



College of Science and Technology
School of Architecture and Built Environment

*MSc in Geo-Information Science for Environment and Sustainable
Development*

**IMPACTS OF UNPLANNED SETTLEMENT GROWTH IN THE
PERI-URBAN AREAS OF KIGALI CITY, CASE OF SHYORONGI
SECTOR IN RULINDO DISTRICT**

Thesis submitted to the University of Rwanda: College of Science and Technology in partial fulfilment of the requirements for the award of the Degree of Master of Science in Geo-Information for Environment and Sustainable Development.

Presented by: NSABIMANA Jean

Reg N°: 219014313

Supervisor:

Ass. Prof. NIYONZIMA Theophile

Kigali, June 2024

DECLARATION

I, **NSABIMANA Jean**, hereby declare that I wrote this thesis myself and it has never been submitted to any other institution.

NSABIMANA Jean

Signature:

Date: / /

APPROVAL

It is hereby confirmed that this thesis entitled “**Impacts of unplanned settlement growth in the peri-urban areas of Kigali city, case of Shyorongi sector in Rulindo District**” submitted by **NSABIMANA Jean** has been assessed and accepted by the post-graduate coordination team in the school of Architecture and Built Environment.

- **Supervisor**

Ass. Prof. NIYONZIMA Theophile

Signature:

Date: / /

- **Post-graduate coordinator**

Dr. UWAYEZU Ernest

Signature:

Date: / /

- **Dean of School of Architecture and Built Environment**

Dr. MALONZA Josephine

Signature:

Date: / /

ACKNOWLEDGEMENT

I thank and praise the Almighty God for this achievement and protection during the whole course of my university study.

My deepest thanks and gratitude go to my supervisor Ass. Prof. Theophile NIYONZIMA for his invaluable support, encouragement and commitment during the progress of this research work.

I am also thankful to Prof. Emmanuel TWARABAMENYE, as before his retirement He supervised this thesis with invaluable commitment. May Almighty God be with him.

My great thankfulness is also addressed to the whole team of lecturers in the MSc of GI-ESD for their time, advices and motivation towards the completion of the master's program.

My sincere gratitude is also expressed to those who supported the writing of this thesis in terms of data acquisition especially local communities and authorities of Rulindo District for their unlimited collaboration and assistance for the completion of this project.

My special thanks are addressed to my beloved wife, my brothers and sisters, my classmates, and friends for their love, wish and support.

May the Almighty God bless you all.

ABSTRACT

This study was carried out in Rulindo District exactly in Shyorongi sector. The main objective of this study was to assess the impact of unplanned settlement growth in the peri-urban areas of Kigali. The study used interviews with local community, authorities and staff in charge of urban issues. The study also made use of RS methods to analyse three Landsat images of 2000, 2010 and 2020 classified via supervised classification methods using maximum likelihood to analyse LULC changes. Existing land use plans were used to examine the reliability of current land use with respect to the planned zoning rules. Data analysis was done using GIS software for spatial data analysis and Ms Word the processing of interview results. The findings revealed that the main drivers of the unplanned settlement growth in the study area are mainly the location in the peri-urban area and vicinity to Kigali; financial chance from wages gained from the city and growing number of inhabitants. The findings show that over the period of 2000, 2010 and 2020, the unplanned settlements have rapidly expanded resulting in various impacts in time and space. Thus, in the study area the non-built-up LULC had presented an excessive decrease of about 862.05 ha with an increase of built-up area. This has led to proliferation of critical negative impacts including inadequate basic infrastructure services, environmental degradation and unexpected land use. Beside negative impacts, the study looked on the positive impact of the settlement, where we found that there are positive impacts including the access to own houses, the settlement suiting the needs of urban poor, employment opportunities. the study advocated for the active measures including monitoring of the settlement variation, upgrading the informal settlements, strengthening implementation of existing policies and regulations related to human settlement, local communities and stakeholder's reflexion in the preparation and execution of land use plans.

Keywords: *Unplanned settlement growth, Peri-urban areas of Kigali city, Impacts*

Table of Contents

DECLARATION	i
APPROVAL	ii
ACKNOWLEDGEMENT	iii
ABSTRACT	iv
LIST OF TABLES	vii
LIST OF FIGURES	viii
TABLE OF ABBREVIATION AND ACRONYMS	viii
CHAPTER I. INTRODUCTION	1
1.1. Background Information.....	1
1.2. Problem Statement.....	3
1.3. RESEARCH OBJECTIVES	4
1.3.1. General Objective	4
1.3.2. Specific Objectives	4
1.4. RESEARCH QUESTIONS.....	4
1.5. RESEARCH HYPOTHESES	4
1.6. SIGNIFICANCE OF THE STUDY.....	4
1.7. LIMITATION OF THE STUDY.....	5
1.8. THESIS OUTLINE.....	5
CHAPTER II: LITERATURE REVIEW	6
2.1. Urbanization.....	6
2.2. Urbanization and Urban Growth.....	6
2.3. Sustainable Urban Growth.....	8
2.4. Drivers of unplanned settlement growth in the peri-urban area.....	8
2.5. Settlement growth in the peri-urban areas of Kigali city	11
2.7. Key National Policies and Strategies on human settlement in Rwanda.....	13
CHAPTER III: RESEARCH METHODOLOGY	16
3.1. PRESENTATION OF THE STUDY AREA.....	16
3.2.1. Secondary Data	20
3.2.2. Primary Data Sources.....	20
3.3. DATA ANALYSIS AND INTERPRETATION	22
3.3.1. Evaluation of the unplanned settlement growth.....	22
4.1. Unplanned settlement growth from 2000 to 2020.....	25
4.2. Settlement expansion	29
4.2.1. Settlement in the area.....	29
4.2.2. The key drivers of unplanned settlement expansion	31

4.2.2.1. The locality and closeness factors.....	31
4.2.2.2. The employment opportunity factors.....	32
4.2.2.3. The demographic factors.....	33
4.2.3. Home ownership and Road accessibility in the settlement.....	34
4.2.4. Facilities and services planning.....	34
4.2.5. Other Challenges in the settlement.....	39
4.2.6. Social-economic positive impacts in the settlement.....	41
4.2.7. Social-economic negative impacts in the settlement.....	42
4.3. Possible solutions to unplanned settlements.....	44
4.3.1. Settlement upgrading.....	44
4.3.2. Awareness of populations in sustainable human settlement.....	45
4.3.3. Stakeholders' consideration in human settlement planning.....	45
4.3.4. Private sector contribution to housing promotion.....	45
5.1. Conclusion.....	46
5.2. Recommendations.....	47
REFERENCES.....	48
Appendix A. Interview guide of the resident and opinion leaders of the settlement.....	51
Appendix B: Interview guide for District staffs.....	55
Appendix C: Observed utilities and services by cell.....	58

LIST OF TABLES

Table 1: Population variation from 1955 to 2020.....	9
Table 2: Research compatibility matrix.....	18
Table 3: Summary of Interviewed respondents	21
Table 4: Image Classification Producer and User Accuracy	23
Table 5: Image Classification Kappa Coefficient and Overall Accuracy	23
Table 6: Land Cover change since 2000 to 2020	27
Table 7: Slope category with respect to Build-up development change since 2000 to 2020	29

LIST OF FIGURES

Figure 1: Location of the study area	16
Figure 2: Data collection methods	17
Figure 3: Changes in land use and land cover in study area from 2000 to 2020	25
Figure 4: Classified Landsat Images of the Study Area for 2000, 2010 and 2020	26
Figure 5: Land cover changes in ha since 2000, 2010 and 2020	27
<i>Figure 6: Slope Map of the study area</i>	28
<i>Figure 7: Facilities and services planning</i>	35
Figure 8: Rutonde health center	36
Figure 9: Road degradation in Rutonde	38
Figure 10: Soil erosion in Kijabagwe	40

TABLE OF ABBREVIATION AND ACRONYMS

AIDS.	Acquired Immunodeficiency Syndrome
CBD	Central Business District
CSEDO	Cell Social Economic Development Officer
DCM	Digital Canopy Model
EDPRS	Economic Development and Poverty Reduction Strategy
FAO	Food and Agriculture Organization
GIS	Geographical Information Systems
GoR	Government of Rwanda
GPS	Global Positioning System
HIV	Human Immunodeficiency Virus
KCMP	Kigali Conceptual Master Plan
LULC	land use and land cover
MININFRA	Ministry of Infrastructure
NISR	National Institute of Statistics of Rwanda
NST1	National Strategy for Transformation
OSC	One Stop Center
REMA:	Rwanda Environmental Management Authority
RS	Remote Sensing
RWFA	Rwanda Water and Forestry Authority
SMS	Short Message Service
UN	United Nations
UNEP	United Nations Environment Programme
USGS	United States Geological Survey
WASAC	Water and Sanitation Corporation

CHAPTER I. INTRODUCTION

1.1. Background Information

According to Bapari (2016), urbanization has a significant importance in the development of humanity as it promotes the economic, social, political and cultural structures of the society as well as the country in general. Viable change is attained while there is an enforcement of the implementation of successful land use and urban planning as its absence result in unplanned and hazardous settlement(Bapari, 2016). The process of unplanned settlement expansion has been linked with various demographic factors including built-up development and population evolution over the globe. The most influence of unplanned settlement growth is the gap between housing demand of the population and housing obligation by-law(Bek et al., 2018)

. The unplanned settlement growth problem is a major challenge for the most of the developing countries as they result in the lack of well-being conditions as well as causing the risk to the population living in the proximity of the settlement.

Urbanization improves the social and economic conditions of the population as it provides viable infrastructures and facilities for the population. In general, urbanization results in the population movement from rural to urban areas as they expect the development of various aspect of life such as improved living condition and opportunities (UN, 2011). According to 2007 United Nations declaration, 50% of the world population has been living in cities after leaving the rural areas and it is predicted that 66% of the biosphere population will be living in urbanized areas in 2050(Nations, n.d.). Global unplanned human settlement has affected human life particularly in terms of sustainable land use, environmental management, land cover, basic infrastructure and facilities planning, accessibility, drainage system, physical condition of the settlement, lack of awareness for waste disposal, lack of affordable housing, land resource degradation, overpopulation leading to air pollution, land slide, flood and other factors linked to the failure of reliable spatial planning of the settlement (Bapari, 2016) .

According to the World Economic Forum report(Weltwirtschaftsforum & Zurich Insurance Group, n.d.), before 2018, Africa was less developed in terms of human urban settlement than other regions with an estimate of 40% projected to be 56% by 2050. The main reason behind was the domination of limited human settlement planning policies and regulations considered to have an impact in terms of

Accelerating the development of urban human settlement providing basic services and facilities to accelerate the settlement magnetism and expansion.

Rwanda as being part of under developed countries, has been facing various challenges related to the past and present development of unplanned settlement as well as unfairness in human settlement planning as there are some requirements of resettlement for population living in the proximity of wetland, informal settlement, the settlement within high-risk zones, the lacking of basic infrastructure and services provided within the settlement(Benken, 2017). Subsequently, Rwanda has proposed various policy documents that guided human settlement sub-sector. These include Vision 2020 launched in year 2000, Vision 2050 as launched in 2020, First and second EDPRS (Economic Development and Poverty Reduction Strategy) of 2008-2012 and 2013-2018 respectively, National Urbanization Policy of 2015, National Settlement Policy of 2009, Rural and Urban Sector Strategy of 2012-2018, Nation Strategy for Transformation (NST1) for the period from 2017 to 2024 , Etc., the mentioned documents focus on sustainable urbanisation(Kigali, 2009).

In settlement context, as presented in the dynamics of unplanned settlements in the city of Kigali, there is a high rate of population movement from rural to urban areas compared to other regions of Rwanda as the migrants expect the improvement of livelihoods opportunities and this led to the growth of unplanned settlements low standards of living(Understanding the Dynamics of Unplanned Settlements in Kigali, Rwanda, n.d.). With the increasing number of people living in Kigali city, there are a massive housing demand to accommodate the population so that the changing aspects of unplanned settlements are created as well in its peri-urban areas.

Shyorongi sector in Rulindo District is located in the peri-urban areas of Kigali city, as the latter shares boundary with Kigali city by Kanyinya Sector of Nyarugenge District at a distance of 19 km from Nyabugogo Taxi Park. In this study, we assessed challenges related to human life in the settlement mainly those linked to sustainable land use as the latter is a reflection of environmental challenges, land cover, basic infrastructure and facilities, accessibility, drainage system, physical condition of the settlement, awareness for waste disposal, affordable housing, land resource degradation, land slide, flooding and supplementary interconnected aspects.

1.2. Problem Statement

With the rapid global development, most developing countries are faced with the challenge of planning for their municipal areas to accommodate the rapidly rising urban population as well as providing the prerequisite for municipal infrastructure that accompanies the development. This inequity between planning and development has led to the spread of unplanned human settlement and unsustainable use of land resources (Benken, 2017).

In Rwanda, urbanization has been taken seriously and focused initiatives throughout different policies and mid-term strategies were put in place with the purpose to ensure the economic transformation and growth. Consequently, the government focused on promoting urbanisation linked to sustainable social inclusive, environmental protection and viable green cities (Kigali, 2009).

The continuous increase of rural-urban migration is the contributing factors to the development of urban informal settlements in Rwanda and the later created a need to develop sustainable interventions. In settlement context, land use planning is a major driver for sustainable management of human settlement and land resource in general. Based on the 2019 world population review report, the estimated population of Rwanda is 12.63 million people with a population density of 479.5 inhabitants per square kilometre in 2019 while it was estimated to 415 persons per square kilometre in 2012. The population of Rwanda is projected to surpass 20 million people in 2042 and 30 million people in 2076.

In Rwanda, the population increase contributes to the agglutination of people in rural and urban areas, especially within the most dynamic urban centers and their peripheries. This is the case of Kigali and its suburbs particularly in Shyorongi sector. The latter is adjacent to the city of Kigali and has been attracting many migrants since its population soared from 23,545 inhabitants in 2012(*RPHC4_Population_Size*, n.d.) to 33,546 inhabitants in 2020 (Shyorongi, 2022). This is an increase of 42.47 % over a period of eight years. The population increase resulted in huge development of unplanned settlement in Rutonde, Kijabagwe and Bugaragara cells. The development of informal settlements in the immediate outskirts of the capital city is worrying and therefore deserves to be analysed in order to better know and understand the driving factors of the settlement and propose possible measures for an adequate solution.

1.3. RESEARCH OBJECTIVES

1.3.1. General Objective

The overall objective of this research was to assess the impact of unplanned settlement growth in the peri-urban areas of Kigali city, case of Shyorongi sector in Rulindo District.

1.3.2. Specific Objectives

1. Analyse the unplanned settlement growth in Shyorongi Sector from 2000 to 2020;
2. Investigate the socio-economic impact of unplanned settlement expansion in Shyorongi Sector;
3. Propose possible solutions to unplanned settlements.

1.4. RESEARCH QUESTIONS

This research attempted to answer to the following research questions:

1. What are the causes of unplanned settlement expansion in Shyorongi Sector since 2000 to 2020?
2. What are the socio-economic impacts of unplanned settlement growth in Shyorongi Sector?
3. What are the possible solutions to unplanned settlement growth?

1.5. RESEARCH HYPOTHESES

This research attempted to verify the following hypotheses:

1. The unplanned settlements have been growing over time in Shyorongi Sector;
2. The unplanned settlement growth of Shyorongi Sector has caused both positive and negative socio-economic impacts;
3. Implementing settlement policies and regulations is an effective way to address unplanned settlement expansion in Shyorongi Sector.

1.6. SIGNIFICANCE OF THE STUDY

This study will be important to Rulindo District since based on the study outcomes; the competent authorities will be informed about challenges. For instance, based on the lessons learned, the authorities may take measures for addressing the challenges to bring more sustainability in urban growth. Likewise, the residents of the settlement will make profit from

the engagement of the district leadership to address the problems. Finally, this study will be used as a referential material for other studies.

1.7. LIMITATION OF THE STUDY

The study considered only three cells of Shyorongi Sector mainly Rutonde, Kijabagwe and Bugaragara cells presenting rapid urban expansion due to resources limitations. In addition, the progress of this study has been hampered by covid-19 pandemic. The later pandemic prevention measures have affected this study especially during the lockdown when social distancing measures was implemented and the physical contact and movement were not allowed at some time.

1.8. THESIS OUTLINE

The thesis report is structured into five chapters. Chapter one describes the background of the study, problem statement, research objectives, research questions, research hypothesis, significance of the study, limitation of the study and the outline of the research. Chapter two presents the review of literature. Chapter three presents and discuss the study area in terms of location, size and administrative elements as well the description of the methods used to achieve the study objectives. Chapter four presents the results and discussion whereas Chapter five give the overall conclusion and recommendations.

CHAPTER II: LITERATURE REVIEW

As this study aimed to assess the impact of unplanned settlement growth in the peri-urban areas of Kigali city, scientific publications and policy documents related to human settlement were consulted and analysed. This chapter is mainly presented into six sections. Section one describes and discusses urbanization in general. Section two gives an overview of urbanization and urban growth. Section three discuss about sustainable urban growth. Section four describes the drivers of unplanned settlement growth in the peri-urban area and its impacts. Section five presents and discusses about the unplanned settlement growth in the peri-urban areas of Kigali city and its impacts. Finally, Section six discuss the key national policies and strategies on human settlement in Rwanda.

2.1. Urbanization

Planned urbanization in peri-urban areas gives variable urban settlement quality and facilities including employment, education, health care, culture accompanying an accelerated national economy. However, accelerated unplanned peri-urban growth is frequently linked with poverty, environmental degradation and population demands that exceed facility capacity resulting in unsustainable human settlement (Melinda et al., 2002).

Reliable urbanization statistics are mainly available all over the world as global data show a series of urban wellbeing hazards and related health risks including substandard housing, crowding, air pollution, insufficient drinking water, inadequate sanitation and solid waste disposal facilities, vector-borne diseases, stress associated with poverty and unemployment of the resident, among other risks (Melinda et al., 2002). Planned settlement is a major driver of sustainable peri-urbanization.

2.2. Urbanization and Urban Growth

According to SATI (2017), urbanization is a process of urban growth by natural growth in population or movement from rural to urban areas as it refers to a growth in the amount of a population living in urban areas as well as the physical growth of already existing urban centres. Therefore, for a given area, the growing share of population living in urban areas typically because of rural to urban movement indicates urbanization, extension of urban land uses and spatial focus of people working in non-agricultural activities.

Again, the literature shows that the social, economic and administrative changes led to urban growth. In the same context, the change of land use differs from one country to another due to

the inconsistencies of socio-economic conditions as well as the status of the country development(SATI et al., 2017).

According to United Nations (2018), urbanization is the greatest significant global revolution processes as the increase of population in urban areas develop global and local urbanization expansion. Urbanization is a complex socio-economic practice that changes the built environment and transform former rural into an urban settlement as well as shifting the spatial distribution of a population from rural to urban areas as it consist of changing occupations profile, lifestyle, culture and behaviour as well as changing the demographic and social structure of both urban and rural areas(Nations et al., 2018).

The main significance of urbanization is the increase of amount of land area and population size of urban settlements. It is also the amount and share of urban dwellers compared to rural dwellers as cities besides come to be the dwellings where public and private services of excellence are available and where basic facilities are frequently more available than in rural areas. Urbanization plays a vibrant role in the social development of countries, national and regional economies development worldwide(Moore et al., 2003). As it offers opportunities for education, employment, services and cultural enrichment as well as the hope of better health. In reality, sometimes these opportunities may not be as consistently as hoped but in general national profits and level of social development are strongly and surely linked with level of urbanization.

Rapid and frequently unplanned urban expansion are linked with settlement on marginal land, environmental degradation and population demands that exceed environmental service capacity such as drinking water, sanitation and waste disposal and treatment. In addition, urban poverty is a major problem related with rapid unplanned urbanization mainly in developing countries. As said by UNEP (2002), sustainable management of the urban surroundings will consequently come to be the major challenges for the future all over the globe. However, the significance of cities in national and global development as well as the predictability of urbanization growth is vital to attain liveable and sustainable cities as a well-managed towns offer an improved economic scale.

According to Haase et al (2018), there is a link between demographic evolution and urbanization in the form of a logical trend where less advanced economies are likely to be more rural and to have advanced birth rates whereas the economy progresses more as its population lives in urban areas with an associated reduction in birth rates. Therefore, highly growing

African cities can be observed as being in the early phases of the transition whereas cities in Europe or United States of America can be observed as getting the later phases of the transition. The most urbanized areas of the world are North America with 82% of urban population, Latin America and the Caribbean :80%; Europe :74 %; and Oceania 71 %. In contrast, Africa and Asia remain mostly rural with 41% and 49 % of their relevant residents living in urban areas respectively. Certainly, Nigeria, Ethiopia, Tanzania, and Kenya in Africa, and China, India, Indonesia and Myanmar in Asia present a big number of rural residents. According to the above publication, the areas that are less urbanized such as Africa and Asia are now urbanizing quicker than those already with higher urban population(Haase et al., 2018).

2.3. Sustainable Urban Growth

Referring to Haase et al (2018), urbanization is certainly the greatest important practice of land-use and land cover change because it has considerable effects on the pattern, dynamics and functionality of ecosystems. The process of urbanization can be clearly detected along the rural-urban gradient that is the best characteristic transect that associates the urban (built, populated) and the rural (open, vegetated), which shows a classic pattern of population density, coverage of built-up zone, relevant resistant cover and demographic arrangement including standard of living and travel performance. Besides, the rural-urban gradient has a growing volume of land consumption specifically the change of green spaces to built-up zones which is designated as site urbanization (Haase et al., 2018).

Urbanisation is one of the most important processes that have affected societies mainly since the last century. It is a cross cutting phenomenon containing all sides of human society and economic development as it implements a number of roles not only for the universe economies but gradually some of them covers the local and universal levels. Nevertheless, urbanisation poses certain challenges if not properly managed. It needs to be stressed that the challenges posed by urbanisation would not simply go away without conscious efforts and interventions. The close association between urbanisation and socioeconomic development requires every effort be made to minimize the challenges, and thus enhance or maximise the benefits of the process (Nations et al., 2018).

2.4. Drivers of unplanned settlement growth in the peri-urban area

Developments in land use change taking place in the peri-urban areas shows that urbanisation in the context of poverty is a significant factor supporting and catalysing variations in land use, land transactions, increased rural–urban migration and the general alteration of land use in the

peri-urban areas. The developed land use arrangement shows an incompatibility with the commonly valued planning standards as well as land value concepts which support urban land use design tools such as zoning and density sharing as well as related ethics like fair provision of basic facilities in urban land improvement(Kombe, 2005).

According to Elsevier (2021), there are no particular factors that accounts for the development of informal settlements. Therefore, factors responsible for the growth of informal settlement are unique in various geographical localities and extents of life. Exceptional growth of informal settlements in economic immobility in some of the sub-Saharan countries has sustained to produce terrors about a looming urban catastrophe which might proceed from continuous urban sprawl, increasing poverty and decline of the built urban situation including lack of basic infrastructure services in the quickly developed informal settlements(Alene, 2022). The problems from rapid urbanisation are encouraged by institutional corruption in many countries that are challenging spatial planning theories especially in the sub-Saharan area.

Again, the population increase is the main factor of the informal development as it is linked with shortage of formal housing and unaffordable cost of formal housing for urban residents contributing to the expansion of informal settlements (Alene, 2022). The same author has stated that as the urban population grows, there are an excessive need of housing resulting in more agricultural land being converted into human settlements. In Rwanda, in the past periods the country’s population has increased from 2,527,294 in 1955 to 12,952,218 in 2020 and it is projected to reach 23,048,005 in 20250 (worldometer, 2022).

The table 1 indicates population variation from 1955 to 2020, showing that in the last 65 years, the population of Rwanda has increased from 2,527,294 to 12,952,218 inhabitants.

Table 1: Population variation from 1955 to 2020

Population of Rwanda (1955 - 2020)			
Year	Population	Year	Population
2020	12,952,218	1995	5,836,495
2019	12,626,950	1990	7,288,882
2018	12,301,970	1985	6,146,891
2017	11,980,961	1980	5,153,312
2016	11,668,827	1975	4,364,706
2015	11,369,071	1970	3,757,358

2010	10,039,338	1965	3,235,531
2005	8,840,215	1960	2,935,582
2000	7,933,681	1955	2,527,294

Source: Worldometer,2022.

The period before 1996, human settlement in Rwanda lacked a settlement development outline as many urban areas didn't have master plans or land use plans to guide development which has generally contributed to the growth of unplanned residential areas in urban centres resulting especially in poor land management, environment degradation and rural population lacking basic infrastructure and non-agriculture economic activities. Thus in 1996, the government passed the national human settlement policy as it came to be known as the *Imidugudu* concept. The 1994 Genocide against the Tutsi led to many Rwandans becoming homeless as well as those who had previously been disadvantaged of their inheritance to Rwandan soils returned from exile. As a consequence, the situation required some actions to improve human settlement. Therefore, there are various measures taken to address the challenges including massive construction of settlements sites, making the improvised camps, production of temporary and permanent housing tent schemes, the provision of urban extension zones. Moreover, the government provided public infrastructure, services and facilities(The State of Population in Rwanda, n.d.).

Nevertheless, the challenges are now how to manage the developed urban environmental problems with the current normal infrastructure. Also, rural-urban migration is a key factor influencing unplanned settlement as the rural area challenges can be seen through absence or poor basic infrastructure and social services, poor sanitation, employment, etc, while in rural-urban movement, most of the migrants expect convenient access to services, infrastructure, facilities and employment. Therefore, these rural-urban migrations if not properly managed, it can lead to various human life challenges including sanitation related diseases, deforestation, malnutrition and poverty(The State of Population in Rwanda, n.d.). Even if the government has tried to address rural migration issues by improving human settlement planning all over the country, human migration is still increasing from rural to urban areas which results sometimes in the issues of inadequate infrastructure and service, lack of adequate water, electricity supply and sanitation systems, inadequate garbage collection methods, poor drainage, poor roads, inadequate public transport network and insufficient housing supply.

2.5. Settlement growth in the peri-urban areas of Kigali city

According to UN-Habitat (2015), the main physical characteristics of the settlements are that the inhabitants have no security of tenure in terms of the land or dwellings they inhabit, with modalities ranging from squatting to informal rental housing, the areas usually lack basic services and city infrastructure. Generally, the housing does not comply with up-to-date planning and building rules as well as frequently founded in hazardous areas (Alene, 2022).

As said by Understanding the Dynamics of Unplanned Settlements in Kigali (2019), the city of Kigali has undergone a rapid increase in human settlement in recent years, so that there was a high demand of housing development which exceeded the existing planning following the migration from outside Kigali city. The majority of immigrants are likely to live in small houses depending on their economic situation as most of them are seeking no agriculture activities as well as education (Understanding the Dynamics of Unplanned Settlements in Kigali, Rwanda, n.d.).

Rwanda as a highly populated country, has recently an urbanisation speed which sometimes results in informal settlement as a major impact, generally from capital city as the low-income population is always obliged to leave populated areas of the capital city due to the higher living cost., moving towards the periphery of the city. As declared by Baffoe et al (2020), Kigali city is a key factor of urbanization and informal settlement development in its neighbouring zones. For instance, the need of surviving in Kigali has led to the increase of many informal zones where housing structures are of poor quality compared to those within the centre of capital city resulting in various environmental and social challenges including lack of proper waste disposal, basic facilities and services, etc. (Baffoe et al., 2020).

On the other hand, the informal settlement in the peri-urban areas of Kigali city has been motivated by the demolishing of the build-up areas located in the wetland of Kigali city which resulted in the search for new location especially in the peri-urban areas. During the period of post-independence, the city has been growing rapidly in an unplanned, uncontrolled and hazardous manner which resulted in actual urban expansion towards wetland areas and onto steep slopes, areas previously considered to be unsuitable for human settlement (Baffoe et al., 2020).

The Kigali Conceptual Master Plan (KCMP) presents a broad vision and guidelines for the entire city as it serves as the basis for more specific planning at the district and CBD level as it

presents the most advanced sustainability in land use, infrastructure, environment, society and economy for sustainable development.

2.6. Methods in informal settlement study

Considering various literature related to informal settlement, most of the study used qualitative, quantitative, literature and imagery data methods to collect research data. Specifically, quantitative research differs obviously from qualitative research. Quantitative research seen to be a static and measurable method as it is suitable for studying linearity in cause and effect questions (Baffoe et al., 2020). The latter approach was considered unsuitable for the contemporary study as it limits the detailed exploration of perceptions and feelings of researcher as well as respondents.

Based on Hitayezu et al (2018), there were various studies focusing on unplanned settlement in Kigali, where one study plotted 1,049 people from entire 35 sectors in Kigali and the questions based on access to services, housing and employment. Again, another study used a mixed procedural approach including focus group discussions, quantitative survey, transect walks, key informant interviews as well as aerial maps analysis. In the study, the quantitative ratio of the study was directed to 900 households from the three districts of Kigali city. The later study focused on variables related to socio-economic situations and access to basic services aimed on the evaluation of infrastructure development in the study area.

The same author, used two main data collection stages, both directed only on the family representative living in informal areas with a person that own and able to use a portable telephone, from where first stage used a face-to-face survey through selected respondents by means of designated enumerators. Second stage involved the collection of data from the early face-to-face survey respondents via a sequence of a weekly SMS surveys (Hitayezu et al., 2018). During interview, the respondents were asked the questions related to migration in the area, housing, access to basic services as well as employment opportunities.

Referred to John-Nsa (2021), a mixed approaches strategy was used as qualitative and quantitative data were collected in parallel but analysed separately and then combined. As in other study, her study revised related documents to get some information on the informal settlements in study area and its outlying areas. During the study, Interviews with crucial informants were done as it assisted in the generation of digital settlement footprint maps (John-

Nsa, 2021). Besides, the questionnaire survey was used to explore drivers of informal spatial dynamics in Enugu City. In selection of the key informants, the selection conditions were founded on inhabitants living in the area for over 20 years as well as individuals whose are dynamically involved in the organization of the informal settlements

2.7. Key National Policies and Strategies on human settlement in Rwanda

A human settlement is a structured grouping of human habitation. It refers to the model in which people live in a given place as it can be rural or urban based on its location. The planning of a settlement is based on different factors including political, social, economic, cultural, etc. Informal settlement in peri-urban areas of Kigali city is still developing day to day. The magnitude of informal housing is likely to propagate mainly because it is accommodating the majority and certainly a number of middle-class economic section of the people who have no supplementary options. Therefore, these developments need a number of measures, responsive institutional framework for narrowing their spatial differences, measures for regulating informal land subdivision, framework for use and development of land resource, actors involved in informal land development as well as instructions regulating upgrading practice in the informal areas. According to Kombe (2003), the State has to take the initiative and put in place an institutional framework for monitoring land use development and protect future public welfares in the quickly growing peri-urban informal settlements so that the framework should be based on corporations, exchange of ideas and team working with the key actors supported by good practices relating in the informal settlements as the later will bring about a reliable governance in land parcelling, land transaction as well as land development. In addition, the later will bring about the future community requirements in relation to the essential guidelines and standards such as minimum acceptable plot sizes and access road sizes to follow in the progress of dealing with sustainable land transactions enabling of sustainability, increased property value as well as improved public health in the informal settlements.

Rwanda as a developing country has adopted various policies and strategies regarding human settlement as well as sustainable use of land resource. National human settlements policy provides the framework for sustainable human settlement and rational use of land resource, urbanisation policy to guide the growth and development of towns and cities, National Human Settlement Policy of 2004 aimed at the development of *imidugudu* based on a participatory approach and an urban planning requiring land security and area allocation. The National Housing Policy on the other hand aims at promoting access to housing, resource use efficiency, land, infrastructure, skills development, enhancement of the local construction industry,

construction materials and technology, townscape as well as public responsibility. The National Government Policy supports Law Governing Urban Planning and Building in Rwanda (2012) which regulate local development based on clear procedures to support sustainable, integral and inclusive development, institutional strengthening and development, decentralization, local economic development, citizen participation and accountability mechanisms ,Vision 2020 aimed at having urbanization master plans and particular development plans for towns; using urban land according to adopted plans; developing basic Infrastructure in urban areas and other rural development zones as well as decentralizing economic activities within the country(Kigali, 2009).

In the same context, Urbanization and Rural Settlement Sector Strategic Plan aimed at improving public services, the quality of public infrastructure, as well as contributing to economic development and poverty reduction in the country, The National Informal Settlement Upgrading Strategy guiding the principles of the implementation of a National informal settlement upgrading program in Rwanda as the program follows the provision of the National Housing Policy as it deal with the existing informal housing units upgraded and integrated into the formal housing stock. The National Strategy for Transformation (NST1), in urbanization context, has a priority of accelerating sustainable urbanization from 18.4% (2016/17) to 35% by 2024.

The government also initiated an economic development and poverty reduction strategy known as EDPRS based on increasing economy and decreasing poverty. According to the updated version of national human settlement policy in Rwanda (2009), the objectives of the strategy with regard to human settlement were about planning and development of improved human facilities in both rural and urban areas, sustainable rational use of land and environment protection, designing urban master plans, construction of regrouped settlements known as imidugudu in order to improve settlement conditions and sustainable use of land resource, etc. The National investment strategy was developed to improve, the investments in housing and settlement. The strategy aimed at improving public and private investments and increasing their influence on beneficiaries in Rwanda. Thus, from this strategy, many individual Rwandans have gained financial support to invest in housing and settlement. In strategic context, the government developed a sectorial strategy for the ministry of infrastructure where the strategies aimed at developing housing, construction and maintenance of public buildings, developing sufficient building plots, reinforcing institutions in charge of human settlement financing,

designing urban master plans for human settlement, making building plots available as well as the improvement of unplanned residential areas.

As already said, population growth is a major factor of informal settlement. Therefore, the government of Rwanda developed a family planning policy as a basic measure for reducing growing number of populations (Author & Bizoza, 2014). The program has major activities including massive family planning campaigns, training for different groups on growth rate planning and management, increased budget allocated to the health sector, strengthening health facilities and services, the provision of more affordable and available contraceptives methods.

In addition, as the globe is facing environmental challenges and climate change, the government of Rwanda has integrated into policies environment consideration with the priority being given to sustainable security of real estate by means of sound planning and management techniques with regard to land registry, rational use of land and soil conservation, reforestation, preservation of biologic diversity, protection of ecosystems, rehabilitation of degraded zones, reinforcement of central and decentralized environmental institutions (Kigali, 2009).

CHAPTER III: RESEARCH METHODOLOGY

Based on the suggested research objectives, various research methods and techniques were applied to meet these objectives. This chapter presents the study area as well as the methods used in data collection and data analysis.

3.1. PRESENTATION OF THE STUDY AREA

The study was conducted in Rutonde, Kijabagwe and Bugaragara cells of Shyorongi sector, Rulindo district in Northern Province. The district is adjacent to Kigali Rwanda's capital city with Kanyinya Sector of Nyarugenge District where it is estimated to be within a distance of 19 km from Nyabugogo Taxi Park to Shyorongi sector. Shyorongi Sector has an estimated surface area of 46.7 km² with a population of 53,546 inhabitants with a population density of 510.3 per km² (Shyorongi, 2022). The sector is subdivided into five cells namely Muvumu, Rubona, Kijabagwe, Bugaragara, and Rutonde, the latter cells having 40 villages. The selected cells of the study area have an estimated population of 36,772 inhabitants with Rutonde Cell having an estimated population of 20,122 inhabitants, Kijabagwe Cell having 5,575 inhabitants and Bugaragara Cell having 11,075 inhabitants (CSEDO,2021). the three cells have a total surface area of 26.3 km² aforementioned cells having 9.7 km², 6.4 km², 10.2 km² respectively.

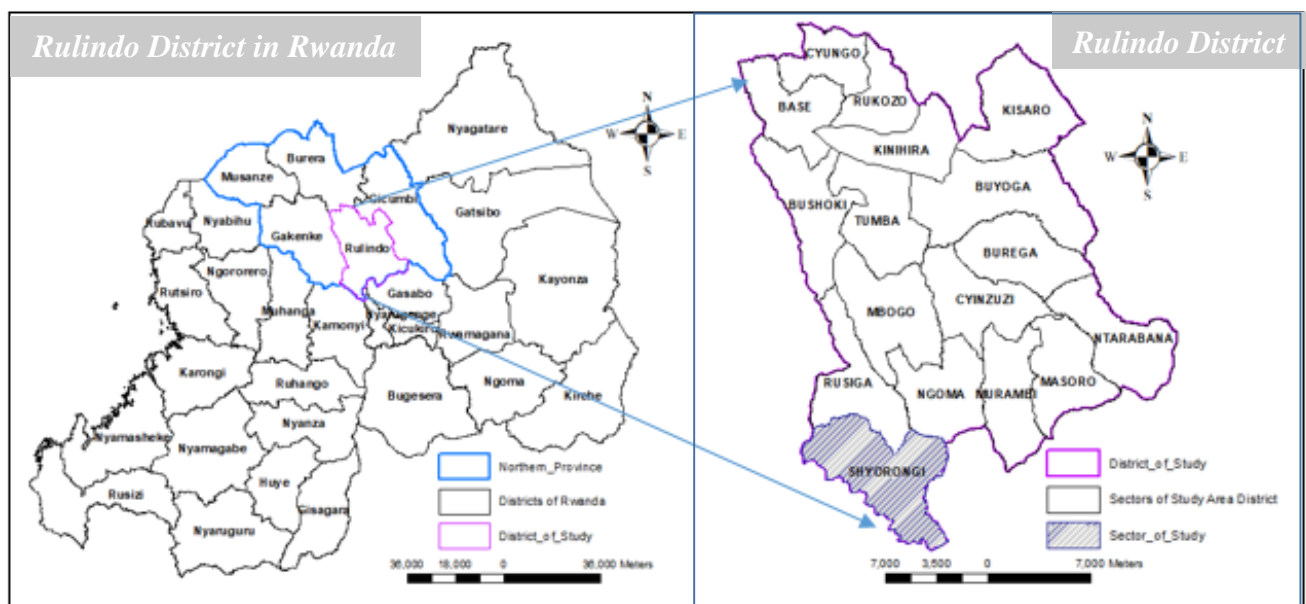


Figure 1: Location of the study area

Source: National Institute of Statistics of Rwanda (NISR, 2012)

3.2. DATA COLLECTION TECHNIQUES

Primary and secondary data were collected using various methods. These include field observations and measurements, interviews with local population as well as from local entities. Desk review was conducted as well as the information analysis and interpretation using Geographic Information Systems (GIS) and Remote Sensing (RS). Consequently, both qualitative and spatial data interfere with a reliability of the informal settlement and its associated impacts. All related analysis was based on a below compatibility matrix as discussed in 3.4 section of this report. Figure 2 summarizes the methods for data collection that were used in this research.

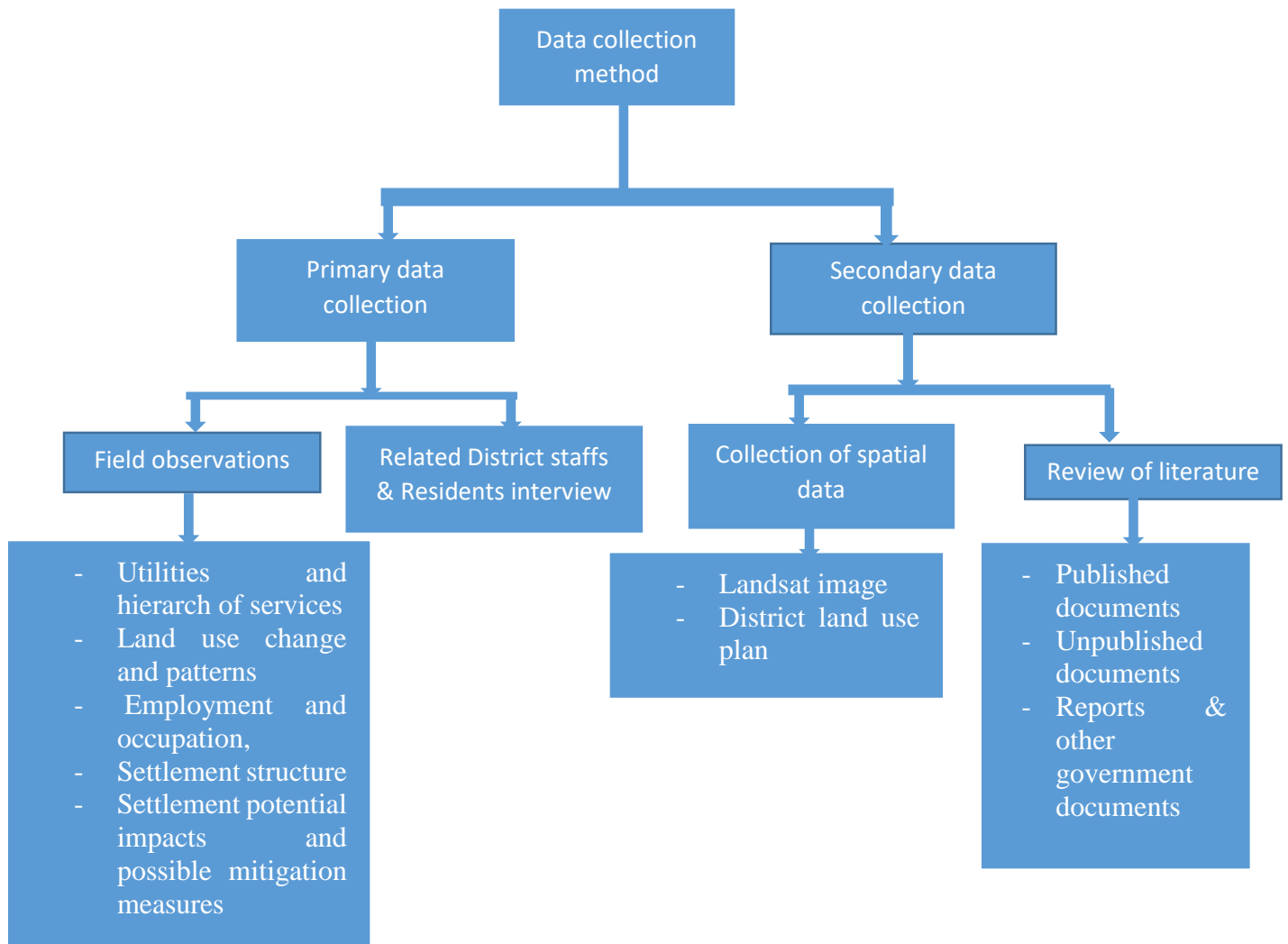


Figure 2: Data collection methods

In relation to research design, research compatibility matrix, summarize the research process presenting the specific objectives and research questions, the data needed, the source of those data, variable to be analysed, methods and the indicators in the study.

Table 2: Research compatibility matrix

Specific objectives	Research questions	Data needed	Where to find those data	Variable to be analysed	Methods	Indicators
1. Analyse unplanned settlement growth in Shyorongi Sector from 2000 to 2020	What are the causes of unplanned settlement expansion in Shyorongi Sector since 2000 to 2020?	Surface of built-up area and non-built-up changes from 2000 to 2020. Population of different years from 2000 to 2020	Landsat images of 2000 and 2020 years showing settlements changed from one year to another. Population and Existing land use plan data extracted from literature and District reports	Surface area of built-up and non- built-up changes from 2000 to 2020, existing land use plan implementation from the approval period and population variation from 2002, 2012 to 2020	GIS and RS (supervised classification)	Land cover change (build up and non-build-up changes), existing land use plan implementation status.
2. Investigate the socio-economic impact of unplanned settlement expansion in Shyorongi Sector	What are the socio-economic impacts of unplanned settlement growth in Shyorongi Sector?	Information from interview	Field observations and measurements, interview with local population and local entities staffs	Socio-economic aspect linked to utilities and hierarchy of services, land use change and patterns, employment and occupation.	Interview results.	Socio-economic deprivation linked to utilities and hierarch of services, land use change and patterns, employment and occupation.

3. Propose possible solutions to unplanned settlements.	What are the possible solutions to unplanned settlement growth?	Information from interviews	desk review, field observations and measurements, etc.	Related socio-economic impacts	Desk review as well as interview	Recommendations
---	---	-----------------------------	--	--------------------------------	----------------------------------	-----------------

As presented and summarized above, the study will include Landsat images analysis enabling to show trends in terms of spatial structure and land use patterns, field observations and measurements as well as interview with local population intended to complement the data extracted from Landsat images.

3.2.1. Secondary Data

The secondary data provided the information on informal settlement development. In this context, we considered various secondary data as presented in research compatibility matrix, including desk review data source such as articles, conferences reports, information from internet, etc. enabling the collection of information about principles and concepts related to the study, existing land use data and Landsat images of 2000, 2010 and 2020 reflecting build-up patterns and non-build-up changes within three period of ten years interval.

3.2.2. Primary Data Sources

Normally, the data collected facilitated to respond to objectives/research questions of the research. Consequently, we used various data collection tools including GPS in order to take geographical coordinates, use of interview guide to conduct interview, field observations and measurements for reality-based analysis.

3.2.2.1. Field Observations and Measurement

This research tool was used after desk review as well as Landsat images processing and analysis. With hand book, GPS receiver and Digital camera data recording tools, we visited the study area for the observations of the existing situation of the settlement and status of utilities and services.

Thus, we considered variables such as electricity, water, schools, religion, health care, selling points, recreational areas, land use change and patterns data looking on accessibility, land subdivision condition and standards in terms of plots size, land cover, build up standard and coverage area. Again, we observed aspects linked to plots boundaries marking, land use functions, drainage system, waste disposal as well as rain water management in the settlement. We measured data on occupation during daytime in general, data on settlement structure looking on physical view of the settlement, data on settlement potential impacts and possible mitigation measures.

3.2.2.2. Interviews

According to literature, this method is a collaborative procedure of data collection and offer the possibility of explaining the intent of the idea either for the researcher or the interviewee as it provides the possibility of adding explanatory comments. Normally, personal interview may be face-to-face, via phone or even online with or without videos. But interviews, whether face-to-face or online, often offer more personalized exchange of information compared to surveys as it has been recommended as one of the suitable data collection tools in the literature(Jain, 2021), This is why the interview data as collection tool in this study was selected for the intended outcome.

The interview was used to collect research data to help understanding the major trends and drivers of unplanned settlement growth and its associated impacts in study area. Interviews as one of the suitable data collection tools was also used to assess and understand the growth mode of the settlement, assess how the communities implement the existing land use plan of the study area, understand the views and attitudes of the residents on such settlement, associated settlement impacts, understand their desires and how they would like to have the settlement organised in the future.

The interview was conducted on 35 respondents where 30 interviewees were selected from the residents of the settlement considering 10 interviewees per cell. Consequently, interviews were directed to 7 people in each Cell that we found physically at the Cell of interest and 3 opinion leaders in each Cell respectively. The selection criteria were to have relevant information, the candidate for interview was individual who could be available, and willing to talk with the researcher offering requested information.

In the same context, the 5 remaining interviewees were the decision makers selected purposively based on the judgment of the researcher in terms of the individual fitting the profile of the respondent needed. In this category of interviewees 2 District staff expected to have information about master plan preparation and implementation were chosen. Then, the concerned 3 Cell leaders were interviewed as they have a better understanding of the local terrain and capable of understanding the challenges as well as proposing upgrading mechanisms. Note that as a way of forming an understanding with the respondents, the researcher conducted the interview himself. The table 3 presents briefly the information on the respondents.

Table 3: Summary of Interviewed respondents

Sector	Cell	Number of interviewees/residents
Shyorongi	Rutonde	10
	Kijabagwe	10
	Bugaragara	10
Total Interviewees: 30		
Institution	Category of interviewees	Number of Interviewees/District staff
Rutonde cell	Executive Secretary	1
Kijabagwe cell	Executive Secretary	1
Bugaragara cell	Executive Secretary	1
Shyorongi sector	Land manager	1
Rulindo District	Construction permitting officer	1
Total Interviewees: 5		

3.3. DATA ANALYSIS AND INTERPRETATION

3.3.1. Evaluation of the unplanned settlement growth

During this stage, various techniques, tools, and approaches were used to analyse and interpret the findings.

3.3.1.1. Remote sensing and GIS techniques

This technique was used to extract data from three Landsat images of 2000, 2010 and 2020. Relevant maps were produced in order to illustrate the settlement growth and land cover changes using supervised classification which is a vital tool for extracting necessary data from remote sensing. During the analysis, we focused on build up and non-build up development as an indicator of settlement growth and land cover change factors. During classification, the Maximum Likelihood Classifier was used as it assumes that each spectral class can be defined by a multivariate standard distribution. The tables 4 and 5 presents the accuracy of the images classification in this study mainly producer and user accuracy as well as Kappa Coefficient and Overall Accuracy.

Table 4: Image Classification Producer and User Accuracy

Year	Producer's Accuracy in %		User's Accuracy in %	
	Built-up	Non-Built-up	Built-up	Non-Built-up
2000	93.7	97.3	95.6	97.7
2010	95.4	96.8	93.9	91.3
2020	98.9	99.3	96.2	96.9
Average	96	97.8	95.23333	95.3

According to literature, the producer accuracy shows how well the conditions on the ground are presented and plotted in map whereas the user accuracy is a demonstration of how consistent the map represents what is really on the ground (Nandam, 2020). As indicated in Table 4 the producer's accuracy was about 0.8% for build-up and 3% for non- build-up respectively.

Table 5: Image Classification Kappa Coefficient and Overall Accuracy

Year	Kappa Coefficient in %	Overall Accuracy in %
2000	0.9873	96.32
2010	0.8603	94.53
2020	0.9541	97.25
Overall	0.9339	96.03333

According to Nandan (2020), the kappa coefficient measures how the classification outcomes are compared to the values given by chance. Consequently, it controls the range of arrangement about the classified images. As presented by table 5, the overall accuracy of the three analysed images was about 96.03333%, whereas the related Kappa coefficient was about 0.9339.

3.3.1.2. GIS techniques

In addition to RS, GIS techniques were used to analyse the settlement conditions based on the field sampled data on basic utilities and hierarchy of services as well as land use change and patterns. Here we have analysed the settlement growth status as provided by RS toward the district proposed land use as well as zoning regulations compliance.

3.3.1.3. MS word

Microsoft word was used to record and perform contents analysis of the interview information as we recorded all the comments and feedback from the interviewees and we explored the views of the respondents. Consequently, the responses provided by the interviewees permitted the researcher to understand the major trends and drivers of unplanned settlement growth and their associated impacts in the study area. They also permitted the understanding of the views and attitudes of the residents on such settlement and their desires on how they would like to have the settlement organised in the future.

Referring to NIYONZIMA (2009), in order to recognise separately the respondents and respecting their privacy without declaring their names, during the responses analysis in this study, a code was given to each respondent in each of the three cell units as well as decision makers where the interviews were conducted. A precise code was assumed changing from one to seven for the people in each cell, one to three for the opinion leaders in each cell and one to five for the decision makers respectively (Land Use Dynamics in the Face of Population Increase. A Study in the Eastern Province of Rwanda. Théophile NIYONZIMA, n.d.). Consequently, the coding was organised based on the initials of the name of the cell followed by the number of the person on the list of interviewees. For Rutonde cell peoples and opinion leaders, the codes were RUP1 to RUP7 and RUO1 to RUO3 respectively. For Kijabagwe cell people and opinion leaders, the codes were KIP1 to KIP7 and KIO1 to KIO3 respectively. For Bugaragara cell, ordinary respondents and opinion leaders, the codes were BUP1 to BUP7 and BUO1 to BUO3 respectively. Finally, for the decision makers the codes were DE1 to DE5.

CHAPTER IV: RESULTS AND DISCUSSIONS

This chapter provides a detailed presentation of the results obtained from this study. As it is mentioned in overall objective, this research aimed to assess the impact of unplanned settlement growth in the peri-urban areas of Kigali city in Shyorongi sector in Rulindo District. To achieve the study objectives, we evaluated the unplanned settlement growth in Shyorongi Sector. The detailed findings and discussion of the results are presented in 3 sections. The first section presents and discusses the unplanned settlement growth from 2000 to 2020. The second section presents the settlement expansion, while the third include the possible solutions to unplanned settlements.

4.1. Unplanned settlement growth from 2000 to 2020

This section presents the findings on the settlement growth in relations with the built-up area altering characteristics in comparison with other LULC types in the study area. The analysis of existing LULC data indicate different changing aspects in land use and land cover where the built-up area has increased with respect to other land use (forest, cropland, water bodies) in study area from 2000 to 2020 as presented by the maps in figure 3.

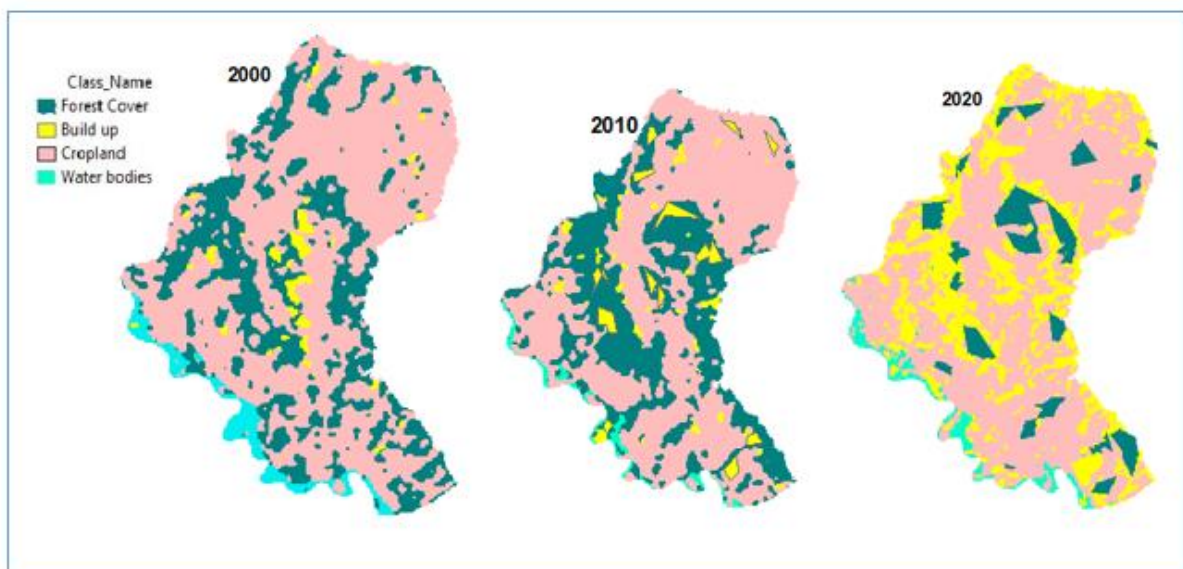


Figure 3: Changes in land use and land cover in study area from 2000 to 2020

Source: RWFA (2023)

After analysing the existing LULC data, we performed an image classification of Landsat of the years 2000, 2010 and 2020. The analysis was inspired by the one performed by KAYITESI (2019). Due to the low quality of Landsat images, all land cover types were not classified, Instead, Kayitesi presented the Classified Landsat Images maps of various period in the same

maps considering two classes, mainly the built up and non-built-up area as the study was about human settlement variation. Consequently, the LULC including water bodies, grassland, cropland and forest have been merged into one class and labelled “non-built up” as the main intent was to analyse the build-up change in the study area(Kayitesi, n.d.).

Thus, as shown in Figure 4, the built-up area has been growing at a high rate and reducing other land use and land cover types in the study area. The table 6 show the actual impacts of the discussed change in figure 4 as the built-up areas has increased at a level of 83% against 36% of decrease of other land use and land cover types.

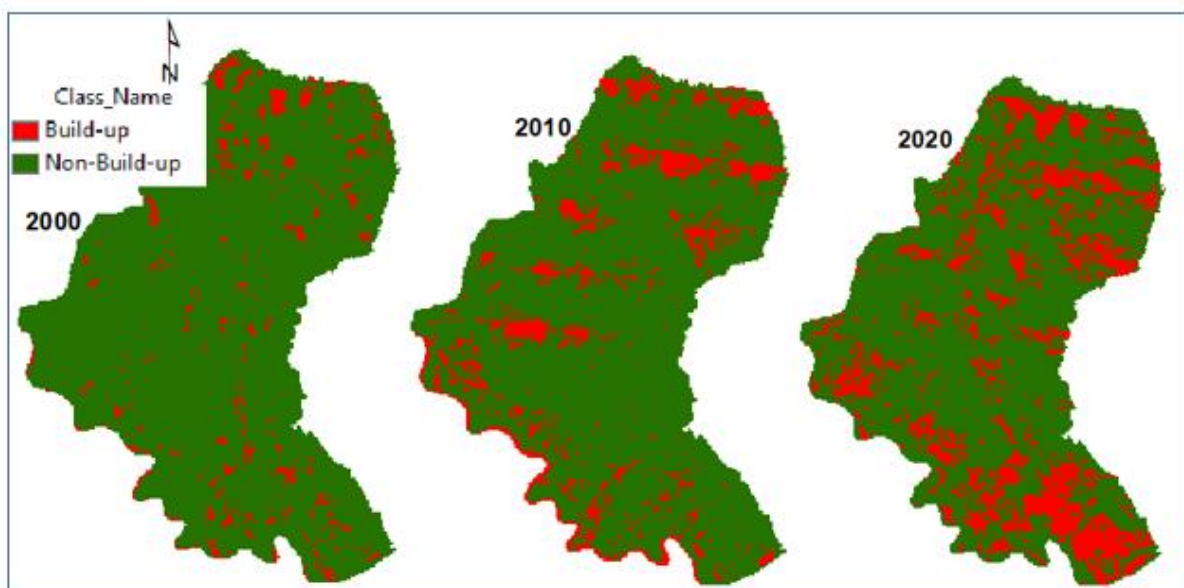


Figure 4: Classified Landsat Images of the Study Area for 2000, 2010 and 2020

Source: USGS Landsat Images (2023)

This study has revealed that the study area has a high rate of variations in different land use and land cover forms in the last 20 years, presenting a high rate of expansion of urban area (built up) compared to other LULCs.

This urban development has led to several effects on land use and land cover types in both positive and negative forms. Positively it assisted job creation and economic growth from the construction materials resources exploitation whereas in other side, it negatively led to the loss of biodiversity, decrease of agricultural land, forest, grasses, among others as pronounced by the interviewed people (both residents and district staff). Considering three Landsat images since 2000 to 2020, this section presents the outcomes of the unplanned settlement growth

considering the built-up area in comparison with other land use types namely the non-built-up area as the later include all other land use and land cover except built up area. Considering the image classification analysis of the indicated periods, it is observable that unplanned settlement growth has rapidly increased, leading to the settlement growth over time as presented by built-up difference of year 2000 and 2020. The figure 4 shows the results from the classified Landsat images demonstrating unplanned settlement growth in the study area for the previous 20 years.

Table 6: Land Cover change since 2000 to 2020

Land use/Cover type	Periods and Area ha			Change in ha and in (%) respectively	
	2000	2010	2020		
Built-Up	272.16	318.24	497.3	225.14	83%(increased)
Non Built-Up	2385.18	1915.1	1523.13	862.05	36% (reduction)

According to the table 6, the non-built-up land use and/covers had presented an excessive decrease during the previous 20 years, as about 862.05 ha have changed into other uses. The figure 5 demonstrates the land cover changes in ha since 2000, 2010 and 2020 in study area.

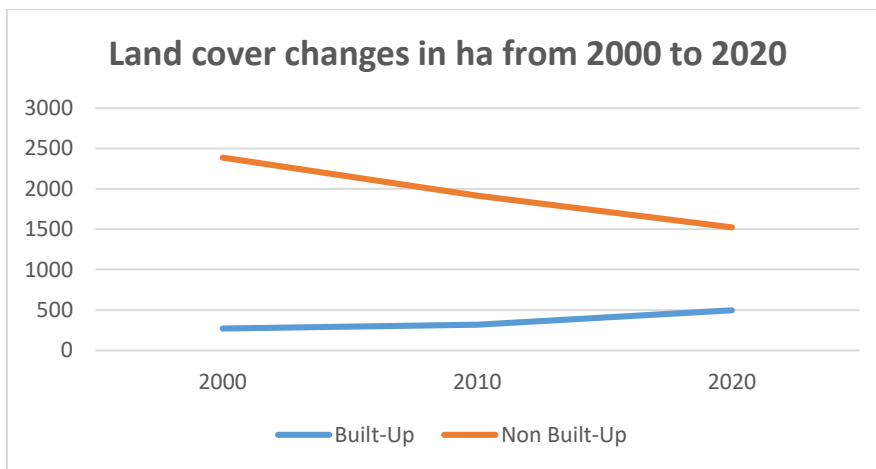


Figure 5: Land cover changes in ha since 2000, 2010 and 2020

As demonstrated in figure 5, there is a negative correlation between built up development with respect to other land use/covers, where other use types were reduced over time. The correlation implies that the study area is subjected to the degradation of land resources as the built-up development has been implemented in informal way.

Consequently, as this study has remarked that the built up development has negatively correlated with other land use/covers, we classified the slope of the study area as presented in figure 6,

As the study considered the build-up development as a main indicator of informal settlement development, the slope classification was based on the build-up development in relation to the permitted residential zone conditions in Rwanda. where we considered the slope in percentages as 0-5, 5-30, 30-55, above 55. In the study area, the analysis shown that the area with a slope between 0 to 5 percent present a flood prone areas, 5 to 30 percent present an optimal slope for residential, 30 to 55 percent present a slope with conditional use. finally, a slope above 55 percentages is considered as a high risk zone.

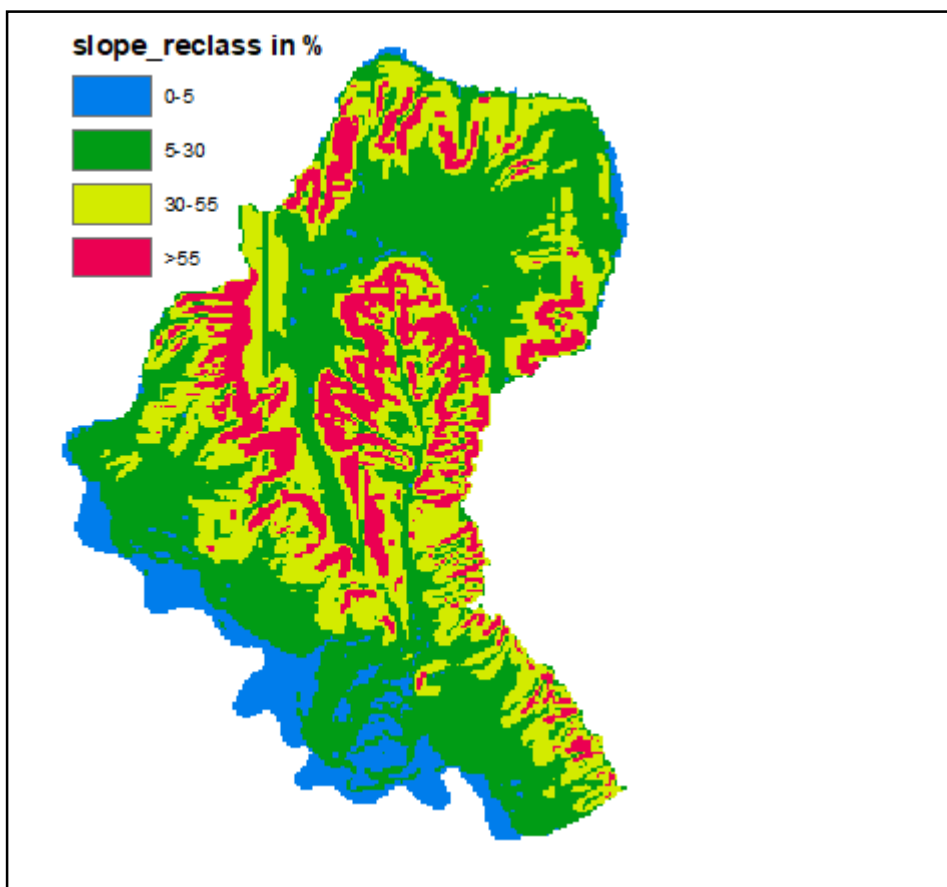


Figure 6: Slope Map of the study area

Source: RWFA (2023)

Considering the unplanned settlement growth in the study area for the previous 20 years from 2000 to 2020, this section presents the outcomes of the change of build-up area in relation to study area slope considering the build-up development of the classified images for the indicated periods.

Table 7: Slope category with respect to Build-up development change since 2000 to 2020

slope category in %	Build up periods and Area in ha			Change in ha
	2000	2010	2020	
0-5	4.291436	23.51349	34.42089	30.129454
5-30	71.79214	235.3137	231.8269	160.03476
30-55	32.45398	52.03366	147.9651	115.51112
above 55	11.26502	15.37764	87.70621	76.44119

As shown in table7, for the previous 20 years, the study area has been characterized by an increase of the build-up development on reliable slope as well as on the inappropriate slope.

4.2. Settlement expansion

This subsection demonstrates and discusses the findings on the settlement including establishment in the area, home ownership and access, facilities and services planning, challenges in the settlement as well as socio-economic impacts of settlement. During interview session, the responses of interviewed residents of the settlement, opinion leaders and decision makers were asked questions on the development mode of the settlement.

4.2.1. Settlement in the area

Through interview conducted, the researcher asked information about establishment in the area, including information on birth place, year of establishment and the possible factors that caused the unplanned settlement growth in the area. In the context of population characteristics, the respondent's information shows that the study area has various categories of residents, where some are the native in the area whereas others had come from other areas of the country with the majority being the non-native. The following are some explanations from interview.

The respondent RUO1 said that, *"I'm a non-native of the settlement, as I come from Cyangugu; most of the people here are the non-native as this place is closer to Kigali"*.

In relation to the settlement, what was said by the previous interviewee was complemented by BUP5 who said that, *"I'm a native but we are experiencing a greater number of natives selling their plots to the migrants from the other regions and they migrate to other areas far from here, may be this area will be a city"*.

In the context of settlement in the area, the information from interviews in the three cells indicate that the majority of people living in the study area have settled in the area between 2015 and 2020 indicating that the settlement has been growing overtime.

According to respondent KIP3, *“buying and selling immovable property like plots and house are at a high rate compared to other regions”*. She added: *“I have reached here in 2016, but from my arrival, there is no week free of vehicles moving the people to this area. Generally, it’s amazing, they buy the houses and plots at a high level”*.

In the study area, there are some people who bought the property and quit the settlement and as the time goes, the study area has changed and they come back to the settlement.

Respondent RUP4 said *“I bought this plot around 2010 and established in 2014 as I was a motorcycle driver in Kigali and this place had a lower value as its name is Nyabyondo. But around 2014, the site experienced a higher change of price. Can you imagine that from that time I’m not able to buy another property? sure, I have only this property as you see”!*

Consequently, the possible major factor that caused the unplanned settlement growth in the area is the implementation of Kigali city master plan of 2011. The expansion of unplanned settlement is due to implementation conditions of the master plan and expensiveness of its parcel acquisition, ease to own parcel as the area was not occupied at a large scale as well as low cost.

In the settlement, other major factors linked to the settlement growth are the proximity to capital city as for a large number of the settlers the livelihoods are made from Kigali city employment, weak monitoring of the settlement by district, illegal construction especially motivated by the local leaders from the cell to village level.

In addition, there is possibility of farming and livestock development due to the settlement in a rural landscape where land acquisition is easy and at low cost, with the low cost of livelihood and the existence of relatives in the neighbourhood.

In this regard, the respondent BUP1 said *“Generally, most of the people living here make profit from the proximity to Kigali either for their employment or other developed services. But as the capital has many challenges of establishment some people prefer to live here. If you want a simple fact, go where the buses park, you see a large number of people waiting for the bus to or from Kigali. In few words, the most influencing factor is the availability of jobs and services presented by Kigali City”*.

For instance, as indicated by different respondents, the place is settled by people from different places. Some of the people living in the settlement learned that the area presented some opportunities through their relatives especially those from Cyangugu who settled in previous years.

In relation with the origin of residents, respondent KIO3 stated that” *this zone has different people from different places of the country and also, we have some Congolese residents. Yes, don’t mind on the settlement, this is a rural place where the buying of a plot is easy as well as the construction. The monitoring and control of urban expansion is less rigorous especially in recent years. During my time, only 50,000Frw were enough for the local leaders to construct a house*”.

4.2.2. The key drivers of unplanned settlement expansion

This study has looked also into detecting the key drivers of unplanned settlement growth in study area. The purpose was to understand and see how those variables can be managed for the sustainable equilibrium of urban growth and viable use of land in our area under investigation. The results shows that the information from the district staff confirm what ordinary citizens said.

Different categories of respondents including ordinary residents, opinion leaders within the settlement as well as the district officers, all confirmed that the study area has a settlement growth over time particularly in Rutonde and Bugaragara cells. In those places, the main drivers included locality and closeness factors, employment opportunity factors and demographic factors.

4.2.2.1. The locality and closeness factors

Normally, the physical or spatial features influence informal settlement growth specifically the spatial factors such as proximity of industrial areas, distance to business centres, distances to Central Business District, distance to major roads, proportion of nearby commercial land use, amount of adjacent vacant land, proportion of surrounding planned residential areas, undeveloped land within informal settlement, close proximity to educational institutions as well as the closeness to a major investment.

According to the interview results mainly about the possible major factors that caused the unplanned settlement growth in the area, the interviewee, insisted on various factors including

Kigali city master plan 2011 as it was not easy for everyone, to own parcel as the study area was less occupied, near capital city as it is estimated a distance of 19 km from Nyabugogo Taxi Park to Shyorongi sector, weak monitoring of the settlement by district, fraud construction, possibility of agriculture and veterinary activities, low cost of living and join relatives, but the pattern locality and closeness factor is the most occurrence.

During interview, the respondent RUO3 said” *The rapid development of Kigali city has enhanced this settlement. especially, the implementation of Kigali master plan in 2011 as it was characterized by the demolition of informal settlement, it was followed by a big number of people to quit Kigali towards its surrounding areas to search for easy way to own property as well as land for other activities such as agriculture, as the regulations and procedures were less than in Kigali. When a person knows the area, she/she communicate to the relatives the advantages of the area, and so on. Consequently, this settlement has started to have a mass land selling and buying*”.

As discussed, both respondents (district staff and residents of the settlement), their information on key drivers present a similarity, as DE4 said “*Normally, this area has been a victim of Kigali city development. As the city grow, peoples search where to find an easy way of living and still enjoying the potentiality of Kigali city. As they found a way such as buying a plot and profit our weakness on construction monitoring, they communicate their contacts to try their chance also*”.

4.2.2.2. The employment opportunity factors

Employment factors influenced informal settlement growth in study area as this factor is linked with locality and closeness factors as discussed in 4.2.2.1. In fact, economic factors are acknowledged as important driver of informal settlement growth in our area of interest. This is especially due to economic pushing as for the majority of the interviewed people the working activities are located within the capital city. Therefore, the capital city factor makes an economic growth of the residents as they hope to earn much money as the settlement is located in the peri-urban area of capital city.

The respondent BUP6 affirmed “*Many of us in this settlement, our lives are Referring to Kigali city, therefore most of us pass the day time in Kigali searching for money then we return during night time to sleep in our houses. Even you, you can see the economic opportunities are located in Kigali rather than other region of the country including industries, schools, hotels, markets, and other many economic pushing opportunities. You can see the proof of what I’m saying, if*

you see a mass of peoples of this settlement in line waiting for the car from or to Kigali city. There are some people working in this area or elsewhere, but for the majority of us the daily activities are Referring to Kigali”.

The findings from the study indicate that the employment of the resident includes different activities. Consequently, some respondents expressed that they are employed locally while others work in the capital city or elsewhere. However, the majority of respondent said that their working place is in Kigali city.

In relation to employment, the respondent RUP7, declared that *“As you know, today’s life is based on struggling for money, as we have a bus from here to Nyabugogo, I work as a temporary worker in a supermarket in Kigali, but when I’m not working there, as the city is the city, I try to find another job in Kigali and I manage to find some money to survive as I have now my own house. Other development comes after eating”.*

Apart from those whose working place is within the capital city and elsewhere, the settlement has developed business activities including boutique, bars and restaurants. In the settlement there are some social services including public and private schools, among others.

In line with the importance of Kigali city for the livelihood of people, the respondent BUP3, stated *“yeah, as I have my house, even if it is not finished, but it is mine. the reason why I live here, I cannot return to Nyamasheke. But now, I am going to Nyabugogo with my moto to search for money. I’m a motorcyclist of course and my wife has beauty salon in Kijabagwe”.*

4.2.2.3. The demographic factors

Controlling and managing the expansion of informal settlements in the peri-urban area needs an integrated and comprehensive understanding of the informal settlement process mainly its driving factors including demographic expansion. Consequently, Rwanda has a growing population resulting in urban expansion, especially in Kigali city and its associated peri-urban areas including our study zone.

Interviewed KIO3 confirmed this, saying *“Rwandan population increase every day and this also influences the settlement growth rate as the increasing number of people pushes to settlement needs., Rwanda will continue to face various challenges related to the population increase and expansion of informal settlements”.*

4.2.3. Home ownership and Road accessibility in the settlement

Among the responses on home ownership, the majority of the interviewees own their houses and most of houses were constructed without a construction permit particularly in Kijabagwe cell. As observed by researcher as well as acknowledged by the respondents in the settlement, home accessibility by a car is limited especially in Kijabagwe cell.

The respondent named RUO3, explained” *I constructed without a construction permits of course. In the past time, we constructed without it, but the issue of permitting is being serious today. Even a kitchen needs a permit from land manager. Therefore, today we are lacking the suitable road in the settlement. Many cars stay at the main road at night. Imagine. But usually in the meeting, the authorities promise us to construct new roads. We are waiting for that, even the feasibility looks like expensive as it requires the demolitions of some constructions”.*

In addition, a large number of respondents, affirmed that the major drivers of growing unauthorized constructions in the study area were justified by ease to construct without permit, authorization were optional and took long-time to get issued.

When asked to give information about the major drivers that caused unauthorized constructions, the respondent KIO2, said “*As you see, this is a rural settlement under development and sometimes, the resident comes to profit from the weakness of the settlement conditions. The reason why many people constructed without authorization is that it was before the regulation were enforced. Some settlers constructed taking advantage of the weakness as well as inadequate services of the competent authorities. You can see, that even today, you can submit a construction permit application and you wait for the authorization until you become tired”.*

4.2.4. Facilities and services planning

The spatial development structure of the urban centre involves the provision of social infrastructure services and facilities to support the improvement of new communities as well as viable monitoring for the future development. The subset of the infrastructure sector includes community facilities and services such as: public infrastructures including schools, libraries, medical centres, emergency services, open spaces, recreational facilities; cultural institutions, churches; commercial building and community housings. The infrastructures above contribute to the improvement of social interaction, improvement of the quality of life within a community, stability as well as the improvement of human and social capital. Moreover, the presence of adequate social infrastructure services and facilities creates a

resilient community and it can be used to attract the external investment to support economic growth.

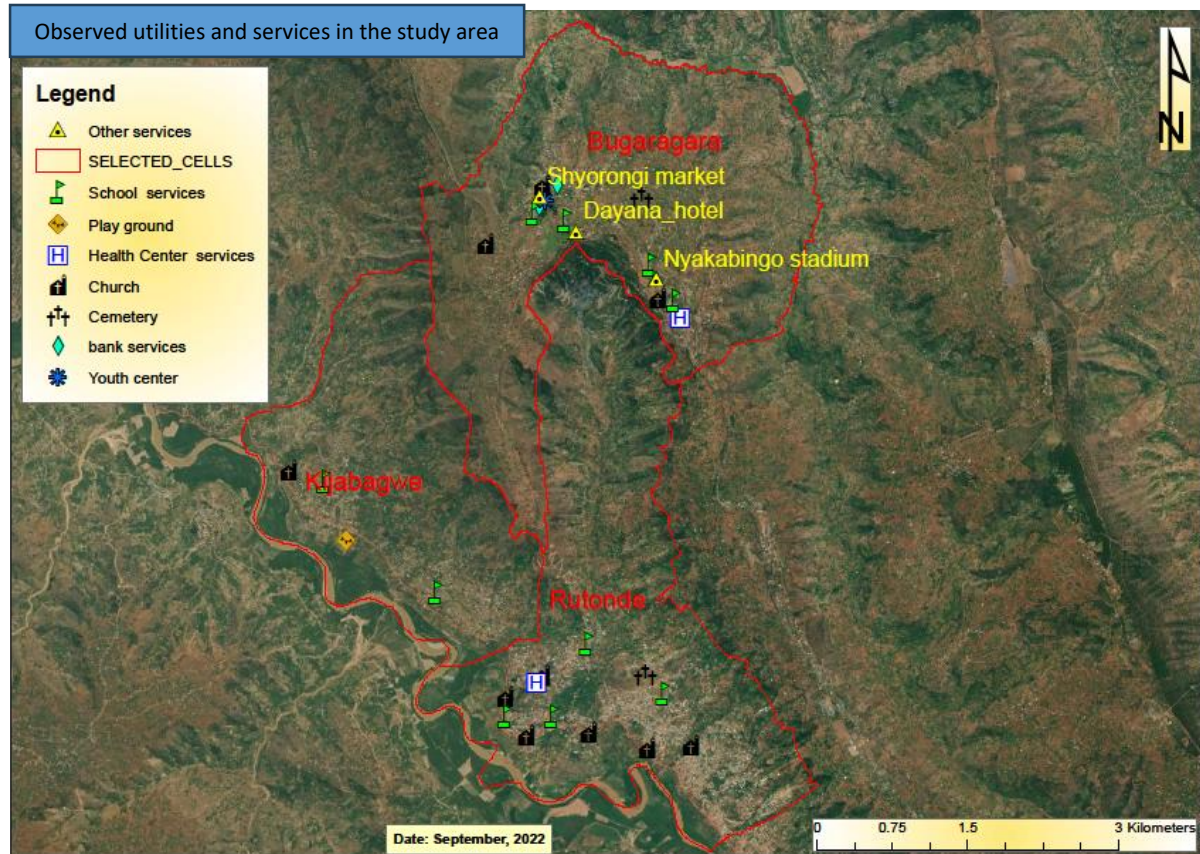


Figure 7: Facilities and services planning

Source: Field survey, June 2023

Some information was collected in relation to the levels of satisfaction with various facilities and services planning in study area. The results show that what the district staff said didn't differ from what the other interviewees said. They all confirm that the facilities and services are not in good conditions as the settlement has developed without a land use plan. Consequently, the settlement needs a sustainable upgrading strategy to make the viability of the settlement.

4.2.4.1. Health facilities in the settlement

The study findings show that most of respondents are not satisfied with health facilities as the majority is not happy with the services mainly the respondent of Rutonde and Kijabagwe cells. In this regard, the respondent RUP2 said “This area has many people even those from Gitarama crossing Nyabarongo to come here, but we have only two health centers (Rutonde and

Shyorongi health center. The nearest health centre for me is Rutonde, but the problem is that it has many people with few workers, so it takes the whole day to get the services. You can't see a private health centre in this area, the rich people go to Kigali and the poor goes to waste time in Rutonde health center". This is echoed by the district staff DE2.

As shown in figure 8, the picture shows Rutonde health center in Rutonde cell as it was said to have a high number of people seeking for health services with a few number of workers.



Figure 8: Rutonde health center

Source: Field survey, June 2023

In relation to the problem of service provision in the study area, with regard to health care, respondents exposed the issues of a little number of workers especially in Rutonde health center compared to Bugaragara health center. Therefore, some people try to seek health services in Bugaragara rather than in Rutonde.

Respondent KIP5 affirmed *“We look like we don’t have any health facility, we take the whole day in Rutonde health center, seeking the services and other activities of the day are cancelled. The workers try to care about us but they have a high number of people to serve. At least Bugaragara health center has a good service and they have a smaller number of people to serve compared to Rutonde. However, the problem is to reach there. But when I have 2000Frw, I take a moto to go there and then I return on foot”*.

4.2.4.2. Fresh water, electricity and school in the settlement

On the other hand, when the respondents are asked about the satisfaction with fresh water and electricity services, they indicated that the majority are satisfied with the services. The respondent BUO1 ascertains *“The government of Rwanda has addressed the problem of water and electricity, that is what we appreciate. Water and electricity supply are regular. Where there is no on grid electricity there are some solar systems. Where there is no WASAC, there is a tradition or pumping water. Someone who is not satisfied is an ungrateful”*.

With regard to the satisfaction with school services we found that the majority of the respondents are not satisfied as there isn’t enough government schools for basic education levels (Nursery, Primary and Secondary schools). The majority of the schools are privately owned and expensive for the general population. Consequently, there is a large number of students in governmental school classes due to the high school fees of the private schools. In line with this, the respondent RUP7 said *“We have the problems of school services as the number of government schools is lower than private. As a consequence, most of the poor students are based in government schools resulting in low education quality as one class has many students to serve. Imagine the follow up of those students in terms of presence, discipline, performance, etc. it looks like the government has left education to the private entrepreneurs. Those with their money educate their children in Kigali or the nearest private schools, but the poor content themselves with schools accessible”*. The respondents DE2 is of the same opinion.

4.2.4.3. Recreational and other service in the settlement

During the interview with respondents, we discussed other various issues in relation to the level of satisfaction with recreational facilities, drainage system, reliability of waste disposal as well as rain water management system. Most of the facilities related to aforementioned services are present but are not in conformity with required standards. The responses from interview indicate that most of respondents are not satisfied with the services. This explains

the socio-economic problems associated with degradation of roads, drainage system and land resources degradation.

The interviewed person named RUO2 affirmed “*We are waiting for the government to plan for our recreational services. Can someone recreate at the bar? Currently, we have many bars but less recreational facilities. In terms of drainage system as well as roofing rain water management system, everyone tries to orient the water outside his/her place. Yeah, there are some serious people who tried to manage the water, but the majority of us we don’t. Therefore, our roads are damaged every day due to that issue of inappropriate drainage systems*”.



Figure 9: Road degradation in Rutonde

Source: Field survey, June 2023

As shown in figure 9, the picture shows a road degradation in Rutonde cell mainly due unreliable rain water management and inadequate drainage system.

4.2.5. Other Challenges in the settlement

The unplanned human settlement growth affects various aspect of life including sustainable land use, environmental management, land cover and accessibility, drainage system, physical condition of the settlement, lack of awareness for waste disposal, lack of affordable housing, land resource degradation, air pollution, landslide, flood and any other factors subjected to unreliable land use planning.

In order to learn whether this settlement have challenges related the living conditions of residents, respondents from both district staffs and residents were asked about other **challenges** faced. They mentioned excessive soil erosion due to inadequate drainage system, inadequate basic infrastructure, degradation of road from Kinyoni-Gakenke; inappropriate rain water management systems and poor services provision in the settlement services.

The analysis shows that inadequate basic infrastructure and facilities planning is considered as the most important challenges for a high number of respondents compared to other factors in the settlement especially in Rutonde and Kijabagwe cell.

The respondent KIO1 estimates that *“All of the challenges can be resolved by the district, but they don’t care. They look like they are waiting for another person to address them. I consider that this District has no planning of its activity and budget. The leadership changes but our challenges remain. We have challenges related to health care facilities, schools, sport area, rain water management, home accessibility, drainage systems, more and more. Another stressful problem is the land and construction permitting services take too long, the reason why some people prefer to construct at night or in fraudulent system without respecting regulations. We will still have those problems until Jesus comes back”*.



Figure 10: Soil erosion in Kijabagwe

Source: Field survey, April 2023

Figure 10 indicate Soil erosion in Kijabagwe cell, where during the raining time, a playground and its surrounding were eroded due to the weak management of rain water and drainage system.

From interview results, many responses show that Bugaragara cell is more developed in the study area as it's development masterplan was prepared in 2011, even though it looks like the monitoring of the implementation has failed.

Respondent DE1, said” *Yeah of course, the settlement has some challenges, mainly associated with the context in which human has settled in the place. The most important challenges are related to the informal settlement development with associated impact including home accessibility, construction without compliance to building code, insufficient infrastructure development especially in Rutonde and Kijabagwe, that have a large number of immigrants. However, Bugaragara has a better potential human development, as at least it has a development master plan but present a weakness in development monitoring*”. This is confirmed by majority of respondents.

4.2.6. Social-economic positive impacts in the settlement

In order to have accurate information about social-economic impact in the settlement, the respondents were requested to mention their views on the social-economic positive impacts considering their living conditions. The majority of resident accompanied by some numbers of district respondent, agreed on that the most positive impacts in the settlement are to own a house, the possibility for urban poor to have a job and make a living.

Even if the settlements were developed in an informal way, they have initiated some positive change, as observed by researcher as well as pronounced by the majority of respondents,

- i. **The possibility for urban poor to have a job and make a living** in this context, **the** settlement created some businesses and job opportunities especially based on selling and buying land as well as construction materials, a need of construction experts and manpower, bars, restaurant and alimentation services, creation and extension of private and public-school services, among other development projects. In this regard, respondent DE2 said *“we can see some positive impacts of course, Normally, the economy of the district is based on the population, meaning that once the population increase in the district, it implies that the district has a chance for development. Once the people are in construction, there is a job creation. Once someone constructs a commercial house, there is a positive economic change either for the population or for the district. Even if it is informal, but it developed the zone”*.
- ii. **Owning a house**, normally, many people like to accommodate in their own house, so that, if someone found a room to own, he/she profit and enjoy the occasion regardless of the impacts generally the urban poor and the migrated peoples. the respondent BUO2 added *“for most of us, our life is based in Kigali, but it is not easy to own a property there. Therefore, once you come in the area like this, you have a chance of owning a house even if it may not be of very high value, but you own the one responding to your capacity. Consequently, the richest and poorest people have the chance to implement their dreams. But don't mind that also the urban areas are being created enabling some job opportunities”*.

Even if, the majority of respondents agreed on positive impacts, there are a little number of respondents disagreed by saying that they don't see any positive impacts of informal settlement.

4.2.7. Social-economic negative impacts in the settlement

Besides, the positive impacts in the settlement, the respondents were requested to mention the social-economic negative impacts. The majority agreed on that the most negative impacts in the settlement are linked to the risk of flooding, limited job opportunities, environmental degradation due to the inappropriate rain water management system, unplanned land use and inadequate basic infrastructure & facilities. according to the observation and spatial analysis made by the research, respondents from the district as well as the residents in the settlement; the settlement has:

- i. **The risk of flooding and environmental degradation**, as presented on slope map, in the study area there some build-up developed in unfavorable slope as well as in flooding areas as the study area has been characterized by excessive constructions without compliance with existing rules and regulations. Therefore, in the settlement, there are some conflicts related to rain water management, some cases of houses collapsing due to the context of illegality in their construction. The candidate KIP4 stated *“The settlement has many negative impacts linked to context in which it was developed. As you see, most of the people have constructed without a development plan. As a result, we have a lack of affordable management of rain water as well as waste disposal resulting in the risk of flooding, soil erosion, etc.”*.

- ii. **Unplanned land use and inadequate basic infrastructure & facilities**, in the settlement there are some development projects implemented on unreliable land use plan. This has negatively affected sustainable land use in the settlement as you can see some mismatching of the existing construction with respect to the planned land use, lack of affordable basic infrastructure & facilities planning, access pathway negotiations between the neighborhoods, among others. On this regards, respondent DE2 said *“Even the context in which the settlement was developed, has a negative effect as it has developed without compliance with the planning. When the budget will be available for the upgrading of the zone or for facilities improvement, it will need a big budget for expropriation. In addition, when we look to the current approved zoning, there are many mismatching of the existing situation with respect to the*

planned use. We can see some constructions within a cemetery zone, under agriculture use, across a planned road, under a social use, and so on. Frequently, we receive complaints about conflicts related to roofing water management, home accessibility mainly path way for home accessibility”.

- iii. **Limited job opportunities**, as the settlement has developed in an informal system, the settlement lack a reliable job opportunity planning, as there are a large number of jobless, so that many peoples in the settlement their employment opportunities are based outside the settlement especially in Kigali city. Respondent BUP4 said, “*we have a problem of employment planning in this settlement, so that a large number of people in this settlement they living condition are based to Kigali city. Yeah, we have some job activities in this settlement of course, but the majority the residents work outside of this settlement due to the limited job opportunity in this area”.*

Apart from interview result, the analysis of Landsat images shows that the settlement has been characterized by unwarranted change of build-up area compared to other LULC named non-build up as presented in chapter4, section 4.1. of this report. Consequently, those variations caused uncontrolled land use in study area. Also, during GIS analysis, by comparing the infrastructures and services available on the ground with respect to land uses master plan, it was found that among the current infrastructures and services in the study area, a high number of them is not in compliance with land uses master plan, as the majority are constructed in agriculture and residential zones. Consequently, this settlement has negatively affected sustainable land use as confirmed by Dagmar al.(2018) who said that the urbanization is certainly the greatest important practice of land-use and land cover change because it has considerable effects on the pattern, dynamics and functionality of ecosystems.

4.2.8. The respondents’ views on the relocation of settlement

To address the challenges caused by the development of information settlement, the relocation has been a solution put forward. In order to have an insight of the respondents’ views on the relocation of the settlement, in responding, the interviewees were not interested with the idea. The majority of the respondents doesn’t agree with the idea of moving to another area. Only a little number agreed with the idea. For those who disagreed, the justification was that the settlement is close to the capital city while others have relatives in the settlement. Those who

find the relocation as a good option, they are not satisfied with the living conditions and would like to see some improvement of the settlement.

The respondent BUO3 said *“I cannot leave the settlement, I’m ready to struggle with the challenges, but I can’t leave. The zone is developed and me I leave? No, I can’t. this is Kigali Boss. Even if we face challenges, I like the zone for many reasons as I have some relatives in this area, when I want to go to Kigali, it takes me one minutes then I am back. Sure, we like the zone. Hhhuumm, five years from now, you will see how the settlement will be shining”*.

In this regard, a district staff explained *“there is no need of relocation, but the improvement of the settlement. That settlement is among the potential and urbanized area in the district. We will collaborate with our stakeholders so that we can mobilize the budget for the improvement”*.

4.3. Possible solutions to unplanned settlements

In terms of solutions for sustainable settlement in the area. Respondents from study area suggested the upgrading of the settlement, raising awareness of population in sustainable human settlement as some residents do not have information on human settlement standards, adequate planning for human settlement, good implementation and monitoring of settlement policies as well as the encouragement of private sector to invest in building accessible houses within the district.

4.3.1. Settlement upgrading

As this study demonstrated, there are many challenges in the settlement. For the sustainable settlement in the area, the government of Rwanda together with concerned stakeholders have to apply various upgrading strategies for ameliorating the living conditions in the settlement as well as sustainable use of land resources.

The respondent RUP1 said *“This settlement should be upgraded. Once it is upgraded, it may be a good place to settle as it is closer to Kigali. Again, the district should contact some financial institutions to facilitate and promote the construction projects in the study area. so that inhabitants can go and ask some loans to upgrade and finalize their houses. In addition, the private institutions should also be motivated to invest in the construction for private health service, day care, recreational facilities, etc. This is confirmed by the respondents DE3 and DE4 from district staff.*

4.3.2. Awareness of populations in sustainable human settlement

Unplanned human settlement growth has been expanding and this resulted in various challenges associated to the mode of occupation in the area. As already pointed out the population growth has been behind unplanned settlement growth. To address this challenge, we propose the mobilization of the population for their contribution to the change needed.

The interviewee RUO3 give an idea of what can be done *“they can improve this settlement by mobilizing the residents on the approved master plan focusing on their role in its implementation, as most of us see that this area was occupied in inappropriate way and we are the victims of their planning and weakness”*. In this regard, the district staff DE3 clarified *“yeah, I think many people in the settlement doesn’t have enough information on approved land use plan, as we don’t take a time to explain to them. We have to go and educate them how to implement it and their role”*.

4.3.3. Stakeholders’ consideration in human settlement planning

Generally, stakeholder’s participation has a dynamic role in the success of project planning and implementation. But, during this study, from different respondents (District staff and Residents), we recognized a lack of stakeholder’s participation at any level of the preparation of land use master plan (pre-planning, initial planning and phase of planning). Therefore, the stakeholders including local residents should be involved at early stage of design and implementation of human settlement.

In this regard, the respondent DE4 confirm in this term *“normally, the settlement has been developed in a rapid and informal way. Therefore, you can see that most of the residents are not satisfied with the settlement and services planning. Even, when the district prepared the development master plan, there were no consultation with the community. May be there was no time to involve the public due to the urgency of the preparation”*.

4.3.4. Private sector contribution to housing promotion

The government of Rwanda has put in place the national investment strategy and employment promotion aimed to promote investments in housing and settlement sector and poverty reduction respectively. Thus from those strategy and other related policies and strategies, the encouragement of private sector to invest in building accessible houses within the district will facilitate many individual residents and groups to have access to employment and financial support to invest in sustainable housing and the improvement of unplanned residential areas.

This is confirmed that respondents DE4 who says “*we have to encourage private sector to invest in accessible houses. So that our people may benefit from the investment to get jobs for their own development project, selling their inappropriate house, renting as well as buying the finished house*”.

CHAPTER V: CONCLUSION AND RECOMMENDATIONS

This chapter presents the conclusion and recommendations from the study findings. Firstly, it gives a summary of the study results in line with the study objectives as well as their equivalent research questions. Secondary, it proposes recommendations for addressing unplanned settlement and enhancing the living condition of the inhabitants.

5.1. Conclusion

The main objective of this research was to assess the impact of unplanned settlement growth in the peri-urban areas of Kigali city, case of Shyorongi sector in Rulindo District. Three specific objectives were developed. The first objective was to analyse unplanned settlement growth in Shyorongi Sector from 2000 to 2020. The second was to investigate the socio-economic impacts of unplanned settlement expansion in Shyorongi Sector and the third was to propose possible solutions to unplanned settlements. The objectives were responded through GIS and remote sensing analysis, review of literature as well as interview results.

The study findings indicated that since 2000 to 2020, unplanned settlement in Shyorongi Sector has increased. The primarily cause was the excessive development of new constructions including residential and commercial houses, infrastructure and facility services. The development generated positive and negative impacts on living conditions in the settlement as well as land use and land cover types changes. The key three identified and discussed negative impacts of unplanned settlement are inadequate basic infrastructures and facilities planning, environmental degradation and unplanned land use whereas the settlement related positive impacts are owning a house, responses to the needs of urban poor, job creation. The study also discussed about the main drivers of this informal settlement expansion and we have found three including closeness to Kigali city, employment opportunity and demography. Finally, the study suggested four main operational measures mainly settlement upgrading, awareness of population in sustainable human settlement, stakeholders’ consideration in human settlement planning and encouragement of private sector to invest in building accessible houses within the district.

5.2. Recommendations

Taking into account the study findings, this study proposes various recommendations. As it was found that the district has a weakness on the monitoring of the settlement variation, the district has to conduct regular monitoring of human settlement especially the build-up development. This will allow the control of informal settlement expansion and its adverse effects. Also, we advise to upgrade the present settlement especially by providing missing basic infrastructure and services, creating employment opportunities, among others.

We also recommend that present protocols related to human settlement and sustainable use of land be applied and monitored. In addition, viable rain water and waste management methods should be applied to guarantee sustainable settlement and environmental management. Again, as the preparation and execution of master plan has been taking place without the consideration of stakeholders, the latter should be fully involved in all steps of planning for urban development.

As it was observed that some people do not have enough information on the master plan as well as its role on their living conditions, the district must help the public to have the vital information. The district has to encourage the private sector to invest in building accessible houses within the district.

Finally, further studies are recommended in terms of assessing the environmental impact linked to natural resource management, water and air pollution, waste management and loss of biodiversity.

REFERENCES

- African, P. (2000). *Land Scarcity May Jeopardise Peace Process*. Pan African News Agency.
- Agatha. (2021). Understanding the factors influencing the spatial dynamics of informal settlements: The case of Enugu City, Nigeria. *UFS*.
- Alchemer. (2021, May 20). *Purposive Sampling 101*. Retrieved from Alchemer survey platform, : <https://www.alchemer.com/resources/blog/purposive-sampling-1>
- Baffoe al. (2020). Understanding the Concept of Neighbourhood in Kigali City, Kigali.
- Bapari, M. Y. (2016). Impacts of Unplanned Urbanization on the Socio–Economic Conditions and Environment of Pabna Municipality, Bangladesh . *Journal of Environment and Earth Science* .
- Benken. (2017). *Nowhere to go : informal settlement eradication in Kigali, Rwanda*.
- Bizoza, R. (2014). Population Growth and Land Scarcity in Rwanda. *African Union Conference Center*.
- Collins. (2018). *Global Risks report*. Geneva: World Economic Forum.
- Dagmar al. (2018). urban planet Knowledge Towards Sustainable Cities.
- Elsevier. (2021). Determinant factors for the expansion of informal settlement in Gondar city, Northwest Ethiopia. *Journal of Urban Management*.
- ElsevierBV. (2022). The role of social infrastructure services in developing the city centre planning. *Ain Shams Engineering Journal*.
- GoR. (2017). *National Strategy for Transformation (NST1)*. Kigali.
- Jacob al. (2017). Qualitative Inquiry & Research Design. *Russian Journal of Sociology*.
- Jain, N. (2021). *Comparing Data Collection Tools for Exploratory Research*. NSUWorks.
- John-Nsa, C. A. (2021). Understanding the factors influencing the spatial dynamics of informal settlements. The case of Enugu . *Town and Regional Planning*.
- KAYITESI, C. (2019). *SPATIO-TEMPORAL ANALYSIS OF URBAN GROWTH AND ITS* .
- Kombe, W. (2003). Land use dynamics in peri-urban areas and their implications on the urban growth and form.

- Laterite. (2018). *The dynamics of unplanned settlements in the City of Kigali*.
- Laterite. (2019). Understanding the dynamics of unplanned settlements in Kigali, Kigali.
- Melinda al. (2002). Global urbanization and impact on health. *International journal of hygiene and environmental health*.
- MININFRA. (2012). *Urbanization and Rural Settlement Sector Strategic Plan (2012 – 2017)*.
- MININFRA. (2009). *UPDATED VERSION OF THE NATIONAL HUMAN SETTLEMENT POLICY IN RWANDA*. Kigali.
- MININFRA. (2015). *National Informal Settlement Upgrading Strategy*.
- Mohita, N. (2018). Rural Settlement of People: Types and Patterns.
<http://www.yourarticlelibrary.com/geography/rural-settlement-of-people-types-and-patterns/12721>.
- MUGISHA. (2011). *From unplanned settlement to new housing development in Kigali city: the case study of Amahoro cell, Muhima sector*. Retrieved from https://www.memoireonline.com/07/15/9176/m_From-unplanned-settlement-to-new-housing-development-in-Kigali-city-the-case-study-of-Amahoro-
- Nandam, V. (2020, January 31). *Out of User's and Producer's accuracy, which of these two is relatively important?* Retrieved from Sardar Vallabhbhai National Institute of Technology: <https://www.researchgate.net/post/Out-of-Users-and-Producers-accuracy-which-of-these-two-is-relatively->
- Napier, M. (2002). *Informal settlement integration, the environment and sustainable livelihoods in sub-Saharan Africa*. Retrieved from https://www.researchgate.net/publication/237811616_Informal_settlement_integration_the_environment_and_sustainable_livelihoods_in_sub-Saharan_Africa
- Nations, U. (2019). *World Population Review*. Retrieved from <https://worldpopulationreview.com/countries/rwanda-population>
- NISR. (2010/11). *Integrated Household Living Conditions Survey Rulindo District*. Kigali: NATIONAL INSTITUTE OF STATISTICS OF RWANDA.

- NISR. (2012). *Population Size, Structure and Distribution*. POPULATION SIZE, STRUCTURE AND DISTRIBUTION, NISR, KIGALI.
- NIYONZIMA, T. (2009). *Land Use Dynamics in the face of Population* .
- OZ Architecture Team. (2007). *Kigali Conceptual Master Plan (KCMP)*.
- Rajashi, M. (2019). How to choose your sampling strategy to guarantee relevant results. *data journey*.
- REMA. (2009). *POPULATION, HEALTH AND HUMAN* .
- RULINDO. (2013). *District Development Plan(2013-2018)*.
- RWANDA, R. O. (May 2009). *UPDATED VERSION OF THE NATIONAL HUMAN*. Kigali: MINISTRY OF INFRASTRUCTURE.
- SATI, V. P. (2017). Urbanization and Its Impact on Rural Livelihoods. *Chinese Journal of Urban and Environmental Studies*.
- Shakirah Esmail, J. C. (2020). Struggles to remain in Kigali’s “ unplanned ” settlements . *sage publications*.
- Shams, A. (2018). the effect of unplanned growth of urban areas on heat island phenomena. *Ain Shams Engineering Journal*.
- Shyorongi, S. (2022). Shyorongi sector population development. (Researcher, Interviewer)
- UN. (2011). *Population distribution, urbanization, internal migration and development*. Department of economic and social affairs, population division.
- UN. (2018). *World Urbanization Prospects the 2018 revision*. United Nations.
- UN. (2019). *World population review report*.
- worldbank. (2015). *Master Planning*. Retrieved from <https://urban-regeneration.worldbank.org/node/51>
- worldometer. (2022). *United Nations*. Retrieved from (www.Worldometers.info): <https://www.worldometers.info/world-population/rwanda-population/>

Appendix A. Interview guide of the resident and opinion leaders of the settlement

Dear respondent,

I am NSABIMANA Jean a master's student in University of Rwanda, in the program of geo-information science for environment and sustainable development. In fulfilment of the requirements for the degree, I am undertaking research on the impact of unplanned settlement growth in the peri-urban areas of Kigali city case of Shyorongi sector in Rulindo District. Therefore, I would like to request you to deliver the reactions to the proposed questions and all your opinions will be used strictly for this study purpose.

1. Questions about establishment in the area

a) Were you born in this Cell?

.....

b) Which year of establishment in this area?

.....

c) According to your observations, what were the possible major factors that caused the unplanned settlement growth in this area?

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

2. Questions about home ownership, employment activities and access

a) Where are your activities/job located?

.....

b) Do you own this house?

.....

c) Have you constructed here with a construction permit?

.....

d) According to your observations, what were the major drivers that caused unauthorized construction?

.....

e) A car can access your home?

.....

3. Questions about facilities and services planning

a) How are you satisfied by the health facilities?

.....

b) How are you satisfied by fresh water services?

.....

.....

c) How are you satisfied by school services?

.....

d) Have you electricity services in your house?

.....

e) How are you satisfied by recreational areas?

.....

f) How are you satisfied by selling point areas?

.....
g) How are you satisfied by drainage systems?
.....

h) Are there in this settlement a waste disposal?
.....

i) Have you a roofing rain water management system?
.....

4. Questions about challenges in the settlement

a) What are the major challenges faced by being in this settlement?
.....
.....
.....
.....
.....
.....

b) Among the above challenges in a), what are the most heavy that need insistent interventions?
.....
.....
.....

c) What are the measures to be applied to mitigate the challenges in b)?
.....
.....
.....
.....

5. Questions about positive and negative impacts in the settlement

a) What are the most positive impacts of this settlement?

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

b) What are the most negative impacts of this settlement?

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

c) If possible (voluntarily, relocation with compensation), how can you hear about to move you to another area of settlement?

.....

d) In e) specify why c):.....

.....

e) What are the alternative solutions can you propose for the sustainable settlement in this area?

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

Thanks for your time and contribution to my MSc thesis!

Appendix B: Interview guide for District staffs

Dear respondent,

I am NSABIMANA Jean a master's student in University of Rwanda, in the program of geo-information science for environment and sustainable development. In fulfilment of the requirements for the degree, I am undertaking a research on the impact of unplanned settlement growth in the peri-urban areas of Kigali city case of Shyorongi sector in Rulindo District. Therefore, I would like to request you to deliver the reactions to the proposed questions and all your opinions will be used strictly for this study purpose.

Questions on master plan preparation and implementation

- 1. As Kijabagwe, Rutonde and Bugaragara cells presents informal settlement, Are the local community involved in the planning process of land use plans?**

.....

- 2. If yes, how are they involved in the planning process? At which level (pre-planning? Initial planning, end phase of planning?)**

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

- 3. If No in 1, why they are not involved?**

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

- 4. Are the community satisfied with the zoning regulation proposed? If yes or no, Why?**

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

.....
.....
5. According to your observations, what is your point of view in terms of amenities availability in the settlement?

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

6. As a staff related with human settlement and community development respectively, how is the implementation of the existing planned land use master plan impacting on the living conditions of the residents?

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

7. What are the main growth priorities in the planned land use that should improve the unplanned settlement Specifically in Kijabagwe, Rutonde and Bugaragara cells?

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

8. What are the main challenges which affect the implementation of District master plan especially in Kijabagwe, Rutonde and Bugaragara cells (from the most important to the least important)?

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

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

9. How those challenges can be handled?

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

10. What alternative solutions can you propose for the sustainable settlement growth in shyorongi sector?

Questions related to positive and negative impacts of development

1. According to your observations, what are the heaviest challenges in the settlement that need insistent interventions?

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

2. What are measures to be applied to mitigate the challenges in 1) above?

.....

.....

3. What are the most positive impacts of this settlement?

.....

.....

.....

.....

.....

.....

Thanks for your time and contribution to my MSc thesis!

Appendix C: Observed utilities and services by cell

BUGARAGARA CELL			RUTONDE CELL		KIJABAGWE CELL
ADVENTIST CHURCH	SHYORONGI SACCO		ADVENTIST CHURCH		GS KIJABAGWE
MOSQUE	SHYORONGI_TVT_SCHOOL		TEMOIN DE JEHOVAH CHURCH	METHODISTE CHURCH	PLAY GROUND
IGOS_SCHOOL	DAYANA_HOTEL		ADEPR RUTONDE	GERA SCHOOL	GS_MUSENYI.
BPR	GS_SHYORONGI		EP_NYAMIREMBE	RUTONDE CELL OFFICE	ADEPR_GASEKE.
SHYORONGI MARKET	NYAKABINGO STADIUM		CEMETERY	CATHOLIC CHURCH	KIJABAGWE CELL OFFICE
ADEPR_SHYORONGI	CATHOLIC_CHURCH		INDATWA SCHOOL		
YOUTH_CENTER	STELLA_MATUTINA SCHOOL		ADVENTIST CHURCH		
BUGARAGARA CELL OFFICE	SHYORONGI_HC		GS_RUTONDE		
SHYORONGI SECTOR OFFICE	GS_GISIZA		RUTONDE HC		
Tot: 18			Tot: 13		Tot: 5