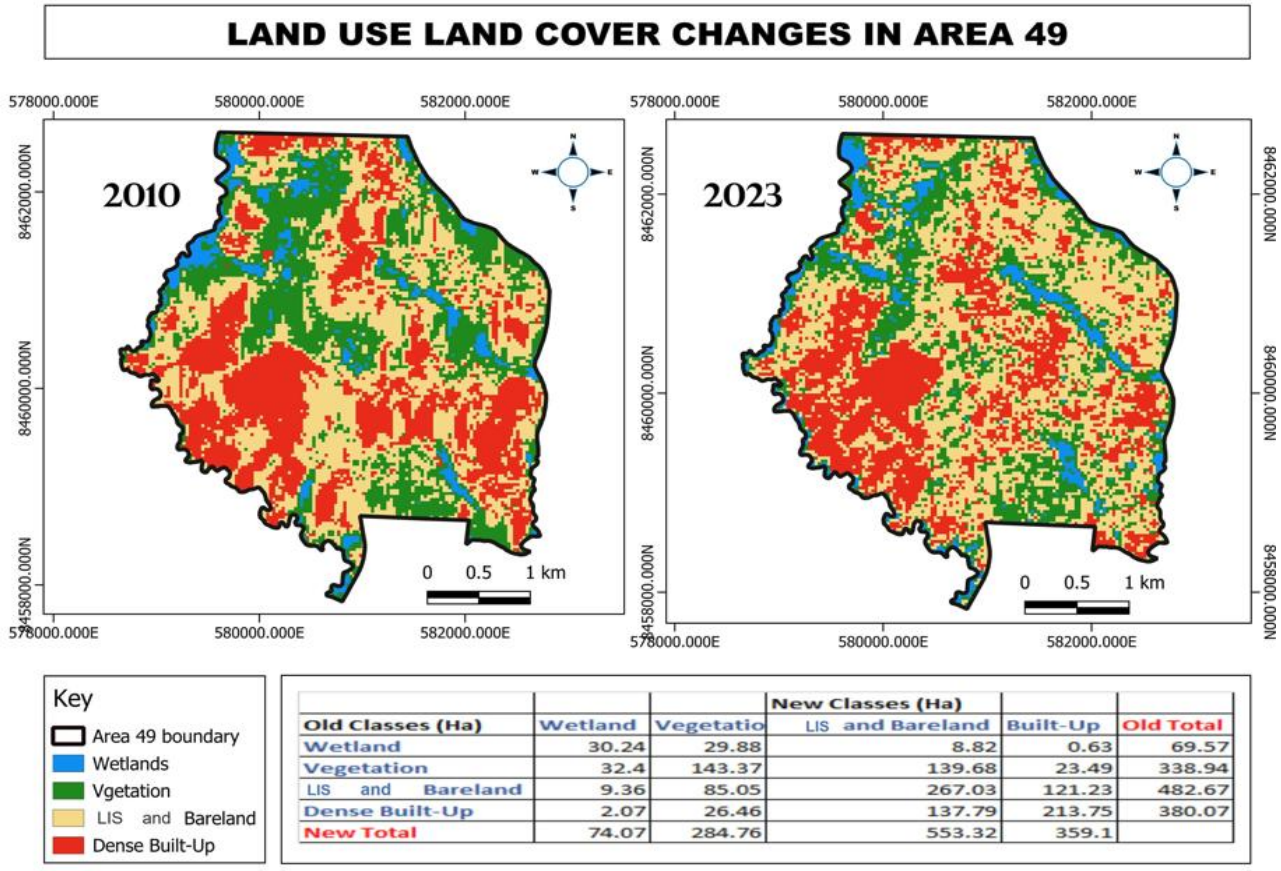
Figure 19: Area 45 Land Cover Maps.

Source: Author (2024)

The land use change detection analysis in Area 45 also showed a similar trend to that of Area 38 (Figure 19). Between 2010 and 2023, both wetlands and vegetation decreased, as the low-income settlements and bare land, as well as dense built-up areas increased in coverage. The wetlands in

the area decreased from 84.33 to 71.28 hectares, while vegetation also decreased from 458.73 to 238.95 hectares. Low-income settlements and bare land on the other hand increased from 596.07 to 701.73 hectares, as dense built-up areas also increased from 224.01 to 351.18 hectares, within the same period. This analysis therefore shows that between 2010 and 2023 Area 45 has also been experiencing an expansion of the low-income settlements.

4.5.7 Land Use Land Cover Changes in Area 49



			New Classes (Ha)		
Old Classes (Ha)	Wetland	Vegetatio	LIS and Bareland	Built-Up	Old Total
Wetland	30.24	29.88	8.82	0.63	69.57
Vegetation	32.4	143.37	139.68	23.49	338.94
LIS and Bareland	9.36	85.05	267.03	121.23	482.67
Dense Built-Up	2.07	26.46	137.79	213.75	380.07
New Total	74.07	284.76	553.32	359.1	

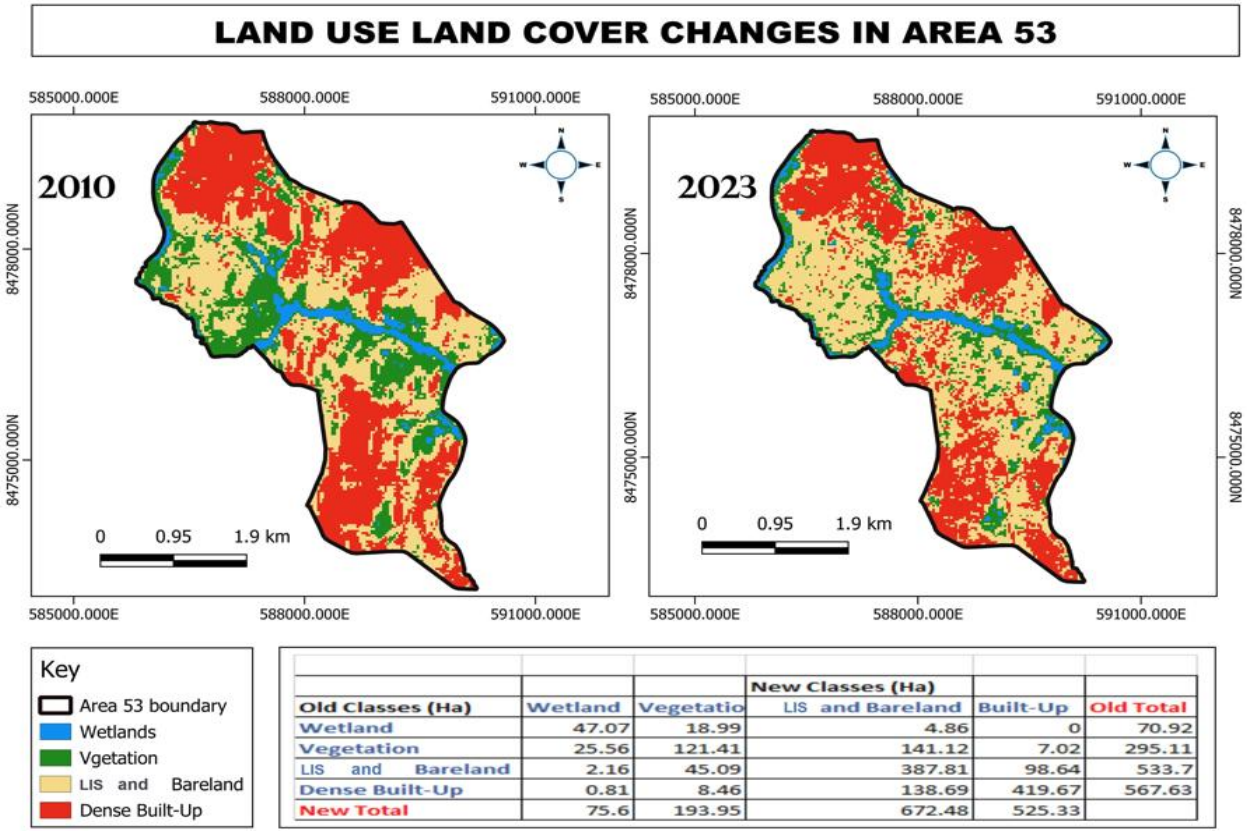
Figure 20: Area 49 Land Cover Maps.

Source: Author (2024)

The land use change detection analysis for Area 49 showed a unique trend. As shown in figure 20, unlike in the other previously discussed areas, in Area 49, there has been an increase in areas covered by wetlands between 2010 and 2023, from 69.57 to 74.07 hectares. However, just like

the in other areas, there has been a decrease in vegetation mainly resulting from the expansion of low-income settlements and bare land, as evidenced by the conversion of 139.68 hectares of vegetation to low-income settlements and bare land. Consequently, the analysis reveals that there has been an increase in low-income settlements and bare land from 482.67 to 553.32 hectares. A decrease in dense built-up areas was also observed in Area 49. However, the analysis in this area also shows that the area has experienced extensive rapid growth of low-income settlements as shown by the combined increase in built up areas.

4.5.8 Land Use Land Cover Changes in Area 53



	New Classes (Ha)				
Old Classes (Ha)	Wetland	Vegetatio	LIS and Bareland	Built-Up	Old Total
Wetland	47.07	18.99	4.86	0	70.92
Vegetation	25.56	121.41	141.12	7.02	295.11
LIS and Bareland	2.16	45.09	387.81	98.64	533.7
Dense Built-Up	0.81	8.46	138.69	419.67	567.63
New Total	75.6	193.95	672.48	525.33	

Figure 21: Area 53 Land Cover Maps.

Source: Author (2024).

Finally, land use land cover change detection analysis was also performed on Area 53 between the same years, 2010 and 2023. As Figure 21 shows, the land use land cover change trend in this

area were similar to those of Area 49, such that there was an increase in wetlands, and low-income settlements and bare land, and a decrease in vegetation, as well as dense built-up areas. Areas covered by wetlands increased from 70.92 to75.6 hectares, while low-income settlements and bare land increased from 533.7 to 672.48 hectares. The decrease in vegetation in this area was also attributed to the conversion more vegetated land (141.12 hectares) into land covered by low-income settlements and bare land. Areas covered by dense built-up in Area 53 decreased from 567.63 to 525.33 hectares. However, the decrease in the area covered by dense built-up environment may be as a result of the misclassification errors as earlier indicated in this specific objective. Like all the other areas analysed, the overall land us change detection shows an increase in the built-up area between 2010 and 2023. The increase in the areas covered by low-income settlements also indicated increased sprawl of low-income settlements in the area

4.5.9 Chapter conclusion

The chapter presented results on assessment of the drivers of rapid growth of low-income settlements in Lilongwe City, analysis of the impact of rapid growth of low-income settlements on delivery of water, electricity and solid waste management services in Lilongwe City, and assessment of the spatial land use and land change between 2010 and 2023 in low-income settlements.

CHAPTER FIVE: DISCUSSION

5.1 Introduction

This chapter discusses the results of the study and concentrated on the objectives of the study which included to assessment of drivers of rapid growth of low-income settlements in Lilongwe City, analysis of the impact of rapid growth of low-income settlements on delivery of water, electricity and solid waste management services in Lilongwe City and assessment of spatial land changes between 2010 and 2023 in low-income settlements.

5.2 Drivers of rapid growth of low-income settlements in Lilongwe City.

The findings of this study have revealed the dynamics of driving rapid urban growth in Lilongwe City. It reveals that rapid urban growth, characterized by the expansion of low-density, fragmented development on the periphery of urban areas, is a complex phenomenon influenced by various economic, social, and cultural factors.

The analysis has shown that economic factors are significant predictors of rapid urban growth in low-income settlements in Lilongwe city. The logistic regression analysis indicated that household income plays a critical role, with higher annual incomes associated with increased likelihood of moving to peripheral areas, a finding which is consistent with findings by Wu (2010), who argued that rising incomes enable households to afford larger plots of land, often available at lower costs in suburban and peri-urban areas. Similarly, the perception of cheap land in Lilongwe's periphery is a critical driver, reflecting trends observed globally where affordable housing and land attract populations to urban fringes (Ogra and Onatu, 2024). The study also found that a significant portion of respondents indicated a preference for peri-urban locations due to opportunities for agricultural activities.

This finding aligns with studies of Rohit *et al.,* (2018) which revealed that in most developing countries which depend on agriculture as their main source of income, urban agriculture in the peripheries prompts people to move towards where more land is available. In regions like Lilongwe, where agriculture remains a primary source of income for many, access to large land

parcels for farming therefore drives the expansion of settlements into peri-urban zones (Manda, 2015).

Adding to the stipulated drivers, this study also identified land governance structures, including land allocations by local chiefs, as well as social cultural factors as notable driver of rapid urban growth in low-income settlements. Customary land tenure systems, prevalent in Malawi, facilitate the acquisition of large plots, often without strict regulatory conditions. This finding is in agreement with Koroso & Zevenbergen (2024), who highlighted the role of informal land markets and weak planning frameworks in enhancing rapid urban growth in Ethiopia and many other African cities. Lilongwe's matrilineal land inheritance system also contributes to urban expansion (Zidana and Luka, 2023). The study found that land inheritance by women, who represented the majority of respondents, supports the expansion of settlements on the periphery. This trend mirrors observations in other matrilineal societies, where land transfer practices influence settlement patterns (Villamor *et al.,* 2015). Accordingly, the Smart growth theory promotes zoning laws, restriction on development, and environmental impact assessments, all of which lead to sustainable urban planning. These tools help manage urban growth, protect community interests, and improve service delivery.

5.3 Impact of rapid growth of low-income settlements on service delivery.

The rapid growth of low-income settlements has significantly impacted service delivery in the study area. This has mainly been due to a doubling in the number of households and population between 2010 and 2023. The findings indicate that areas such as Dzenza and Westernby-pass experienced the most growth due to road infrastructure improvements and enhanced accessibility to utility services such as electricity and piped water. Contrary to these areas, the research shows that locations like Lumbadzi have limited expansion due to limited land availability for expansion. These spatial differences reveal the realities of how local conditions shape settlement growth and service demand. These findings were found to be in agreement with Parienté (2017) who also found that the introduction of basic utility services such as water and electricity into an area tend to encourage people and businesses to relocate to such areas. Tong et al., (2021) and Tong et al., (2020) also revealed that land ownership in cities and towns tend to influence

patterns of settlements expansion as is the case in Lumbadzi where more areas are owned by industries and companies that cannot sell their land to low-income settlers. The Smart Growth theory encourages compact and mixed use development to ensure easy access to services instead of haphazard developments which raises the demand for services.

The expansion of low-income settlements has directly translated into increased demand for essential services, with water and waste collection being the most affected, from 9.967m³/day in 2010 to 178.90m³/day in 2023 and 19.88tonnes/day in 2010 to 38.08tonnes/day in 2023. respectively. The study revealed a significant increase in water demand and service connections, particularly in rapidly growing areas like Katete Farm, which saw a near doubling of demand. However, areas with slower growth, such as Lumbadzi, experienced minimal changes. These trends are consistent with findings from other urban studies which link population growth in underserved areas to increased utility demands, often resulting in system strain (Gonzales & Ajami, 2017; Salazar *et al*., 2020). Additionally, illegal water connections, most prevalent in Lumbadzi, reflect the inadequacy of formal service expansion as also stipulated by Cheng, (2014)., posing significant management challenges.

The electricity consumption also showed a marked increase over the study period, but the demand for new electricity connections did not rise proportionately. This disparity suggests that while usage expanded among existing consumers, infrastructural or financial barriers may have hindered new service uptake. Similar observations have been documented in other studies, where affordability and policy limitations restrict equitable access to energy services despite growing need (Winkler *et al.,* 2011). Meanwhile, waste generation significantly increased alongside a rising demand for waste collection services, indicating the essential role of municipal waste management in sustaining urban health and hygiene.

Finally, the regression analysis demonstrated strong correlations between household growth and formal service demand, while informal or alternative service systems showed weaker relationships. This indicate the challenges posed by unregulated systems in low-income urban settings, where demand for formal services is clear and quantifiable, but informal solutions remain unpredictable as stipulated by Winkler *et al.,* (2011). In an urban planning study by

Przybysz *et al.,* (2024), he reveals that such dynamics as revealed by the regression analysis show the importance of integrated urban planning and investment to accommodate future growth sustainably. The study therefore reveals the critical need for targeted policy interventions to address the differences in service provision and enhance the resilience of urban infrastructure.

5.4 Spatial Land Changes between 2013 and 2023 in low-income settlements.

The findings of this study indicate very significant land use and land cover (LULC) changes across the six low-income settlements between 2010 and 2023 (The built-up areas expanded by 3,028.54 hectares, while vegetation decreased by 1,723 hectares, and bare land declined by 490 hectares). This is consistent with global trends of urban expansion in rapidly developing regions. The application of the Normalized Difference Build-Up Index (NDBI) also demonstrated robust performance in detecting urban growth, which aligns with earlier studies that have utilized NDBI and remote sensing methods to monitor rapid urban growth and its environmental impacts (Wang *et al.,* 2017) .

The LULC change detection analysis reveals a consistent increase in low-income settlements and bare land areas across all settlements. For example, in Area 25, low-income settlements and bare land expanded by 177 hectares, which was accompanied by a decline in vegetation and wetlands. Such observed patterns are found to be in line with findings by Nguyen *et al.,* (2020), who documented urban expansion as a major driver of vegetation and wetland loss in developing regions. Tumwesigye *et al.,* (2021) also stipulate that such changes are often driven by socio-economic pressures, including population growth and rural-to-urban migration, resulting in the expansion of informal settlements as seen in most sub-Saharan Africa. The notable decline in vegetation across areas such as Area 25 and Area 45 also echoes similar trends identified by Muchelo *et al.,* (2024), who found that unplanned urban growth typically comes at the expense of green cover and ecological balance.

The results of this study also show that in many parts of the study area, except in Areas 49 and 53, the expansion of low-income settlements has resulted into reduction of wetlands. The observed wetland land cover trend supports the findings of Asante *et al.,* (2024) who noted that wetland dynamics in urban settings are often shaped by both human activity and ecological

processes. While anthropogenic activities such as the encroachment of wetlands due to the expansion of low-income settlements may result into the reduction of wetland, (Asante *et al.*, 2024) argues that changes in climatic patterns, such as those related to increased precipitation do also enhance the expansion of wetlands.

The observed widespread increase in low-income settlements and bare land in all six areas reflects the broader trend of unplanned urban growth in low-income settlements, which are normally driven by rapid urbanization and limited housing infrastructure. This finding concurs with the research from Tumwesigye *et al.*, (2021), which shows that informal settlements often expand faster than formal urban development due to socio-economic constraints. Such growth often leads to increased demand for services such as water, electricity and waste collection. The increase in dense built-up areas observed in several study locations is also reflective of findings by Wang *et al.*, (2020), who noted that rapid urban growth often involves both horizontal and vertical growth, resulting in increased population density and pressure on urban resources/services.

5.6 Chapter conclusion

This chapter discussed the study results on the drivers of rapid growth of low-income settlements in Lilongwe City, impact of rapid growth of low-income settlements on service delivery in Lilongwe City, and spatial changes over a period of 13 years in Lilongwe City. The next chapter concludes the study and makes recommendations.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter provides the conclusions and recommendations of the study: *Assessing the Impact of Rapid Growth of Low-Income Settlements on Service Delivery in Lilongwe City, Malawi*. Recommendations are made to address rapid growth of low-income settlements and improve service delivery.

6.2 Conclusion of the study

The study identified annual income, land cost perceptions, and agricultural land preferences as key drivers of low-income settlement growth, explaining 63.7% of the variability (Nagelkerke R^2 = 0.637). Subsequent to the changes in household numbers, a strong correlation was observed between increased household numbers and increased service demand for water (r = 1.0), electricity (r = 0.983), and waste collection (r = 0.915). Statistical analyses also showed significant impacts of rapid urban growth on service delivery (ANOVA F-statistic = 231.24, p = 0.000). Approximately 65.6% of respondents in areas 25, 36, 38, 45, 49, and 53 reported an increase in lack of access to water, electricity, and solid waste collection services.

The study showed that over a 13-year period, the population in low-income settlements increased significantly from 166,132 to 301,567, with household numbers doubling from 37,757 to 68,538. At the same time, built-up areas expanded by 3,028.54 hectares, while vegetation decreased by 1,723 hectares, and bare land declined by 490 hectares.

6.2.1 Drivers of Rapid Growth of Low-Income Settlements on Service Delivery

The study has found that the expansion of low-income settlements is driven by economic, social, and cultural factors, including affordable land on the periphery, agricultural opportunities, and weak land governance frameworks. It has also revealed that customary land tenure systems and matrilineal inheritance practices have further enhanced rapid urban growth, enabling the expansion of settlements without stringent regulatory controls.

6.2.2 Impact of Rapid Growth of Low-Income Settlements on Service Delivery

The doubling of households and population between 2010 and 2023 in the study area has strained essential services of water supply, waste management, and electricity distribution. For instance, rapidly growing areas like Katete Farm have witnessed increased demand for water and waste collection, while slower-growing areas like Lumbadzi face challenges such as illegal water connections. The study has also found that electricity consumption in the all areas under study has risen, although infrastructural and financial barriers hinder equitable access to new connections. Finally, the research has found that waste generation has also surged, outpacing municipal collection capacity and exacerbating hygiene concerns.

6.2.3 Spatial Land Changes between 2010 and 2023

The spatial analyses have revealed significant land use and land cover changes, including the expansion of low-income settlements and bare lands at the expense of vegetation and wetlands. These changes align with global trends in rapid urban growth in low-income settlements but present unique challenges for Lilongwe City, such as loss of wetlands and ecological degradation.

6.3 Recommendations

The following recommendations are suggested:

6.3.1 Drivers of rapid growth of low-income settlements.

- The Lilongwe city council should strengthen land governance systems by formalizing low-income settlements, customary land tenure and integrating it into urban planning frameworks as stated in the Land Act of 2016.

6.3.2 Impact of rapid growth of low-income settlements on service delivery.

- The is need to expand water supply, electricity and waste management infrastructure in rapidly growing low-income settlements to meet rising demand as envisaged in the Malawi 2063 blueprint.

6.3.3 Spatial Changes to determine rapid growth in low-income settlements.

- As envisaged by the Lilongwe Urban Structure of 2010 and the Physical Planning Act (Amendment) of 2022 the Lilongwe City Council should enforce zoning and development control regulations in low-income settlements to avoid uncontrolled rapid urban growth.

6.3.4 Future Studies

- Researchers must study how the declaration of the whole country as a planning area in the Physical Planning Act (Amendment) of 2022 will help in combating uncontrolled urban development.

- Researchers must study the effectiveness of regulations to control rapid growth of low-income settlements.

6.4 Chapter conclusion

The chapter presented the study conclusion and recommendations.

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APPENDICES

Appendix 1: Questionnaire for Residents and Local Leaders

Mzuzu University

Faculty of Environmental Sciences

(Department of Built Environment)

I am Obvious Nyirenda, a Master of Science Student in Urban and Regional Planning at Mzuzu University (MZUNI). I am conducting a study on the "Impact of Rapid Growth of Low-Income Settlements on Service Delivery in Lilongwe City". The purpose of this questionnaire is to collect related data to the research topic aforementioned. Be assured that any data collected will be kept confidential, will be stored and used for academic purposes only. Aggregate results shall be used to write a paper to be presented to the Mzuzu University. No names of participants in part/full shall be appear in the final write up.

Section I - General Information

i. What category of age are you?

[1]	[2]	[3]	[4]	[5]	[6]
18 - 30	31 – 40	41 - 50	51 - 60	61 - 70	80 +

ii. What is your gender?

[1]	[2]
Male	Female

iii. What is your occupation?

[1]	[2]	[3]	[4]	[5]	[6]
Retired	Unemployed	Fulltime	Part-time	Self Employed	Business

iv. What is your level of education?

[1]	[2]	[3]	[4]	[5]
None	MSCE	Diploma	Degree	Post Graduate

v. What is your average annual income?

[1]	[2]	[3]	[4]	[5]
500,000+	1000,000+	1,500,000+	2000,000+	2500,000+

vi. Why do you prefer living in the area?

[1]	[2]	[3]	[4]	[5]

Land Cheap	Agriculture	Available Service	No Rates	Other

vii. How long have you stayed in this area?

[1]	[2]	[3]	[4]	[5]
Less than 5 years	5 years +	10 years +	15 years +	20 years +

viii. Before staying here where else did you stay?

[1]	[2]
Within City (can mention location)	Outside Lilongwe (can mention district or other city

ix. What are the advantages of living outside the City?

_____

x. What challenges do you experience living outside the City?

_____

Section II - Land Access

xi. Where did you buy the land from?

[1]	[2]	[3]	[4]	[5]
Local Chiefs	City Council	Government	Estates Agents	Other

xii. What is the size of your land?

[1]	[2]	[3]	[4]	[5]
0 - 500m²	500m² - 1000m²	1000m² - 2000m²	2000m² - 3000m²	3000m² +

xiii. What was the cost of land/acre?

[1]	[2]	[3]	[4]	[5]
-5,00,000	500,000 – 1 million	1- 2 million	2 – 3 million	3 million +

SERVICES

xiv. Which services are you connected to?

[1]	[2]	[3]	[4]	[5]
Water	Electricity	Road	Sewer	Other

xv. If not connected, why are you not connected to services?

[1]	[2]	[3]
Expensive	Not Available	Other

xvi. How do you compensate for the unprovided services?

[1]	[2]	[3]	[4]
Solar	Borehole	Pit latrine	Other

3. Services Delivery level of satisfaction

xvii. Which is better for you when you have no services to live inside the city or outside

[1]	[2]	[3]
better outside	better inside	Other

If other please explain……..

xviii. Which is better for you when you have services to live inside the city or outside?

[1]	[2]	
better outside	better inside	

Why? _____

xix. Is there increased household expenditure due to lack of services?

[1]	[2]
Yes	No

xx. What are effects of developments outside the City on service delivery in the City e.g. water, power, etc

_____

xxi. Are you satisfied with the service delivery offered to you?

[1]	[2]	[3]
Satisfied	Not Satisfied	Other

xxii. Are the services easily provided when requested for?

[1]	[2]
Yes	No

xxiii. Is the cost of services higher in the outskirts than within the City? (For those who have lived both in and outside the City).

[1]	[2]	[3]	[4]	[5]
Not Cheap	Cheap	Expensive	Affordable	Other

xxiv. What are your recommendations to ensure provision of services?

_____

xxv. Do you think the settlement here is developed to ensure easy access to services?

[1]	[2]	[3]
Yes	No	Other

Do you have any views on how Lilongwe city can grow or provide services better……...……
……

Appendix 2: Questionnaire for Service Providers

Mzuzu University

Faculty of Environmental Sciences

(Department of Built Environment)

I am Obvious Nyirenda, a Master of Science Student in Urban and Regional Planning at Mzuzu University (MZUNI) and currently conducting a research titled "Assessing the Impact of Rapid Growth of Low-Income Settlements on Service Delivery in Lilongwe City". The purpose of this QUESTIONNAIRE is to collect related data to the research topic aforementioned. Be assured that any data collected will be kept confidential, will be stored and used for academic purposes only. Aggregate results shall be used to write a paper to be presented to the Mzuzu University. No names of participants in part/full shall be appear in the final write up.

Section I - General Information

i. Which age category are you in?

[1]	[2]	[3]	[4]	[5]	[6]
18 - 30	31 – 40	41 - 50	51 - 60	61 - 70	80 +

ii. Respondent's Gender?

[1]	[2]
Male	Female

iii. What is your profession?

[1]	[2]	[3]	[4]
Town Planner	Engineer	Administrator	Other

iv. What is your level of education?

[1]	[2]	[3]	[4]	[5]
None	MSCE	Diploma	Degree	Post Graduate

v. What is your position in the organization?

_____

vi. When did you start working here?

[1]	[2]	[3]	[4]	[5]
5 years +	10 years +	15 years +	20 years +	years +

Section II – Land Access

i. How long does it take to acquire land?

[1]	[2]	[3]	[4]	[5]
2 months	6 months	12 months	24 months	36 months +

ii. What are the steps of acquiring land?

_____

iii. What is the average cost of land per square meter in the City?

[1]	[2]	[3]	[4]	[5]
Less than 5000	5 - 10000	10,000 – 20,000	20,000 – 30,000	30,0000 +

iv. How long does it take to acquire a tittle deed?

[1]	[2]	[3]	[4]
Less than 1 year	1 year	2 years	2 years +

Section II – Effects of Rapid Growth

i. Is rapid growth a threat to efficient provision of services in the City?

[1]	[2]
Yes	No

Explain: _____

ii. What is the average cost of service for people within the City compared to those outside the City/ or in the fringe of the City?

[1]	[2]	[3]	[4]
Less than 50,000	50 – 100,000	100,000 – 200,000	200,000 +

iii. What are the effects of rapid growth on service delivery to residents within Lilongwe City?

[1]	[2]	[3]	[4]
Lack of Services	Depletion of Forest	No Social Cohesion	Other

a. What are the factors leading to rapid growth of low-income settlements?

[1]	[2]	[3]	[4]
Cost of Land	Population Growth	High Rates	Other

iv. Do you agree that urbanisation, rural-urban migrations, population growth are the major drivers affecting service delivery?

[1]	[2]
Yes	No

Explain: _____

v. Some say providing services to the low-income settlements encourages rapid growth of the City? What is your view

_____

vi. Do you have any regulations on services to residents outside the City?

_____

vii. Would it be cheaper to provide services in a well-planned and compatible City?

[1]	[2]
Yes	No

Explain: _____

Section III – Effects of Rapid Growth of Low-Income Settlements

i. What are possible ways to lower the cost-of-service provision?

_____

j. What are your plans to ensure that the majority of residents are provided with services?

_____

k. What are your solutions to prevent rapid growth of low-income settlements?

_____

l. Do you think change of laws to prevent rapid growth of low-income settlements will help reduce provision of service delivery?

_____

Do you have any further questions or comments:

_____

Appendix 3: Questionnaire Cover Letter

TO WHOM IT MAY CONCERN

Date: October 2022

Data Collection for an Academic Research Study

The researcher is a student pursuing a Master of Science in Urban and Regional Planning with the Mzuzu University and is currently carrying out an academic research Title "Assessment of the Impact of Rapid Growth of Low-Income Settlements on Service Delivery in Lilongwe City'.

Your area has been selected for data collection through assess challenges of service delivery and its impacts on the City of Lilongwe. You have been selected to provide this information by answering the question in the questionnaire attached. The information obtained will be used for this particular purpose and your right not to answer this questionnaire or any part of it is reserved. It is estimated that the questionnaire may take ten (10) to fifteen (15) minutes to complete.

Please do not hesitate to contact the Researcher in case of any clarifications required and your favourable response to this questionnaire will be appreciated.

Yours Faithfully

Obvious Nyirenda
(Researcher)

Appendix 4: Ethical Approval Letter

MZUZU UNIVERSITY

DIRECTORATE OF RESEARCH

Mzuzu University
Private Bag 201
Luwinga
Mzuzu 2
MALAWI
TEL: 01 320 722
FAX: 01 320 648

MZUZU UNIVERSITY RESEARCH ETHICS COMMITTEE (MZUNIREC)

Ref No: MZUNIREC/DOR/22/78 **17/08/22**

Obvious Nyirenda,
Mzuzu University,
P/Bag 201,
Mzuzu.
obviousnyirenda11@gmail.com

Dear Obvious Nyirenda,

RESEARCH ETHICS AND REGULATORY APPROVAL AND PERMIT FOR PROTOCOL REF NO: MZUNIREC/DOR/22/78: ASSESSING THE IMPACTS OF URBAN SPRAWL ON SERVICE DELIVERY IN LILONGWE CITY

Having satisfied all the relevant ethical and regulatory requirements, I am pleased to inform you that the above referred research protocol has officially been approved. You are now permitted to proceed with its implementation. Should there be any amendments to the approved protocol in the course of implementing it, you shall be required to seek approval of such amendments before implementation of the same.

This approval is valid for one year from the date of issuance of this approval. If the study goes beyond one year, an annual approval for continuation shall be required to be sought from the Mzuzu University Research Ethics Committee (MZUNIREC) in a format that is available at the Secretariat. Once the study is finalised, you are required to furnish the Committee with a final report of the study. The Committee reserves the right to carry out compliance inspection of this approved protocol at any time as may be deemed by it. As such, you are expected to properly maintain all study documents including consent forms.

Wishing you a successful implementation of your study.

Committee Address:
Secretariat, Mzuzu University Research Ethics Committee, P/Bag 201, Luwinga, Mzuzu 2; E-mail address: mzunirec@mzuni.ac.mw

Yours Sincerely,

Gift Mbwele

SENIOR RESEARCH ETHICS ADMINISTRATOR

For: CHAIRMAN OF MZUNIREC

Appendix 5: Consent Form

Mzuzu University Research Ethics Committee (MZUNIREC)

Informed Consent Form for Research Titled

Assessing the Impact of Rapid Growth of Low-Income Settlements on Service Delivery in Lilongwe City

Introduction

I am **Obvious Nyirenda** from **Mzuzu University**. I am doing research on **Assessing the Impact of Rapid Growth of Low-Income Settlements on Service Delivery in Lilongwe City.** This consent form may contain words that you do not understand. Please ask me to stop as we go through the information and I will take time to explain. If you have questions later, you can ask them of me or of another researcher.

Purpose of the research

This research aim is to assess the impact of rapid growth of low-income settlements on service delivery in Lilongwe City.

Type of Research Intervention

This research will involve your participation as an individual interview.

Participant Selection

You are being invited to take part in this research because you are part of the live in the area falling within the research study.

Voluntary Participation

Your participation in this research is entirely voluntary. It is your choice whether to participate or not. If you choose not to participate, nothing will change. You may skip any question and move on to the next question.

Duration

The research takes place for a period of **One Year**.

Risks

You do not have to answer any question or take part in the discussion/interview/survey if you feel the question(s) are too personal or if talking about them makes you uncomfortable.

Reimbursements

You will not be provided with any incentive to take part in the research.

Sharing the Results

The knowledge that we get from this research will be shared with you and your community before it is made widely available to the public. Following, we will publish the results so other interested people may learn from the research.

Who to Contact

If you have any questions, you can ask them now or later. If you wish to ask questions later, you may contact Mr. Obvious Nyirenda on 0999362442 or Email obviousnyirenda11@gmail.com or obvious.nyirenda@lcc.mw

This proposal has been reviewed and approved by Mzuzu University Research Ethics Committee (MZUNIREC), a committee whose task is to make sure that research participants are protected from harm. If you wish to find out more about the Committee, contact Mr. Gift Mbwele, Mzuzu University Research Ethics (MZUNIREC) Administrator, Mzuzu University, P/Bag 201, Luwinga, Mzuzu 2, Phone: 0999404008/0888641486

Do you have any questions?

Part II: Certificate of Consent

I have been invited to participate in research about assessing the impact of rapid growth of low-income settlements on service delivery in Lilongwe City.

I have read the foregoing information, and/or it has been read to me. I have had the opportunity to ask questions about it, and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study

Print Name of Participant_____

Signature of Participant _____

Date _____

Day/month/year

If illiterate [1]

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print name of witness_____ **Thumb print of participant**

Signature of witness _____

Date _____

Day/month/year

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the potential participant and to the best of my ability, made sure that the participant understands the research project. I confirm the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Signature of Researcher /person taking the consent_____

Date _____

Day/month/year

_____

A literate witness must sign (if possible, this person should be selected by the participant and should have no connection to the research team). Participants who are illiterate should include their thumb print as well.

Appendix 6: Checklist

Checklist for Service Delivery Organisations

No.	Issue	Yes	No	Comment
1.	How has rapid growth of low-income settlements affected the delivery of services provided by your organization?			
2.	Are you facing any challenges in reaching areas that are further away from the city center due to rapid growth of low-income settlements?			
3.	Have you had to make any changes to your service delivery model to accommodate the increasing demand from suburban areas?			
4.	Have you noticed any changes in the types of services required in suburban areas compared to urban areas?			
5.	Does rapid growth of low-income settlements impact the cost and efficiency of delivering services to these areas?			
6.	Have you noticed any differences in the attitudes and expectations of customers in suburban areas compared to urban areas?			
7.	Are there any specific areas in Lilongwe that you feel are particularly impacted by rapid growth of low-income settlements and why?			
8.	Are you able to manage coordination and communication with other service providers in suburban areas to ensure seamless service delivery?			
9.	Have you noticed any changes in the infrastructure			

	or resources available in suburban areas that may impact service delivery?			
10.	Are there any suggestions or recommendations you would like to make to improve the delivery of services in suburban areas?			
11.	Are there any initiatives or programs in place to improve service delivery in areas affected by rapid growth of low-income settlements?			
12.	How has the local government addressed the challenges posed by rapid growth of low-income settlements on service delivery in your area?			
13.	Has the cost of services delivery increased or decreased due to rapid growth of low-income settlements?			

Appendix 7 – Key Informant Table

No.	Organization	Position	Date of Interview
1.	ESCOM	Regional Manager	23 February 2023
2.	Lilongwe Water Board	Deputy Director of Operations and Distribution	24 February 2023
3.	Lilongwe City Council	Chief Sewerage Engineer	25 February 2023
4.	Lilongwe City Council	Director of Planning and Policy Development	25 February 2023
5.	Area 25	Block Leader Area 25	19 October 2022
6.	Area 36	Block Leader Area 36	19 October 2022
7.	Area 38	Block Leader Area 38	19 October 2022
8.	Area 45	Block Leader Area 45	19 October 2022
9.	Area 49	Block Leader Area 49	19 October 2022
10.	Area 53	Block Leader Area 53	19 October 2022
11.	Area 25	Cllr. Maloni Chathewa	19 October 2022
12.	Area 36	Cllr. Ganizani Thawani	19 October 2022
13.	Area 38	Cllr. Joe Katalama	19 October 2022
14.	Area 45	Cllr. Samuel Beni	19 October 2022
15.	Area 49	Cllr. Ruth Njirayafa	19 October 2022
16.	Area 53	Cllr. Bishanti Chiombe	19 October 2022

Appendix 8: Letter of Consent: Lilongwe City Council

PLANNING & DEVELOPMENT

Your Ref:

Our Ref: LCC/PLAN/ADMIN/2

LILONGWE CITY COUNCIL
P.O. Box 30396
Lilongwe 3
MALAWI
Cell: +265 (0) 999964225

05th August 2022

Mr. Obvious Nyirenda,
P.O. Box 30396,
Lilongwe 3.

Dear Sir,

RE: PERMISSION TO PROCEED WITH RESEARCH STUDY.

We acknowledge receipt of your letter on the above subject matter.

We write to advise that the Council has no objection to your request to carry out research on assessing the impact of urban sprawl on service delivery in Lilongwe City.

We wish you all the best in your research.

Yours faithfully,

Hilary Kamela
DIRECTOR OF PLANNING AND DEVELOPMENT
FOR: CHIEF EXECUTIVE OFFICER.