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DEPARTMENT OF CIVIL ENGINEERING

OPTION: LAND SURVEY

FINAL YEAR PROJECT

Submitted in partial fulfillment of the requirement of the award of Advanced Diploma in Land survey Engineering

SUBMITTED BY: NZAYISENGA Herondine

Roll number: 202150015

Under the guidance: Eng.CIMANUKA Bongwa David

Kigali, September, 2024

DECLARATION

I, NZAYISENGA Herondine, hereby affirm that my project titled "The Impact assessment of Urbanization growth on Agricultural Land in the Cyuve Sector of Musanze District" is an original piece of work that has not been previously submitted to any educational institution. This research represents my independent efforts, with due acknowledgment given to the works of other scholars through proper citation and referencing. I assert full ownership of

this project, which was successfully completed under the guidance of Eng. CIMANUKA Bongwa David. All utilized sources and quotations have been appropriately cited and referenced.

Submitted by:

NZAYISENGA Herondine Roll:202150015

Signature……

APPROVAL SHEET

This dissertation has been formally submitted with the endorsement of the supervisor, Eng. CIMANUKA BONGWA DAVID, and Eng.NKIRANUYE Bonaventure the head of department in Civil Engineering.

Supervisor Head of civil Engineering department

Eng. CIMANUKA BONGWA DAVID Eng. NKIRANUYE Bonaventure

Signature…… Signature……

Date: / / Date: / /

DEDICATION

I dedicate this project to:

My almighty GOD

My parents

My lecturers

My brothers

My sisters

My classmates

The UPI staff and to my family, colleagues, friends who being in my side.

CERTIFICATION

This document serves as a declaration confirming that the research project titled "Assessing the Impact of Urbanization growth on Agricultural Land in the Cyuve Sector of Musanze District" represents the authentic efforts and contributions of NZAYISENGA Herondine This project was undertaken as part of my academic pursuits towards earning an advanced diploma in land surveying during the academic year 2023-2024.

Supervisor:

Eng. CIMANUKA Bongwa David

Signature ……...

ACKNOWLEDGEMENT

I begin by offering my heartfelt praise to the Almighty for His continuous guidance, provision, and protection throughout my academic journey. His unwavering support sustained me not only during my coursework but also throughout the challenging process of completing my final year project.

my deepest gratitude goes to my supervisor, Eng. CIMANUKA Bongwa David, whose exceptional guidance, encouragement, and unwavering support were instrumental in my final year project's success. Under his mentorship, I gained valuable insights, essential skills, and invaluable advice, particularly in the field of surveying. Without his expertise and motivation, completing my research project would have been an arduous task.

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ABSTRACT

The study investigated the effects of urbanization growth on agricultural land in the Cyuve sector of Musanze district, Northern Province, spanning from 2005 to 2022. To analyse and map these changes, I utilized ArcGIS and Landsat images and google earth. I collected and analysed data through a combination of fieldwork, reconnaissance, and data integration methods.

The findings of the study indicated substantial alterations in land utilization patterns over the specified period. There was a noticeable in urbanized areas accompanied by a decline

in agricultural land from 68% to 50% in 2022. This transformation was primarily driven by the rapid expansion of urban areas due to population migration and urban development, resulting in a 18% reduction in agricultural land between 2005 and 2022 after 17 years. The prediction found that in 2050 agricultural land will decline to 47% while built up area will increase 54% Considering these findings, it is advisable for the Cyuve sector to prioritize the preservation of the remaining arable land to protect and sustain agricultural resources in the face of urbanization pressures.

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LIST OF ABBREVIATION

DGPS: Differential Global Positioning System

GDP: Gross Domestic Product

GIS: Geographical Information System

GNSS: Global Navigation Satellite System

GOR: Government of Rwanda

GPS: Global Positioning System

IPAR-Rwanda: Institute of Policy Analysis and Research Rwanda

LULC: Land Use and Land Cover

MINAGRI: Ministry of Agriculture and Animal Resources

MININFRA: Ministry of Infrastructure

NLUDMP: National Land Use and Development Master Plan

RAB: Rwanda Agriculture and Animal Resources Development Board

RDB: Rwanda Development Board

RHA: Rwanda Housing Authority

USGS: United states geological survey

CHAPTER1: GENERAL INTRODUCTION

1.1. Introduction

Land represents the solid surface of the Earth that isn't permanently underwater, mostly found at elevations above sea level, primarily composed of geological materials like rock,

sand, soil, and sometimes ice. Agricultural land is specifically used for farming, which involves controlled cultivation of crops and livestock to produce food for human consumption, often referred to as farmland, cropland, pasture, or rangeland. Urban growth pertains to the increase in urban population, signifying the expansion and contraction of economic hubs. The impact of urbanization on agricultural land tends to be negative due to uncontrolled and uncoordinated urbanization, which often leads to the depletion of agricultural resources and overrides positive aspects. (bank, 2020)

1.2 Background of the study

Rwanda, known as the "Land of a Thousand Hills," is experiencing rapid economic growth and stability, thanks to progressive policies and political stability. Cyuve sector, located in the Musanze district at Northern Province, covers an area of 3,316.27 hectares and is undergoing significant transformation due to human activities. (bank w. , 2023)

This transformation is causing noticeable changes in land use and land cover patterns over time. Urbanization's impact on agricultural land in Cyuve sector is a result of socioeconomic factors and evolving land use practices. As the population grows and agriculture intensifies, land is becoming a scarce and precious resource. Understanding how urbanization affects agricultural land is crucial for sustainable land management and development to meet the increasing demands for basic needs and welfare. To address this, a study is being conducted to map the land use changes in Cyuve sector from 2005 to 2022, with a particular focus on assessing the rate of land consumption, especially in built-up areas. Geographic Information Systems (GIS) and Google Earth imagery are being used to detect and predict these changes. This information will guide informed decision-making to ensure the sector's continued growth while preserving its natural resources. (smith, 2023)

1.3 Problem statement

The rapid urbanization in Cyuve sector, located in Musanze district, Northern Province, has led to the encroachment on fertile agricultural lands. This expansion of urban areas has

presented numerous challenges for local farmers who are left with fragmented and shrinking parcels of land due to urbanization. These challenges include the pollution of irrigation water, declining soil fertility, rising labour costs, reduced institutional support, and a shift in the types of crops being cultivated, all of which contribute to the urbanization's negative impact on agriculture in the region. (ndikubwayo, 2018) The continuous growth of urbanization in Cyuve sector is a matter of great concern because it not only affects agricultural lands but also has broader implications for forests and other land classes. Moreover, the influx of people driven by house construction, road development, and general urban expansion exacerbates the problem, leading to further loss of agricultural land and a subsequent decrease in local income. This situation has been further compounded by private investments predominantly concentrating in Cyuve sector. Given these pressing issues, researchers have undertaken a project to assess the impact of urbanization growth on agricultural lands in Cyuve sector. This study aims to better understand the consequences of urbanization on agriculture and provide insights that can help address the challenges faced by local farmers and the broader community. (ntirugulirwa, 2017)

1.3 purpose of the study

The purpose of this study will be to conduct an impact assessment of urbanization in Musanze District, focusing specifically on Cyuve Sector from 2005 to 2022. By examining the transformation of Cyuve Sector over the past Nineteen years, this research aims to systematically evaluate the effects of urbanization on various aspects such as infrastructure, land use patterns, demographic shifts, economic activities, and quality of life indicators. The findings of this study will contribute valuable insights into the opportunities and challenges brought about by urbanization in Musanze District, providing a basis for informed policy recommendations and strategies .

1.4 Research objectives

1.4.1 General objectives

This project aims to evaluate how the expansion of urban areas in the Cyuve sector is

affecting agricultural land.

1.4.2 Specific objectives

 To create a map that visually represents land use land cover classes in different years in cyuve sector in 2005, 2012 and 2022.

 To generate a map that illustrates LULC change detection in Cyuve sector from 2005 to 2022.

 Prediction of cyuve land use land cover classes in 2050

1.5 Research questions

 How has land use and land cover changed in the Cyuve sector between 2005, 2012, and 2022?

 What are the spatial and temporal patterns of land use and land cover changes in the Cyuve sector from 2005 to 2022, and what are the drivers behind these changes?

 What are the potential future scenarios for land use and land cover in the Cyuve sector by 2050, considering current trends and potential socio-economic and environmental drivers?

1.6 The scope

The scope of the projects involves a comprehensive analysis of the land use and land cover classes in cyuve sector, to assess the impact of urbanization on agricultural land. This analysis encompasses factors such as changes in land use patterns, agricultural productivity, and the socioeconomic implications for local communities. Additionally, it should explore potential strategies for sustainable urban development that mitigate the adverse effects on agricultural land while promoting economic growth and urbanization.

1.7 Limitations of the Study:

The limitations in this project include the challenge of assessing the population growth rate and population density in Cyuve sector accurately, which can affect the analysis of urbanization impact on agricultural land. Additionally, the availability and accuracy of

historical land use and land cover data may constrain the comprehensiveness of the study, and potential seasonal variations in land use might introduce variability in the findings, impacting the project.

1.8. Significance of the study

1.8.1 Social significance.

 To update the planners what they will do for land use and land cover.

 It will facilitate the local authorities or administrative office in change of land to observe the change detected.

 It will assist in monitoring the dynamics of land use resulting out of changing demands of increasing population.

1.8.2 Personal significance

 It will help researchers to increase skills and improve my experience in practice of my studies.

 It will facilitate researchers to know deeply about how GIS technology can work efficiently to identify problem about land is and making decisions.

1.8.3 Academic significance

 Collaboration of privates and public stake holders with UPI for the same projects.

 It will be the reference to the next students of UPI in their studies and in their projects.

1.9 Organisation of the study (process chart)

Table 1: Structure of the project

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CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

Agriculture is vital for Rwanda's economy, contributing 39% to GDP, employing 80% of the workforce, and providing 90% of food needs. However, it faces challenges like land constraints, poor water management, and limited access to markets. The rural poverty rate is 49%, rising to 76% for farming families. Urbanization and industrialization are rapidly expanding cities in developing countries, leading to the conversion of agriculture land. Urban expansion, both horizontal and vertical, affects food production by displacing traditional farmers and reducing labour availability. Urban growth and sprawl are interconnected, driven by factors like population growth and people's preference for rural living. Geographic Information Systems (GIS) help monitor land changes over time. (RSP,2017)

2.2 Terms and basic definition

2.2.1 Urban growth

Urban growth is an increase in the absolute size of an urban population. This could be at the level of an individual settlement or a collection of settlements (e.g. at the national level). Urban growth and urbanization often occur together, but not always. “Time is running out. We need to act now to protect and restore the environment” (David SUZUKI August 2023).

2.2.3 Urban area

The definition of urban areas varies globally, relying on factors like administrative boundaries, population size (typically 2,000 to 50,000 people), population density, economic activities (non-agricultural employment), and urban infrastructure presence (e.g., paved roads, electric lighting). Urban classification can differ within a country over time.

2.2.4 Land

the part of the earth's surface that is not covered by water. “The best investment on earth is earth’s land” (Louis Glickman 2007)

2.2.5 Land cover

Land cover is the physical material at the surface of the earth. Land covers include grass, asphalt, trees, bare ground, water, etc. (frederick edward 2018)

2.2.6 Land use

Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods.

2.2.7 Land use Land cover change detection

Land use/land cover change detection involves analyzing changes in how land is used and the types of vegetation or structures covering it over time, using data from sources like satellite imagery and remote sensing. It includes data preprocessing, classification, change detection methods, and validation to monitor and manage land changes for various applications like urban planning and environmental conservation. Continuous monitoring is essential to identify trends and make informed decisions. (Zubair 2006)

2.3 Causes and consequences of urban growth

2.3.1 Causes

Urban growth results from factors such as population increase, rural-urban migration, economic opportunities, infrastructure development, and government policies. It can have both positive and negative impacts, necessitating effective urban planning and management.

 Population growth

Population growth refers to the increase in the number of people living in a particular area or the world over a specified period. It can result from births, net migration, and reduced mortality rates, and it has significant implications for economies, societies, and the environment.

 Independence of decision

The competitors (government and/or private) hold a variety of expectations about the future and a variety of development demands. Often these competitors can take decisions at their own to meet their future expectations and development demands. (Samuel Brody 2013)

 Economic growth

Economic growth is the ongoing expansion of a nation's production of goods and services, often measured by rising GDP. It signifies an improved capacity to create wealth and enhance living standards, driven by factors like productivity, technology, population growth, and investment. (Besley and Cord 2007)

 Industrialization

Industrialization is the transformation of a society from agrarian and manual labor-based production to mechanized manufacturing. It involves the establishment of factories, the use of advanced technology, and the growth of urban areas. This process brings significant economic, social, and technological changes (Industrialize Africa 2019).

Figure 1: Industrialization (source: The new time, Prime cement.ltd)

 Advancement of transportation and communication

Advancement in transportation and communication involves the development of efficient systems for moving people, goods, and information. This includes innovations in modes of transportation and communication technologies like telegraph, telephone, and the internet. These advancements have greatly improved global connectivity and accelerated economic and social interactions worldwide. (Clemence L Munuo 2020)

 Availability of educational and recreational facilities

The availability of educational and recreational facilities refers to the presence and accessibility of institutions and spaces that support learning and leisure activities within a

community. This includes schools, colleges, libraries, museums, sports facilities, parks, and cultural centers. The provision of such facilities contributes to personal development, community engagement, and overall quality of life. (Comfort Etor 2014)

 Urban planning policies

Urban planning policies are government regulations and strategies that shape how cities develop. They address land use, transportation, housing, and sustainability to improve urban life. These policies are vital for accommodating population growth, fostering economic development, and mitigating environmental issues. They influence the physical and social aspects of urban areas, aiming to create more liveable, functional, and sustainable cities. (Cities Alliance 2019)

 Topographical factors

The topography of an area can has huge impacts on the growth of a city. An area with a suitable topography is usually easy to develop and expand. Urban areas in or around an excellent topographical area are easily extended and refined, thus drawing more people to such areas. (Lea Tien Tay 2013)

2.3 Consequences of urban growth

 Loss of farmland

The expansion of urban areas often leads to the loss of farmland, which can result in reduced food production, food security concerns, and negative economic impacts on rural communities. Strategies like land use planning, agricultural preservation programs, and sustainable urban development are crucial for mitigating these consequences and preserving valuable agricultural land. (Brahima Coulibaly 2020)

 Housing of poor urban people

Urban growth often leads to increased demand for housing, which can result in challenges for housing poor urban populations. The consequences may include housing shortages,

rising costs, and the displacement of vulnerable communities, necessitating affordable housing initiatives and equitable urban planning to address these issues.

Figure 2: Housing of poor urban people(source: ideas4development.org, June202

 Impacts on Wildlife and Ecosystem

Urban growth can harm wildlife and ecosystems by causing habitat loss, fragmentation, pollution, and the spread of invasive species. This can lead to biodiversity decline, altered ecosystem dynamics, and increased vulnerability to climate change.

Figure 3: impacts on wildlife and ecosystem (source:safarirwandasafari.com)

 Increase in Temperature

Increasing temperatures, primarily driven by human activities like fossil fuel burning, result in global warming and climate change. This leads to extreme weather events, biodiversity loss, and food security concerns. (James Hansen Oct 2006)

 Poor air quality

Urban air quality refers to how “clean” the ambient air is inside of cities with a density, population, and level of activity that generally are recognized as “urban.” Urban air quality generally differs from rural air quality since there are more concentrated sources and the ability for the pollutants in the air to be dispersed are limited by the physical constraints of the urban environment. Urban air quality varies significantly in urban cities in industrialized worlds, and non-industrialized world generally because of the difference between control on pollution sources and use of open fires in the urban areas. Nevertheless, illness, deaths, and damage to the environment are still attributed across the world to air pollution. (Springer nature, Feb 2010)

2.4 Rural-to-Urban migration effects on agriculture

Rural-urban migration is the movement of people from rural villages, towns, and farms to urban centres in search of jobs. The rapid growth of rural-urban labour force migration has been a common feature of developing countries which occurs in response to natural and

human-induced factors (2022 Haymanot Bassie)

Rural-to-urban migration has mixed effects on agriculture. It often leads to labour shortages in rural areas, an aging agricultural workforce, and abandoned farmland. Changes in land use and agricultural practices can occur, with urban areas driving increased food demand. Infrastructure development benefits rural agriculture by improving market access. Remittances from migrants support rural households, enabling investment in agriculture. Skills and knowledge transfer can lead to innovation in rural farming. However, the pressure on natural resources and changes in dietary patterns are also challenges associated with this migration. Balancing these effects is crucial for sustainable agriculture and rural development.

2.5 Connection between land use change and Urbanization

Land use change and urbanization are closely linked processes. Urbanization involves the expansion of cities and the shift of populations to urban areas.

This often leads to the conversion of rural and agricultural land into urban land, impacting food production and the environment. Infrastructure development, housing, and commercial expansion are common outcomes of urbanization, altering land use patterns. These changes can have environmental effects, such as reduced biodiversity and increased resource consumption. Transportation networks and zoning regulations play a role in shaping land use in urban areas. Economic growth and social changes are associated with urbanization, influencing land utilization for businesses and recreational spaces. Sustainable urban planning is crucial for addressing the challenges posed by these interconnected processes.(Henning Nuissl,Jan 2021)

2.6 Land use change analysis and modelling

Land use change analysis and modelling are crucial for understanding how land transforms over time due to factors like urbanization and climate change. This process involves data collection, preprocessing, and change detection techniques using remote sensing and GIS. Land use classification categorizes land into types such as urban or agricultural. Models, including Cellular Automata and Markov models, predict future land use patterns based on

historical and environmental data, helping policymakers make informed decisions. (Prof. Dr. Peter H Verburg, Jan 2004)

Drivers of land use change, such as population growth and policy changes, are considered in modelling. Scenario analysis evaluates policy impacts, while validation and accuracy assessment ensure model reliability. Visualization aids in conveying complex findings to stakeholders. These insights guide sustainable land use planning and natural resource management. Continuous monitoring and adaptive management are vital for staying up to date with changing landscape. (Isle of Vilm, Germany, 2 to 6 June2001)

2.7 Land use and Land cover changes

Land use and Land cover change (LULCC), Land use and land cover changes involve alterations on Earth's surface driven by natural and human factors. Land use pertains to how land is utilized, encompassing residential, agricultural, industrial, and conservation activities, while land cover describes the physical features like forests and buildings. Drivers include urbanization, agriculture, deforestation, infrastructure development, and climate change. These changes impact the environment, causing habitat loss, deforestation, urban heat islands, water quality issues, and affecting food production. Societal effects encompass population growth, economic development, infrastructure changes, and public health implications. Monitoring relies on remote sensing and GIS, and managing changes requires sustainable land management and conservation practices for long-term ecological balance and human well-being. (Nathalie Girouard, April 2018)

2.8 Land change science

Land change science is an interdisciplinary field that studies changes in land use and land cover over time. It uses remote sensing and data analysis to monitor shifts in land use, identifies drivers like population growth and policy decisions, and assesses environmental and socioeconomic consequences. This science informs land-use planning and policy decisions, aiding in sustainable development and conservation efforts. Additionally, it involves modelling to predict future land use patterns and plays a vital role in ongoing land change monitoring, using technologies like GIS and remote sensing.

Land-change science (LCS) and political ecology (PE) are two interdisciplinary approaches that study human-environment dynamics for sustainability. While they share intellectual roots and emphasize the coupled human-environment system, they differ in problem framing and explanatory perspectives, particularly concerning the causes and effects of land change. Both, however, recognize the complexity of interactions and the significance of context in land-change outcomes. They converge on key issues like forest transitions, vulnerability, and the collaborative nature of science and its application in addressing sustainability challenges.(Paul F Robbins,Jun2021)

Over the last two decades, land-use changes in World have been dominated by an urban transformation unprecedented in human history. The World landscape, which for thousands of years was mainly rural, is becoming increasingly urban. Natural ecosystems, farms, rangelands, towns, and villages are being converted into, or enveloped by, extended metropolitan regions. This urban revolution has profound environmental impacts, including local and regional climate change, loss of wildlife habitat and biodiversity, stress on food production systems, and pressure on water resources. Urbanization can also lead to poor housing conditions, inadequate waste disposal, and rapid spread of infectious diseases. (Dr. Garik Gutman,2012)

2.9 Land use plan/pattern

A land use plan, also known as a land use pattern, is a structured approach to organizing and managing land within a specific area. Increasing competition for land due to various demands like food security, renewable energy, and urbanization necessitates efficient allocation of land resources. Land use planning, including spatial and environmental approaches, helps balance conflicting land uses and promote sustainability. These tools strengthen land governance, enhance economic opportunities through sustainable land management, and harmonize conservation with development goals. (Graciela Metternicht, Sept 2017)

2.9.1 Land use plan in Rwanda

Rwanda's small land size of 26,338 km2, coupled with a rapidly growing population of 12.5

million by 2019 (with a 2.4 percent annual growth rate), poses significant challenges for optimal land use. With urbanization increasing at 4.4 percent and agriculture contributing over 36.7 percent of export earnings, the need for land has become pressing. Rapid urbanization is closely tied to economic growth, aligning with the government's Vision 2050 to accelerate urbanization and boost GDP and per capita income.

The National Land Use and Development Master Plan (NLUDMP) was adopted in 2011 to efficiently manage resources and facilitate development. In 2016-2017, an assessment revealed problems like poor land use management, land competition, sprawl, and infrastructure challenges. Consequently, the NLUDMP was revised from December 2018 to June 2020.

The new NLUDMP 2020-2050 aims to address these issues, provide implementation guidelines, and create an updated national spatial structure. It emphasizes a normative planning approach, departing from "Business as Usual" to seek innovative solutions. The plan seeks to resolve land allocation conflicts and assess current land use while aligning with Vision 2050 objectives.

Ultimately, the NLUDMP aims to achieve a balanced land-use framework for Rwanda, providing data, arguments, and recommendations for preferred land allocations coordinated by a national land balance sheet. This strategic planning is pivotal for Rwanda's transformation into a prosperous, food-secure, knowledge-based economy while mitigating climate change impacts and enhancing citizens' well-being. (Official Gazette n° 15 bis of 26/04/2021)

2.10 Geographic Information System (GIS)

A Geographic Information System (GIS) is a system that captures, stores, analyses, and manages spatially referenced data on Earth. It integrates, edits, and analyses geographically referenced information, allowing users to create interactive queries and generate models using maps and remote sensing data. GIS finds applications in scientific research, resource management, environmental assessment, urban planning, and various fields. For instance, it aids agricultural planners in deciding crop locations by combining

soil, topography, and rainfall data with factors like land ownership, infrastructure, and market proximity. GIS is a versatile tool for leveraging geographic concepts and applications. (Dr.K. Sreenivas, May 10, 2004)

The use of geo-information systems for monitoring and development of the basis of web-maps has become increasingly widespread in recent years. These systems provide a range of functionalities for creating, analysing, and sharing geospatial data, and are used for a variety of purposes, including disaster response, climate resilience, and sustainable development. This article provides a brief overview of the current situation regarding the use of geo-information systems for web-mapping in Uzbekistan, as well as some of the popular software options and key players in the field. (Kh. T. Murodilov, Apr 20, 2023)

2.10.1 GIS application in land records phenomena

Maintenance of land records and the availability of easily accessible land information is one of the challenges of the governance today and becomes necessitates to embark upon scientific measures for better management of the scarce land resources and of course, for ensuring good governance including the implementation of land record spatial data infrastructure (LRSDI) in country.

Use of geospatial techniques for the land record computerization including field book and paper maps where mapping can lay foundation for intelligent archiving and leverage for applied applications. (Mobushir Riaz Khan, October 2020)

CHAPTER 3: DATA COLLECTTION AND ANLYSIS PROCEDURES

3.0 Introduction

Referring to objectives, the adopted approach of this study will be based on production of map which will identify the impact of the rate of urban growth on agriculture land in Cyuve sector with specifying existing land use and land cover change from 2005,2012 and 2022.In order to achieve the objectives of the study, an integrated approach of data collection and analysis will bee adopted for better understanding of the study areas current situation to ensure the provision of all the need of the local people over long period.

(Ndagijimana, 2023)

3.1 Description of my case study area

Cyuve sector belonging to the Musanze district with Latitude:1° 28'47" S and Longitude:29°37'56"E, which is in Northern province. Cyuve sector has five neighboring sectors which are Nyange, Gahunga,Gacaca,Muhoza and Musanze it covers an area of 33.1627sq km. In Cyuve sector, it comprises 6 Cells such as; Migeshi, Cyanya, Kabeza Buruba,Bukinanyana and Rwebeya.

Figure 4: Geographical location of case study area (source: Authors)

3.2 Research Design: Figure 5: Research design (source aouthors)

3.3 Research Instrument:

 Checklist

Here I have focused especially on the points related to my project such as agriculture, urban and built-up area of Cyuve sector.

 ArcGIS Pro

I have used ArcGIS Pro to analyse and manipulate the data and used in georeferencing, clipping, buffering the required area in order to produce the map of land cover classes or layers, to produce the map showing areas of land cover classes and to produce change detection map of Cyuve sector from 2005 to 2022.

 Google earth

Google earth helped me to get the different orthophotos of Cyuve sector in different years. In addition, it helps researchers in georeferencing

 Data obtained from the Landsat image

Landsat images are collected by a series of Earth-observing satellites operated by NASA

and the USGS. These images capture the Earth's surface in visible, infrared, and thermal wavelengths. They provide valuable data for monitoring land use, natural resource management, and environmental changes over time. Landsat data is freely available to the public and has been collected since the launch of Landsat 1 in 1972, making it a crucial resource for scientific research and land monitoring worldwide. The most recent satellite in the series, Landsat 9, was launched in September 2021, continuing the legacy of this vital Earth observation program.

3.3.1 Choice of Research Instrument:

The choice of research instrument is crucial for conducting a comprehensive impact assessment of urbanization growth on agricultural land in Musanze District, focusing specifically on the Cyuve sector from 2005 to 2022. a combination of quantitative and qualitative research instruments would be ideal.

By employing a mixed-methods approach combining both quantitative and qualitative research instruments, this study aims to achieve a comprehensive understanding of the impact of urbanization growth on agricultural land in Musanze District, with Cyuve sector as a case study, from 2005 to 2022.

3.3.2 Validity and Reliability of the Instrument:

The survey instruments will be piloted prior to the study, in order to map their concurrent and predictive validity. Results from pre-tests will inform the refinement of these instruments so that they effectively measure variables and concepts being investigated. Moreover, the use of measures like inter-coder reliability for qualitative data analysis will also contribute to increase the reliability findings.

3.4 Data Gathering Procedures:

In this project, I would use primary and secondary data in collectioning and interpreting of it to have correct information.

The primary data: They are the ones collected by researchers, were amongst local people of Cyuve sector and sensor cameras.

Secondary data: This is the data that has been used by researchers but collected either

from others including administrative boundaries, agriculture land use, built-up area. As wellas in the reaserchers, geoprotal got these orthophotos then help them to %age between agriculture land with urban area of cyuve sector. Overall transition over time to 2022 and demographic shift from 2005

Data

Type of Data

Source of data

Use

Satellites data (Landsat 9 OLI for 2022)

In (Landsat 7 ETM Plus for 2005 and 2012).

Raster

Downloaded from USGS (https://www.usgs.gov)

Used to classify land use land cover of study area

Administrative boundary

Vector

Downloaded from Rwanda Geo-portal(http://geoportal.rlma.rw)

Used for describing study area

3.5 Data Analysis and Interpretation:

 Adding data

 Relocate to Google earth

Enhancement of satellite imagery, which includes the removal of cloud The satellite images will be reference and ortho-rectified.

overlay operation maximum like hood classification

The use of tables to represent statics from the classified imagery of the study area

Calculation of area in square meters of the resulting cover change types for each study year and subsequently comparing the result.

3.6 Ethical Consideration:

The research will be performed in line with ethical principles, which includes ensuring that informed consent is received from individuals participating and a level of confidentiality being maintained for all participants. Approval will be obtained from appropriate authorities and institutional review boards prior to the commencement of data collection. In raw terms, a study must inform the participants about what it aims to assess (purpose of the study) reassure him that his rights are protected as respondent and state in clear language this is voluntary.

CHAPTER 4: DATA PROCESSING AND RESULT

4.0 introduction

This chapter presents the research findings, which involve analysing data from the study area to align with the research objectives. The study aims to test the thesis concerning urban growth impacts on the Cyuve sector's population, primarily through the assessment of existing agriculture land use and land cover changes. The research employed ArcGIS software and field surveys to identify and describe these changes. The results were effectively communicated through maps and pie charts, with a particular focus on two key aspects: the agriculture land area and the built-up area within Cyuve sector.

4.1 Extent of Land use/Land cover classes in 2005, 2012 and 2022

This study investigates the dynamic changes in land use and land cover classes over a 19-year period, spanning from 2005 to 2022, in the Cyuve sector. It seeks to assess the impact of urbanization on agricultural land, focusing on the transformation of the landscape during this period. By analysing the evolution of land use and land cover classes, this research aims to provide critical insights into the effects of urban expansion on agricultural areas, offering valuable information for sustainable land management and urban development planning in the region.

4.2 Land use land cover classification mapping in 2005, 2012 and 2022

The image was classified into four classes such as built-up area, agriculture, forest and bare soil in order to generate the land cover classes map for the study area. The red colour represents built up area, deep green colour represents the forest, bright green colour represent agriculture and yellow colour represents the bare land.

Map showing land use land cover classes in 2005

Figure 6: Land use land cover map of Cyuve sector 2005 (source: Authors)

2005 Land Use / Land Cover Map: This map represents the land use classes in 2005, providing a baseline view of the landscape.

Representation of land use land cover classes in cyuve by using bar charts and pie charts where it shows the area of each land use classes available in 2005.

Figure 7: Bar charts of Land use land cover classes in 2005 (source: author)

Figure 8: Pie chart of Land use land cover classes in 2005 (source: author)

Table 2: accuracy assessment 2005

Classes

Reference Totals

Classified

Total

Number of correct

Producers’ accuracy%

users’ accuracy%

Forest

73

77

67

91.78

87.01

Agriculture

114

110

104

91.23

94.55

Built-up

17

18

18

80

100

Bare land

26

25

20

89.19

86.84

TOTAL

230

230

209

Overall Classification Accuracy = 90.87%

Overall, Kappa Coefficient (T)= 0.83783

The assessment of Landsat 7 ETM Plus imagery from 2005 demonstrated a robust classification accuracy of 90.87%. Furthermore, the overall kappa statistic, measuring agreement with actual data, stood at 0.83783, signifying strong consistency. These results validate the reliability of the classification for this dataset.

Map showing land use land cover classes in 2012

Figure 9: Land use land cover map of Cyuve sector 2012 (source: Authors)

2012 Land Use / Land Cover Map: it reveals the state of land use and land cove as of that year. It serves as an intermediate snapshot, allowing for a comparison between 2005 and 2012 to understand trends and shifts in land utilization.Representation of land use land cover classes in by using bar charts and pie charts where it shows the area of each land use classes available in 2012.

Figure 10: Bar charts of land use land cover 2012 (source: Authors)

Figure 11: Pie chart of land use land cover 2012 (source: Authors)

Table 3: Accuracy assessment of 2012

Classes

Reference Totals

Classified Total

Number of correct

Producers’ accuracy%

users’ accuracy%

Forest

28

36

27

96.43

87.01

Agriculture

13

9

9

69.23

100

Built-up

26

25

22

80

100

Bare land

17

19

20

89.19

86.84

TOTAL

84

89

78

Overall Classification Accuracy = 90.1%

Overall, Kappa Coefficient (T)= 0.828

The Landsat 7 ETM Plus imagery from 2012 achieved a strong classification accuracy of 90.1% through random point assessment. The overall kappa statistic of 0.828 indicated a reliable and consistent classification process

Map showing land use land cover classes in 2022

Figure 12: Land use land cover of Cyuve 2022 (source: Authors)

2022 Land Use / Land Cover Map: This most recent map shows the current land use and land cover classes as of 2022. It offers insights into the latest developments and alterations, aiding in tracking on going changes, like urban growth. Representation of land use land cover classes in by using bar charts and pie charts where it shows the area of each land use classes available in 2012.

Figure 13: Bar charts of land use land cover 2022 (source: Authors)

Figure 14: Pie chart of land use land cover 2022 (source: Authors)

Table 4: Accuracy assessment of 2022

Classes

Reference Totals

Classified

Total

Number of correct

Producers’ accuracy

users’ accuracy

Built-up

5

7

5

71%

100%

Agriculture

8

8

8

100%

100%

Forest

6

6

10

100%

60%

Bare land

7

8

9

70%

77.77%

TOTAL

32

29

38

Overall Classification accuracy=84.2105%

Overall, Kappa Coefficient (T)= 0.8421

The assessment of Landsat 8&9 OLI imagery from 2022, based on random point sampling, yielded a strong classification accuracy of 84.21% and a reliable overall kappa statistic of 0.8421.

the Land Use/Land Cover (LULC) accuracy assessment consistently exceeded reliability standards. The overall classification accuracy for 2005, 2012, and 2022 surpassed 75%, with values of 90.87%, 90.1%, and 84.21%, respectively. Additionally, Kappa coefficient scores were well above the threshold at 0.83783, 0.828, and 0.842 for these respective years,

4.3 The result of land use land cover classes in 2005,2012and 2022

The results show that the area of each land use land covers and year respectively, the Built up area occupied 2% with 0.51sq.km, 16% with 5.29 sq.km and 22% with 7.25 sq.km in 2005, 2012 and 2022 respectively, forest occupied 19% with 6.39sq.km, 17%with 5.56 sq.km and 10% with 3.38 sq.km in 2005, 2012 and 2022 respectively, Agriculture occupied 68% with 22.47sq.km, 59%with 19.59 sq.km and 50% with 16.59 sq.km in 2005, 2012 and 2022 respectively, and Bare Soil occupied 11% with 3.75 sq.km, 10.31% with 3.4 sq.km and 10% with 3.38 sq.km in 2005, 2012 and 2022 respectively.

Table 5: show how the LULC classes areas are distributed in different years

LULC 2005

LULC 2012

LULC 2022

Class Name

Area in sq. km

Area (%)

Area in sq.km

Area (%)

Area in sq.km

Area (%)

Agriculture

22.47

68

19.59

59

16.59

50

Bare soil

3.75

11

2.65

8

3.38

10

Built-up

0.51

2

5.36

16

7.25

22

Forest

6.39

19

5.56

17

5.90

18

Total

3319.4

100

33.16

100

33.12

100

4.4 Land use land covers change detection from 2005-2012 and 2012-2022

Land use/land cover changes in the study area from 2005 to 2012 and 2022, driven by urban migration, city expansion, and climate change, have led to an increased build-up area. These changes have also caused fluctuations in other land use/land cover classes, with some experiencing growth and others declining. The resulting land use/land cover change detection maps illustrate these dynamic transformations.

Map showing Land use land covers change detection from 2005-2012

Figure 15: shows LULC Change detection from2005 to 2012 (source: Authors)

This map represent the change detection occurred in land use from 2005 to 2012 where the buit up area increased from 2% to 16% this affect agricultural decreased from 68%to 59%

Table 6: Table of LULC Classes Change 2005-2012

LULC Changes	Changed Area Hectare	Changed Area in %
Agriculture-Agriculture	1436.7	43.39172455
Bare soil-Agriculture	67.3	2.032618544
Built-up-area-Agriculture	37.8	1.141649049
Forest-Agriculture	335.9	10.14497131
Agriculture-Bare soil	404.1	12.20477197
Bare soil-Bare soil	35.1	1.060102688
Built_up_area-Bare soil	14.7	0.004439746
Forest-Bare soil	109.6	3.310178194

Agriculture-Built-up-Area

291.3

8.79794624

Bare soil-Built-up-Area

42

0.643310178

Built_up_area-Built-up-Area

21.3

0.643310178

Forest-Built-up-Area

60

1.812141347

Agriculture-Forest

378.1

11.41951072

Barsoil-Forest

10.6

0.320144971

Built_up_area-Forest

0.7

0.021141649

Forest-Forest

65.8

1.987315011

TOTAL

3311

100

Table 7: Change and no change Matrix table from 2005 to 2012

2005

2012

Classes

Agriculture

Bare soil

Built-up

Forest

Total

Agriculture

1436.7

(no change)

404.1

291.3

378.1

2510.2

Bare soil

67.3

35.1

(no change)

42

10.6

155.0

Built-up

37.8

14.7

21.3

(no change)

0.7

74.5

Forest

335.9

109.6

60

65.8

(no change)

571.3

Total

1877.7

563.5

414.6

455.2

3311.0

Map of land use land cover class detection from 2012 to 2022

Figure 16: Land Use Land Cover Change from 2012 to 2022 (source: Authors)

Figures 6 and 7 depict change detection maps for Cyuve sector, spanning from 2005 to 2012 and 2012 to 2022, respectively. These maps visually represent alterations in land use and land cover, emphasizing the magnitude and nature of transitions between different land classes. Table 9 complements these maps by offering detailed data, including precise percentages and class transitions, enabling a comprehensive understanding of the observed changes over the two time periods.

4.5 Change detection analysis

Over the past two decades, the Cyuve sector has witnessed a significant surge in

built-up areas, with a notable increase from 2% to 16% between 2005 and 2012, and a substantial leap to 22% by 2022. This growth is attributed to extensive urban development and infrastructure expansion. Unfortunately, this rapid urbanization has come at the expense of agriculture land, which saw a decline from 68% in 2005 to 50% of the total area by 2022, underscoring the challenges posed by urban expansion on agricultural resources.

4.5.1 Impact of urban expansion on agricultural land

Loss of agricultural land

Over a 17-year period, remote sensing revealed significant changes in Cyuve's land use and land cover (LULC). The built-up area increased from 2% in 2005 to 22% in 2022, with a notable 18% loss of agricultural land. Between 2005 and 2022, 18% of agricultural land converted to built-up areas. Urban growth continued through 2022, particularly in the southern region, where substantial agricultural land transformation into built-up areas occurred. In contrast, the north experienced minimal change. Over the decade from 2012 to 2022, 18% of agricultural land was lost to built-up areas, this study underscores the significant impact of urban expansion on agricultural lands in Cyuve sector.

4.6 prediction of land use land cover classes in 2050

Predicting land use and land cover changes in cyuve sector in Musanze City, for the year 2050 is a critical undertaking that combines environmental science, urban planning, and data analysis. Cyuve sector, is experiencing rapid urbanization and population growth, which poses significant challenges for sustainable development and land management. To ensure the city's growth is well-planned and environmentally responsible, accurate predictions of land use and land cover in 2050 are essential.

4.6.1 Spatial data and geographic information systems(GIS)

Spatial data and Geographic Information Systems (GIS) play a crucial role in predicting land use and land cover classes for 2050 in cyuve sector in Musanze City, data and GIS are utilized in this:

 Land use land Cover Classification: Spatial data is employed to classify land cover types, such as forests, , agricultural areas, built up area, and agriculture. This is typically

done through image classification techniques that segment the landscape into different classes.

 Change Detection: GIS tools are used to detect and quantify changes in land cover over time. By comparing historical data with current data, GIS can identify areas that have experienced significant transformations, in cyuve sector we compared change detection from 2005 to 2022

4.6.2 statistical Analysis of prediction in 2050

GIS enables spatial analysis by applying geoprocessing tools and spatial statistics to identify spatial patterns, trends, and correlations between various factors and land use changes. GIS to forecast future land use and land cover changes based on historical data and influencing variables.

Figure 17: bar charts of lulc classes prediction in 2050 (source: author)

Figure 18: pie charts of lulc classes prediction in 2050 (source: author)

This figure A) represent lulc classes prediction in 2050 by using bar charts and B) represent lulc classes prediction in 2050 by using pie charts

4.7.3 land use land cover classes prediction in 2050

expected land use land cover classes in 2050 in cyuve sector

Table 8: prediction of land use land cover 2050

Depending on prediction in from 2005 up to 2050 shows that the agriculture land will be affected by urbanization from 68% to 21% there was decline of 47%. In cyuve sector urbanization and development are significant, the use of spatial data and GIS is essential for making informed decisions about the city's future growth and ensuring that land use changes are sustainable and well-managed.

CHAPTER 5: CONC LUSIONS AND RECOMMENDATIONS

5.0 introductions

This overview summarizes the findings and recommendations of the case study on the impact of urbanization on agriculture land in the sector Cyuve of Musanze District. As long as it continues to rise, urban expansion is swelling into extremely valuable agricultural land, displacing traditional farming practices and changing local ecologies. This chapter summarizes the different analyses in order to give an overview of the effects of urban growth on agricultural productivity and land use. It also makes strategic recommendations with a view to mitigating those impacts and achieving a balance between urban development and the preservation of agricultural resources, at the same time improving the resilience of local farming. The chapter, therefore, discusses how to raise more awareness among policy-makers, planners, and various stakeholders about necessary appropriate measures to be taken against the challenges arising due to urbanization and, at the same time, promote sustainable development of the region.

5.1 Conclusion

The study assessed the impact of urban growth on agriculture land in Cyuve sector, revealing a significant reduction in agricultural land area. In 2005, agriculture land covered 22.54 square kilometer, and in 2022, agriculture land covered 16.58 square kilometer. The rapid urban growth in the sector, driven by building construction on agricultural land, led to this decline. By 2022, indicating a substantial reduction from 68% in 2005 to 50%, This alarming trend aligns with the concerns voiced by the local residents of Cyuve sector.

A study in Cyuve sector using GIS and remote sensing found that urban areas have expanded significantly over the past 20 years, nearly equalling the agricultural land area. Urban expansion is increasing, while agricultural land is decreasing, posing a potential threat to food production and rural communities. If this trend continues, it may lead to insufficient crop production to meet the population's needs, making food security a top

concern in the future.

5.2 Recommendations

Based on the findings of my project, I strongly advise the leadership in the Cyuve sector to encourage the local population to engage in the construction of multi-story buildings. This recommendation stems from the necessity to preserve agricultural land and ensure conformity with the master plan established for the Northern province. It is imperative to closely monitor and regulate construction activities within areas designated for agriculture to prevent any unauthorized construction that might disrupt agricultural endeavours.

"Balancing land development with environmental protection is vital for sustainable urban growth in Rwanda. So that why we must always think about the following "

Firstly, one of the primary factors contributing to the city's expansion is rapid population growth resulting from natural increases and rural-to-urban and urban-to-urban migrations. Consequently, significant attention should be directed towards improving spatial and urban planning to address this issue effectively.

Secondly, it is imperative that local residents adhere to Organic Law 4/2005, which outlines the methods for safeguarding, conserving, and promoting the environment in Rwanda. This law aligns with the National Policy on Environment, which provides guidance on protecting, conserving, and promoting the environment, particularly with regard to safeguarding forests, water sources, and managing land effectively, including initiatives like the land consolidation program.

Thirdly, local leaders must reinforce the enforcement of planning policies by upholding environmental regulations that pertain to restricted areas, such as forested lands, vegetated areas, urban development zones, and specific zoning regulations. This also extends to the careful management of water bodies, valleys, and wetlands, ensuring their preservation and sustainable use.

Fourthly, fostering public awareness and community engagement is crucial. Initiatives should be developed to educate and involve local communities in sustainable land management practices. This includes organizing workshops, seminars, and awareness

campaigns to inform residents about the importance of responsible land use, waste management, and the preservation of natural resources.

Furthermore, a comprehensive land use and zoning plan should be developed and consistently updated. This plan should align with the city's long-term vision for sustainable growth and development. It should also consider factors such as transportation networks, infrastructure development, and the preservation of green spaces, ensuring that urban expansion occurs in an organized and environmentally friendly manner.

Lastly, investment in sustainable technologies and infrastructure is essential. This includes the implementation of eco- friendly transportation systems, renewable energy sources, and smart city technologies. By integrating these innovations into urban planning, the city can reduce its carbon footprint and enhance the overall quality of life for its residents while simultaneously promoting sustainable land management practices.

5.3 suggestion for further study

It is further recommended that for future research, a longitudinal study of long-term impacts of urbanization on agricultural lands in the Cyuve sector, Musanze District, be conducted with comprehensive economic analyses and land use mapping using GIS technologies. It should also dwell on the socio-economic effects that this may have upon the farming communities at the local level, examine the efficiency of the existing policies as regards land use, and investigate sustainable farming practices which can mitigate these adverse effects of urban expansion. Perceptions of community and adaptive strategies, infrastructural development-driven land conversion would provide comprehensive analysis of the challenges and possible solutions on how to strike a balance between urban growth and agricultural preservation.

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7. Rwanda Ministry of Agriculture and Animal Resources (MINAGRI) - The official website may provide reports and publications related to agriculture and land use.
8. Rwanda Housing Authority (RHA) - The RHA may have data and reports on urbanization and its impact on land use in Rwanda.
9. Rwanda Environment Management Authority (REMA) - REMA's website may contain valuable information on environmental issues, including urbanization's impact on land use.
10. "Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities: A Global Assessment" edited by Thomas Elmqvist, et al.
11. "The New Landscape Declaration: A Call to Action for the Twenty-First Century" edited by Charles Waldheim.
12. "Agriculture in Urban Planning: Generating Livelihoods and Food Security" edited by Mark Redwood.
13. Rwanda Ministry of Infrastructure (MININFRA) - MININFRA may have reports and data related to urban development and infrastructure, which can offer insights into urbanization's impact on agriculture.
a. Website: [MININFRA](http://www.mininfra.gov.rw/)
14. Rwanda Development Board (RDB) - RDB is involved in economic development and investment promotion in Rwanda. They may provide information on urbanization trends

and their effects on various sectors, including agriculture.

a. Website: [RDB](https://rdb.rw/)

15. World Bank - The World Bank often publishes reports and studies on urbanization, agriculture, and economic development in Rwanda and other countries.

a. Website: [World Bank - Rwanda](https://www.worldbank.org/en/country/rwanda)

16. Rwanda Integrated Household Living Conditions Survey (EICV) - This survey is conducted regularly by the National Institute of Statistics Rwanda (NISR) and provides valuable data on various aspects of life in Rwanda, including agriculture and urbanization.

a. Website: [National Institute of Statistics Rwanda] (http://www.statistics.gov.rw/)

17. "Rwanda Vision 2050" - This is Rwanda's long-term development vision, and it may contain information about how the government envisions the balance between urbanization and agriculture.

18. "Rwanda Land Tenure Regularization Program" - Information on land tenure and land use in Rwanda, including how urbanization impacts land ownership and usage.

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APPENDICES

Appendix 1: Geographical location of cyuve sector in musanze district

Figure 19: geographic location of cyuve sector (Source: authors)

Appendix 2: Housing in cyuve sector

Figure 20: housing

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