DEMOGRAPHIC CHANGE AND RURAL LAND USE DYNAMICS IN RONGO, MIGORI COUNTY, KENYA

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Registration Number: N50/28703/2019

A RESEARCH PROJECT SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ENVIRONMENTAL PLANNING AND MANAGEMENT IN THE SCHOOL OF ENGINEERING AND ARCHITECTURE OF KENYATTA UNIVERSITY

SEPTEMBER, 2025

DECLARATION

Declaration by Student

This Research project is my original work and has not been submitted for a degree or award in any other university

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Declaration by Supervisor

I confirm that this Research Project was carried out by the candidate under my supervision

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DEDICATION

I dedicate this research project to my dear family for their relentless prayers, support, and emotional encouragement throughout the study period.

ACKNOWLEDGEMENT

The actualization of this professional course was enabled by first and foremost the help of Almighty God. Heartfelt appreciation to my supervisor, Dr Christine Majale for her most motherly and proficient support. Thank you so much, your input and guidance formed great pillars for the success of this study and the preparation of the document. My sincere thanks to the members of staff in the Department of Spatial and Environmental Planning, Kenyatta University, your input equally made this study a success.

My deepest appreciation equally goes to my Family for the financial and moral support towards this great achievement, I want to thank my dad for his unending care and counsel, and for ensuring that I accomplished the study despite numerous challenges. I equally acknowledge my classmates for their impactful insights during the study. Finally, I must acknowledge all the study participants for their time and contribution during data collection.

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LIST OF ACRONYMS AND ABBREVIATIONS

AOI	Area of Interest
ASGM	Artisanal Small-Scale Gold Mining
CIDP	County Integrated Development Plan
CPLUDP	County Physical and Land Use Development Plan
CSP	County Spatial Plan
ETM	Enhanced Thematic Mapper
FGDs	Focus Group Discussions
GDP	Gross Domestic Product
GIS	Geographical Information System
HSQ	Household Survey Questionnaire
KATTC	Kamagambo Adventist Teachers Training College
KII	Key Informant Interview
KNBS	Kenya National Bureau of Statistics
LU	Land Use
LUC	Land Use Change
MT	Motorcycle Taxi
NACOSTI	National Commission for Science Technology and Innovation
NEMA	National Environment Management Authority
OLI	Operational Land Imager
RU	Rongo University
SIT	Siala Institute of Technology
SPSS	Statistical Package for Social Science

TIRIs	Thermal Infrared Sensor
TM	Thematic Mapper
USGS	United States Geographical Survey
UTM	Universal Transverse Mercator

ABSTRACT

Demographic change in most instances is considered the principal factor of human impact on land use change. The drivers of these changes, however, are dependent on the location, timeframe, and institutional design of the human environment prompting the changes to appear spontaneously or gradually. Agriculture for a long time has been the main development activity on most lands in Rongo Sub-County. However, in the last decade the area has been experiencing diverse development on its land posing numerous challenges such as uncontrolled development. It is in this view that this study analyzed the rural land use change trends in Rongo Sub-County between 2002 and 2022, examined the impact of population size on land use trends, and evaluated the influence of population socioeconomic status on trends in rural land use change in Rongo Sub-County. The Population and Environment Theory informed the conceptual framework and guided the study. The study site was purposively selected based on its rapid growth and visible land use transitions. A descriptive research design was adopted, allowing the use of both qualitative and quantitative data from primary sources including household survey questionnaires, field observation, key informant interviews, focus group discussions, and satellite imagery. Cluster random sampling was employed by dividing the population into locations where the required 384 households were randomly selected, while purposive sampling targeted key informants. Satellite images were downloaded from the United States Geographical Survey website and classified for the time interval between 2002 and 2022. The study adopted supervised classification where the area of interest was extracted. A review of relevant literature was undertaken to acquire secondary data. Arc Map 10.4.1 was used to analyze remotely sensed data, SPSS was employed for quantitative analysis, while qualitative data was analyzed thematically. Findings which were presented in tables and charts show that the study area's population has increased by 45.5% over the study period (2002-2022) and that there is an increased number of households. Additionally, land area under rural agriculture extended constantly into forest lands between 2002 and 2022. The settlement area equally extended continuously into agricultural lands and forest lands, and wetland areas experienced minimal change. Majority with extra sources of income (45%) venture into other businesses thereby influencing the development of land. Agriculture is the main source of livelihood for the majority (43%) thus impacting the rate of demand for farmland. The study concludes that population size influences trends in land use change due to its impact on household number and consumption rate. Consequently, there is an expansion of farmlands for the production of food and a continuous increase of the area under settlements. Additionally, education attainment and access to extra sources of income impact the trend in rural land use change due to the efforts of the rural population towards the enhancement of livelihood. The trend in land use change in Rongo Sub-County involves the modification of forest land to farmlands and settlements. The study recommends training on sustainable approaches to maximizing farm yield, development, and implementation of policies that can influence the aspects associated with rural land use change transition tendencies.

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

Human beings for a long time, have lived in relative harmony with available resources by adjusting the environment and enriching the resources it offers (Livi-Bacci, 2017). However, this equilibrium is no longer sustainable due to demographic mechanisms such as changes in reproductive intensity and the recurrent occurrence of disasters that radically alter the population–resource balance. The ability of human populations to re-establish balance between numbers and resources varies across societies and historical periods.

Globally, population growth and household food consumption diversity have been shown as chief drivers of land use change (Doelman, 2018; Hassan et al., 2016; Msofe et al., 2019). Moreover, the introduction of advanced technology and improved healthcare has increased life expectancy, sustaining the productivity of older age groups (Park et al., 2022). Demographic change is recognized as a key driver of land use dynamics (Hersperger & Bürgi, 2009). Still, its effects interact with other global trends such as economic shifts, climate change, resource scarcity, and institutional policies, which may either amplify or mitigate the demographic influences (Hoffmann, 2020).

Some changes in land use occur gradually, while others are spontaneous; the drivers remain broad and multifaceted, and the impacts complex (Kroll & Haase, 2010). Political decisions, cultural values, and policies shaping land use are often affected by oversimplifications and myths (Lambin et al., 2001). Additionally, development of transport infrastructure, automobile use, and rising income levels have been shown to further accelerate land use change globally (Colsaet et al., 2018).

Africa experiences rapid demographic transitions characterized by high fertility rates, population growth, and urbanization. Land use is relentlessly changing, especially in suburban areas and major watersheds, driven largely by changing population structures (Iwasaki et al., 2021). Urban settlements and agricultural land remain the dominant land uses across the continent.

Demographic changes including migration, rising income levels, and shifting cultural practices interact with institutional factors such as customary land tenure and access to financial capital, shaping how land is used (Kleemann et al., 2017). Migration and labor shortages are particularly interdependent, influencing both agricultural productivity and settlement patterns. Historically, large-scale land use change in Africa dates back about 4,000 years, with the domestication of livestock, the spread of pastoralist communities, and the adoption of iron technology that enabled massive forest clearances (Marchant et al., 2018).

Unlike regions experiencing population decline, Africa's youthful and expanding population places intense pressure on land resources. Expansion of settlements, infrastructure, and agriculture has accelerated deforestation, wetland conversion, and degradation of watersheds. These pressures are amplified by climate variability and weak land governance systems, making sustainable management increasingly complex.

In Kenya, demographic change has significantly shaped both rural and urban land use dynamics. Rapid population growth, migration, and urbanization have led to the conversion of forests, wetlands, and agricultural land into settlements and other uses. Massive land use changes in Kenya's forest reserves are attributed to anthropogenic activities aimed at enhancing livelihoods (Onyango et al., 2021). Forests continue to be cleared for agriculture and settlement (Muhati et al., 2018).

Kenya's major watersheds are undergoing significant transformations due to high population pressures on environmental resources (Opiyo et al., 2022). Productive and agriculturally viable watersheds attract migrants seeking farmland and settlement space, leading to rapid conversion into farms and residential areas (Muriithi, 2016). Land fragmentation, often resulting from inheritance and immigration, further reduces agricultural productivity while reshaping land use patterns.

Nkedienye et al. (2009) highlight that land use change in Kenya is closely correlated with population change dynamics, especially in areas experiencing an influx of immigrants and expansion of institutions such as universities. These dynamics intensify land subdivision and alter land demand structures. Overall, Kenya faces the dual challenge of meeting the needs of a growing youthful population while protecting fragile ecosystems and ensuring sustainable land use.

At the county level, Migori, where Rongo Sub-County is located reflects similar demographic and land use change dynamics observed nationally. Agricultural land, the dominant land use in the county, experienced marginal changes between 1979 and 2009, but a significant decline occurred between 1999 and 2009, with a drop of 3,392.5 hectares (Ogola, 2018; Yaser & Saba, 2016). During the same period, forest lands also recorded a reduction in area coverage, correlating with sustained population growth.

These changes indicate increasing demographic pressure on available land resources, leading to agricultural land contraction and encroachment on forests. The trend underscores the strong link between population dynamics and land use patterns at the local level, where livelihoods are heavily dependent on land for subsistence and commercial activities.

1.2 Problem Statement

Unsustainable land use practices are worsening environmental degradation (Sadeh et al., 2020). In rural areas, sustainable land management faces challenges linked to demographic changes that drive land use change. According to Meyfroidt et al. (2018), modifications in land use systems are the primary barrier to sustainable management, yet food security, biodiversity, and climate regulation all depend on proper land use. The socioeconomic and environmental challenges facing rural communities are therefore directly tied to land use, creating an urgent need for policy interventions.

Rongo Sub-County, though largely rural, is experiencing rapid and uncontrolled development. Land formerly under sugarcane, food crops, shrubs, and trees has been converted into settlements, mining sites, and commercial areas. Rising demand has accelerated land subdivision into smaller plots, while frequent changes in land and building use have reduced food security, destroyed ecosystems, and worsened waste management.

The situation has been intensified by the establishment of higher learning institutions, which has attracted students, staff, and immigrant workers, boosting local economies but also increasing land pressure. Expanding mining, business activities, and massive road infrastructure linking markets, institutions, and neighboring Sub-Counties have further fueled this transition.

While past studies have often focused on population growth and land use change, limited attention has been given to how demographic characteristics such as education, income, and occupation shape rural land transitions. This study therefore analyzes land use change trends in Rongo Sub-County between 2002 and 2022 and examines their relationship with population size and socioeconomic status to provide insights for sustainable land use policy formulation.

1.3 Research Questions and Objectives

This study is guided by the following research questions and corresponding objectives:

Research Question 1:

What are the trends in land use change in Rongo Sub-County between 2002 and 2022?

Objective 1:

To analyze the land use change trend in Rongo Sub-County between 2002 and 2022.

Research Question 2:

How does population size affect trends in land use change in Rongo Sub-County?

Objective 2:

To examine the influence of population size on the trend in land use change in Rongo Sub-County.

Research Question 3:

How does population socioeconomic status influence trends in land use change?

Objective 3:

To determine the influence of the socioeconomic status of a population on trends in land use change.

Main Objective:

The main focus of this study is to establish the impact of demographic change on rural land use dynamics in Rongo Sub-County, Kenya.

1.4 Research Hypotheses

$H_{0:}$ There is no significant increase in land use change in Rongo Sub-County between 2002 and 2022

Hi: There is a significant increase in land use change in Rongo Sub-County between 2002 and 2022.

$H_{0:}$ Land use trend in the study area is not significantly influenced by population size

Hi: Land use trend in the study area is significantly influenced by population size

1.5 Significance of the Study

Understanding the circumstances of land use change (LUC) plays a significant role in planning future developments and strategy opportunities for ecosystem services, food security, climate change, biodiversity, and sustainable development (Meyfroidt et al., 2018). The findings of this study will be instrumental in curbing and moderating incompatible land uses, predicting future scenarios, and developing strategies to achieve more desirable developments within Rongo Sub-County by ensuring proper management of land, vegetation, and water resources.

Further, the results will assist neighboring sub-counties that are yet to experience rapid population growth and transition in land use to plan and implement sustainable land management strategies. The findings will also be valuable to land use policymakers in Rongo Sub-County and to government agencies in other sectors mandated with regulating land use and development.

1.6 Justification of the Study

Rongo Sub-County was selected as the study area because it has experienced rapid population growth, urban expansion, and agricultural intensification over the last two decades, making it a critical hotspot for analyzing the interactions between demographic dynamics and land use patterns. The sub-county is predominantly rural but is undergoing transition toward increased urbanization and commercial activities, which poses challenges such as farmland fragmentation, pressure on natural resources, and competing land demands. Studying this region therefore provides insights into how rural–urban transitions affect land use in fast-growing regions of Kenya.

The period between 2002 and 2022 was deliberately chosen to capture land use trends over two decades that coincide with significant demographic changes, policy reforms in land governance (such as the 2010 Constitution of Kenya and the 2009 National Land Policy), and shifts in socioeconomic development within Migori County. This period also aligns with major infrastructural and agricultural investments that have influenced settlement patterns, land subdivision, and land cover change. Analyzing land use dynamics across this timeframe provides a robust understanding of both short- and long-term trends necessary for sustainable planning.

1.7 Research Limitation

Obtaining data from the senior National and County Government officials was not easy due to their tight engagement thus affecting the comprehensiveness of the data obtained from key informants and the government offices. Nevertheless, the study ensured that all the data obtained from key informants was corroborated and complemented by the data obtained through literature review and FGD. Similarly, obtaining data on issues of land was challenging to the study due to the prevailing administrative nature of government offices. Limited data on land subdivision was provided from the County government which had to be supported by data from FGD and field observation.

1.8 Definition of Terms

Demography is often described as the study of populations in terms of size, distribution, and processes such as fertility, mortality, and migration (White & Weeks, 2020). In this study, demography is understood as the analysis of population characteristics such as household structures, socioeconomic conditions, and mobility patterns that influence how land is utilized. By

examining these dynamics, the study focuses on the relationship between demographic patterns and the pressure they place on land resources.

Demographic change generally refers to shifts in the size, composition, and distribution of populations, including age and sex structures, migration, and household dynamics (Haase et al., 2008; Weith et al., 2020). Within the scope of this study, demographic change is conceptualized as a key driver of land use change. Processes such as population growth, rural-urban migration, and changing socioeconomic status create direct pressures that alter patterns of land allocation, intensification, and conversion.

Land- Briassoulis (2020) defines land as a section of the earth's terrestrial surface encompassing soils, vegetation, water, and the biosphere above and beneath it. For this study, land is considered the foundational resource base upon which demographic processes exert influence. It is the finite surface where human activity, settlement expansion, and resource use occur, making it central to the analysis of land use change dynamics.

Land use refers to the ways human beings employ and manage land and its resources for specific purposes such as farming, settlement, commerce, or conservation (Srivastava et al., 2019). In this study, land use is examined as a direct outcome of demographic and socioeconomic processes. It reflects how populations adapt land resources to meet livelihood needs, economic aspirations, and settlement demands, often leading to competing uses of limited land resources.

Land use change has been defined as the transformation of land from one use to another, such as the conversion of agricultural land to residential areas (Briassoulis, 2020). Ochola (2019) further describes it as the modification of existing land uses to meet changing demands. In this study, LUC

is conceptualized as a dynamic process that emerges from demographic pressures, including population growth, migration, and shifts in socioeconomic status. It represents the visible outcome of population–land interactions over time.

Native populations are culturally distinct groups with ancestral ties to specific landscapes and resources (Davis, 2021). For this study, native populations are considered important actors in land use change dynamics, as their settlement traditions, cultural practices, and livelihood strategies both influence and respond to demographic transitions. Their role provides insights into how traditional land management systems adapt under conditions of population pressure and socioeconomic change.

1.9 Research Project Outline

This Research project is organized into five chapters. The background of the study, problem statement, research question, objectives, hypotheses, study justification and significance, conceptual framework, and limitations of the study are contained in Chapter One. Chapter two covers a literature review on trends in land use change, theoretical framework, and research gap. Chapter three entails research methodology comprising an account of the area of study, research design, sample size and sampling procedures, data collection and analysis, and research ethical requirements. The presentation of results and discussion based on objectives is found in chapter four. Finally, chapter five presents a summary of findings, conclusions, and recommendations, including areas for further study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of existing literature related to demographic change and land use change dynamics. It explores how population processes such as growth, migration, and socio-economic shifts influence patterns of land use, and how these interactions shape sustainable development. The review draws on global, regional, and Kenyan perspectives, examining theoretical foundations and empirical studies. It equally identifies gaps in knowledge and highlights how the current study contributes to ongoing debates on the relationship between demographic trends and land use transformations.

2.2 The Drivers of Land Use Change

2.2.1. Global Perspectives

Globally, land use change (LUC) is widely acknowledged as a multifaceted process shaped by both natural and human-induced drivers. Briassoulis (2020) defines LUC as the alteration of land from one use to another, or modification within the same use, while Liu and Long (2016) emphasize transformations in the structure and morphology of land use over time. These changes are broadly driven by biophysical factors (climate variability, natural processes, soil productivity) and socio-economic factors (population dynamics, technological innovation, institutional frameworks, and market forces). Hoffmann (2020) highlights that increasing human demands on land, alongside natural processes, continue to accelerate LUC globally.

Demographic change emerges as one of the most significant human influences on land use. Hersperger and Bürgi (2009) and Onyango et al. (2021) argue that population dynamics including growth, density, migration, and household composition directly alter land demand and patterns of

consumption. However, as Kroll and Haase (2010) observe, the impacts are complex and multifaceted, producing outcomes that are often contradictory. Lambin et al. (2001) caution that many narratives linking population growth directly to deforestation or agricultural expansion are oversimplified myths, neglecting the mediating influence of governance, culture, and institutional arrangements. Hoffmann (2020) further notes that demographic change interacts with economic trends, climate variability, and resource scarcity, suggesting that treating it as a singular driver risks oversimplification.

Land regulation and infrastructure development are also critical global drivers. Stehfest et al. (2019) emphasize sustainable land regulation and consumption as central to development planning. Yet, rapid population growth, income expansion, and infrastructure development such as roads and rail networks continue to open new areas for settlement and economic activity, often accelerating LUC (Kato et al., 2014; Colsaet et al., 2018; Msoffe et al., 2011). Owuor et al. (2019) similarly note that agricultural expansion, driven by rising food demand, remains one of the most significant contributors to global land transformation, with forests, grasslands, and agricultural land increasingly being converted into settlements.

Population pressure is frequently cited as a dominant driver of land use change (LUC), particularly in developing countries. In the Lake Victoria Basin in Kenya, Onyango et al. (2021) reported that rising populations have intensified food demand, triggering agricultural expansion, logging, and fuelwood extraction. Similarly, Mekuria (2014) found that increasing human populations remain the primary cause of agricultural land expansion across sub-Saharan Africa. These findings align with the widely accepted narrative that demographic growth directly fuels land conversion and resource degradation.

However, contrasting perspectives challenge this population-pressure model. Juniyanti et al. (2021) argue that LUC in some contexts is primarily driven by political and institutional factors such as weak land governance, policy failures, and corruption rather than sheer population growth. Likewise, Ceddia et al. (2019) demonstrated that agricultural expansion can occur even in areas experiencing declining population densities, suggesting that market incentives, land tenure systems, and agricultural policies may be more influential than demographics alone.

At the global scale, demographic transition further complicates the narrative. Fertility rates in most developing countries have dropped below the replacement level of 2.1 births per woman, largely due to modernization and socio-economic changes (Gu et al., 2021). While declining fertility could suggest reduced demographic pressure, population momentum continues to sustain growth because of large cohorts of young people entering reproductive age. Consequently, the global population is still projected to increase by 1.9 billion between 2020 and 2050 (Gu et al., 2021), illustrating that demographic dynamics will remain relevant even amid fertility decline. Vander Borght and Wyns (2018) similarly emphasize that fertility rates, alongside mortality and migration, remain fundamental to population growth or decline.

However, these mixed findings highlight the complex interplay between demographic and non-demographic factors in shaping land use dynamics. Studies that attribute LUC exclusively to population pressure (Onyango et al., 2021; Mekuria, 2014) risk oversimplification by neglecting the influence of political economy, governance, and land markets. Conversely, studies that downplay demographics (Juniyanti et al., 2021; Ceddia et al., 2019) may underestimate the cumulative effect of population momentum, especially in rapidly growing regions such as sub-Saharan Africa. A more nuanced understanding must therefore integrate demographic trends with institutional, economic, and cultural drivers to explain land use outcomes across different contexts.

While global studies provide broad categorizations of LUC drivers, they often remain too general to explain local variations. For example, the biophysical socioeconomic dichotomy (Briassoulis, 2020) underplays political economy aspects such as weak governance, land tenure insecurity, and conflicts, which are particularly significant in developing regions. Similarly, population pressure narratives (Lambin et al., 2001; Owuor et al., 2019) risk oversimplifying the nuanced interplay between demographic shifts, market demands, and policy frameworks.

2.2.2 Regional Perspectives (Sub-Saharan Africa and East Africa)

In sub-Saharan Africa, population growth, agriculture, and infrastructure development are widely recognized as key drivers of land use change. Studies from East Africa show that rapid demographic expansion has contributed to forest clearance, farmland expansion, and peri-urban sprawl (Msoffe et al., 2011). In the Maasai steppe of northern Tanzania, for example, the past four decades have witnessed a shift from small-scale subsistence farming to extensive cultivation, largely driven by population pressure and changing livelihood systems. Similarly, peri-urban areas across Africa have experienced accelerated land fragmentation due to infrastructure expansion, which interacts with weak land regulation and governance frameworks.

Nevertheless, regional literature often highlights demographic expansion and agriculture as primary drivers but tends to adopt a deterministic perspective that equates population growth with inevitable land conversion. This neglects adaptive strategies such as land intensification, conservation agriculture, and land sharing initiatives, which have mitigated demographic pressures in some contexts. Furthermore, limited attention is given to the role of policy failures, land tenure systems, and market dynamics that amplify or moderate land conversion in African landscapes.

2.2.3 Kenya Perspectives

In Kenya, the interplay between demographic pressures, agricultural expansion, and infrastructure development has significantly reshaped land use patterns. Population growth has been a key driver of natural landscape conversion into settlements and infrastructural developments, particularly in rural and peri-urban areas. For instance, in Migori County, population increase has led to the expansion of farmland and the transformation of natural ecosystems into settlements and roads, with farmland extension identified as a major contributor to LUC (Opiyo et al., 2022). Similar dynamics are evident across other counties, where agricultural expansion into forests and wetlands reflects the demand for food and land for settlement (Owuor et al., 2019).

Studies have shown that cropland has expanded at the expense of forests and grasslands, largely due to smallholder farming and commercial agriculture for crops such as tea and subsistence cereals. Accessibility to markets and favorable topographic conditions have been identified as major factors influencing this trend (Kiprotich et al., 2022). In the Cherangany Hills, similar patterns of agricultural encroachment have been observed, with weak governance structures, corruption, and unclear land tenure systems further facilitating deforestation and land degradation (Wekesa et al., 2021).

Wetlands and riparian areas are also under intense pressure. Many of these ecosystems have been converted into farmlands and settlements as a result of population growth, land scarcity, and the need to meet household food requirements. Farmers and settlers often cite livelihood needs as the main motivation for cultivating or settling in these sensitive areas, leading to the loss of biodiversity and the degradation of water catchment functions (Jebiwott et al., 2021; Mwangi et al., 2020).

The construction of the Standard Gauge Railway (SGR) and associated road networks has led to rapid expansion of built-up areas, industrial activities, and settlements along transport corridors. Increased accessibility has stimulated speculative land acquisition, industrial parks, and housing estates, all of which have contributed to the conversion of vegetation and agricultural land into urban uses (Sang et al., 2022).

In Kenya's arid and semi-arid lands (ASALs), land use change is driven by shifting pastoral livelihoods, sedentarization, and infrastructure development. Roads, conservation initiatives, and the fencing of communal lands into private parcels or conservancies are reshaping rangeland use, sometimes reducing open grazing areas and leading to increased land fragmentation (Ole Koissaba, 2021).

Institutional and governance factors remain central in shaping land use patterns across the country. Inadequate enforcement of land use plans, corruption, and tenure insecurity encourage unplanned settlement expansion, encroachment into protected areas, and forest loss. The Mau and Cherangany cases illustrate how governance gaps amplify direct drivers such as agricultural expansion and population pressure (Wekesa et al., 2021).

Climate variability and change compound these pressures by influencing farming systems and settlement patterns. Increased frequency of droughts and unpredictable rainfall have forced communities to change cropping patterns, migrate to new areas, or exploit marginal lands. These climate-induced responses often result in further deforestation and encroachment into ecologically fragile zones (Kogo et al., 2021).

While Kenyan studies rightly point to population pressure and agriculture as central drivers, many analyses remain narrowly focused on demographic explanations. They often underplay the influence of weak planning institutions, land tenure insecurity, and policy gaps that exacerbate unregulated land conversion. This leaves a research gap in understanding how governance frameworks, economic policies, and market incentives shape land use change in Kenya, beyond the demographic–agriculture nexus.

2.3 Demographic Characteristics and Land Use Change

Population growth is not uniform across space; it varies in both degree and intensity, producing different land use outcomes depending on growth trajectories. According to Livi-Bacci (2017), rapid growth can lead to resource expansion and pressure, while declining growth may result in stagnation or even extinction within certain strategic spaces. The biological limits of fertility, particularly the reproductive capacity of women, set the upper threshold of population expansion. Vander Borght and Wyns (2018) highlight that the age of the female partner significantly influences the probability of conception, underscoring the role of demographic biology in shaping long-term population dynamics. These biological constraints link directly to land resource use, as expanding populations inevitably impose greater demands on finite resources, which may in turn adapt or expand in response to persistent human development (Livi-Bacci, 2017).

Beyond biological determinants, household-level dynamics also play a crucial role in land use outcomes. Several studies demonstrate that population growth, coupled with household food consumption diversity, is a significant driver of land use change (Doelman, 2018; Hassan et al., 2016; Msofe et al., 2019). Household composition, including gender and age structures, influences production decisions and therefore patterns of land use (Hettig et al., 2016). For example, households dominated by elderly members or women often face labour shortages, leading to land

fragmentation or even abandonment (Tang et al., 2022). This highlights how demographic factors operate not only at the macro scale (population growth) but also at the micro scale (household structure) to reshape landscapes.

While these studies effectively establish the link between demographic characteristics and land use, they risk presenting the relationship as deterministic. In reality, the impacts of age, gender, and household composition on land use vary depending on social, cultural, and economic contexts. For example, women's influence on land use may differ in patriarchal societies where land rights are restricted, compared to more gender-inclusive contexts. Similarly, land abandonment among elderly populations may be mitigated where strong land markets or mechanization exist. Thus, demographic characteristics should not be viewed as isolated drivers but as part of a broader socio-economic system that conditions their effects on land use change.

2.3.1. Influence of Population Size on Trends in Land Use Change

2.3.1.1 Global Perspectives

Population size remains one of the most frequently cited drivers of land use change worldwide. The United Nations (2019) projects that the global population will reach 9.1 billion by 2025, with much of this growth concentrated in developing regions. Rising population size is often linked to increasing pressure on land for food production, settlement expansion, and infrastructural development. Hussain and Bhat (2018) highlight that the projected increase of 2.0 billion people between 2020 and 2050 will significantly intensify global demand for land resources, leading to widespread land conversion and fragmentation.

However, while global projections strongly associate population growth with land demand, they often assume a direct linear relationship. This perspective risks oversimplifying the complex interactions between population dynamics, technological innovations, and governance

frameworks. In some regions, for instance, agricultural intensification and land use planning have moderated the impacts of population growth, showing that numbers alone cannot fully explain land use outcomes.

2.3.1.2 Regional Perspectives (Sub-Saharan Africa)

Sub-Saharan Africa is projected to bear the greatest demographic burden, with its population expected to grow from 1.1 billion in 2020 to 3.8 billion by 2100 (Hussain & Bhat, 2018). With an average annual growth rate of 2.5%, Africa faces mounting challenges of balancing food security, settlement expansion, and environmental conservation (UN, 2019). This rapid demographic increase is already manifesting in land use pressures, particularly in peri-urban areas and agricultural frontiers where farmland expansion and deforestation are accelerating.

Regional analyses often emphasize population growth as the dominant driver of land conversion. Yet, they sometimes neglect other equally critical factors such as weak land tenure systems, limited institutional capacity, and political instability, which exacerbate the impacts of demographic growth. Furthermore, attributing land use change solely to rising population risks reinforcing a "neo-Malthusian" perspective that downplays local adaptive strategies, such as land intensification or diversification of livelihoods.

2.3.2 Population Growth and Land Use Change in Kenya

Kenya has experienced rapid population growth in recent decades, with the population increasing from 28.7 million in 1999 to 47.6 million in 2019 (Kenya National Bureau of Statistics [KNBS], 1999, 2019). At the county level, Migori County where Rongo Sub-County is located—recorded an increase from 666,784 people in 1999 to 1,116,436 in 2019 (KNBS, 2019). This demographic expansion has placed immense pressure on land resources, accelerating the conversion of

farmlands into settlement areas and driving deforestation (Ogola, 2018; Owuor et al., 2019; Onyango et al., 2021).

Empirical studies link population growth to intensified resource utilization. Yaser and Saba (2016) identify population increase as the primary driver of natural resource exploitation, while Deng et al. (2015) conclude that unsustainable forest use is among the leading causes of land use change. In Migori County, agricultural land historically the dominant land use remained relatively stable between 1979 and 1999, but a significant decline occurred between 1999 and 2009, with a loss of 3,392.5 hectares. During the same period, forest cover also decreased, coinciding with continued population growth (Ogola, 2018; Yaser & Saba, 2016).

While these studies establish a strong correlation between population growth and land use change, they tend to adopt a linear population–pressure model that risks oversimplifying the dynamics at play. For instance, Ogola (2018) and Owuor et al. (2019) attribute farmland conversion mainly to demographic expansion, but they give limited attention to governance issues such as weak enforcement of land use regulations, land tenure insecurity, and speculative land markets. Similarly, while Yaser & Saba (2016) and Deng et al. (2015) link resource exploitation to population growth, they underexplore the role of economic incentives, agricultural practices, and technological change, which may exacerbate or mitigate land degradation. This suggests a gap in the Kenyan literature, where the interaction between population size and institutional frameworks remains under-investigated.

2.3.3 Population Growth, Land Subdivision, and Land Use Change

Globally, population growth has intensified pressure on natural resources such as land, as people seek space for cultivation, settlement, and infrastructure development. Omuruli (2022) observes that increasing human populations drive land acquisition for agriculture and housing, while Marchant et al. (2018) similarly highlight migration and population increase as key factors influencing land use worldwide. These pressures frequently manifest in forest clearance, farmland expansion, and urban sprawl, underscoring the strong association between demographic dynamics and land transformation.

At the regional level, Africa has witnessed relentless changes in land use, particularly in peri-urban and watershed areas where population density is increasing. Kato et al. (2014) attribute this trend to changing population structures, while Kamwi et al. (2015) and Munthali et al. (2019) note that population growth stimulates demand for housing and amenities, leading to forest loss and landscape alteration. Owuor et al. (2019) further emphasize that growing populations and changing household sizes increase food demand, thereby fueling farmland expansion. Importantly, land subdivision has become a significant outcome of population growth, reducing average landholding sizes and creating fragmented landscapes (Omuruli, 2022).

In Kenya, similar dynamics are evident. Kanda et al. (2022) document that rising population levels are influencing land use dynamics in the Elgeyo escarpment of Elgeyo Marakwet County, where farmland expansion and settlement have intensified. Across the country, increasing population density has contributed to land fragmentation, conversion of forests into settlements, and agricultural encroachment into fragile ecosystems. These dynamics are particularly visible in densely populated rural counties and peri-urban zones, where demographic pressures intersect with weak land governance to accelerate unregulated land transformation.

Despite the fact that these studies collectively affirm the influence of population growth on land use change, many adopt a deterministic perspective that directly links demographic expansion to land conversion. This risks neglecting the moderating role of policy frameworks, land tenure arrangements, and economic incentives, which can either exacerbate or mitigate the impacts of population growth. For example, land subdivision is not only a demographic outcome but also a product of inheritance practices, land market dynamics, and inadequate land use planning. Similarly, attributing forest loss solely to population growth (Kamwi et al., 2015; Munthali et al., 2019) overlooks the role of governance failures and weak enforcement of conservation policies. These gaps highlight the need for more nuanced, multi-dimensional analyses of population–land use relationships in both Africa and Kenya.

2.3.4 Gender Dimensions of Demographic Change and Land Use

The role of gender in shaping land use change (LUC) remains contested in the literature. Villamor et al. (2014a) argued that gender specificity does not directly influence land use decisions, implying that broader socio-economic or institutional drivers may override gender differences. However, subsequent studies highlight that males and females often have different exposures, responsibilities, and perceptions of risk related to land use (Chrisendo et al., 2020). Traditionally, farmland activities have been male-dominated, while women are disproportionately responsible for firewood and wild fruit collection for household consumption (Villamor et al., 2015). This unequal division of labour reflects entrenched social norms that marginalize women from key decision-making processes regarding land use.

Changing land use patterns, however, are increasingly shifting farmland responsibilities toward women, especially as men migrate or diversify livelihoods (Villamor et al., 2015). While this shift

expands women's role in production, their exclusion from formal decision-making processes limits their influence on land allocation and management choices. Indeed, women's inability to resist development proposals or secure formal land rights accelerates processes such as deforestation, agricultural expansion, and carbon emissions (Villamor et al., 2014b). Kieran et al. (2015) further emphasize that the lack of land ownership rights for women severely constrains their agency in shaping land use outcomes.

These findings reveal that gender is not merely a social variable but a structural determinant of land use. Yet, existing literature often underestimates the institutional and cultural barriers that prevent women from exercising decision-making power, even where they bear the burden of land-based responsibilities. This disconnect highlights a critical policy gap: without gender-sensitive land governance frameworks, shifts in land use responsibilities may reproduce inequalities and intensify environmental degradation. A gender-based approach in land and resource policy formulation is therefore essential to ensure both equity and sustainability.

2.3.5 Migration, Immigration, and Land Use Change

Migration and immigration are important demographic processes shaping land use change (LUC), especially in rural and forested landscapes. Immigration influences population growth by increasing population densities, which in turn drive agricultural expansion and forest degradation (Soby, 2017). In some rural areas, immigrant investments and development projects expand agricultural landholdings, further intensifying pressure on natural resources. However, the literature remains divided on the extent of migrants' contribution to LUC. For instance, Jones et al. (2018) observed that migrants may not contribute to land use change more than native

populations, yet their presence inevitably enlarges population size and, consequently, demand for land and forest resources (Msofe et al., 2019).

Beyond direct land pressure, migration also reshapes the socioeconomic and cultural context of rural communities. Kizgin (2011) argues that immigration is often driven by the search for better living standards and employment opportunities, and migrants are not only land users but also consumers with distinct behaviors and cultural values. These differences may create opportunities, such as investment in agricultural productivity, but they also present challenges in integrating diverse land use practices and preventing unsustainable exploitation of natural resources.

Whereas existing studies acknowledge the role of immigration in population growth and LUC, they often oversimplify migrants as either drivers of degradation or neutral actors, without examining the complex interaction of tenure insecurity, cultural adaptation, and institutional regulation. For example, tenure security for local communities and forest protection measures are frequently proposed (Kizgin, 2011), yet policies rarely address how to balance these with the livelihood needs of both migrants and host populations. This gap suggests the need for integrated migration-sensitive land governance frameworks that consider not just demographic growth but also cultural and institutional dynamics influencing LUC.

2.4 Socioeconomic Characteristics and Land Use Change

Socioeconomic characteristics are widely recognized as critical drivers of land use change, influencing how demographic pressures translate into land-based outcomes. Factors such as income growth, market access, energy consumption, and dietary transitions have been shown to accelerate agricultural expansion, urbanization, and deforestation (Meyfroidt et al., 2022). Rising incomes and shifting diets, for example, are increasing global demand for meat and processed

foods, thereby driving cropland intensification and conversion of natural habitats (Alexander et al., 2021).

In Sub-Saharan Africa, socioeconomic conditions such as poverty, informal employment, and limited access to capital strongly determine how rural households interact with land resources (Jayne et al., 2021). Studies show that livelihood diversification, migration, and remittance flows are reshaping rural land use by reducing direct dependence on subsistence agriculture while simultaneously fueling new forms of land investments, including peri-urban housing and smallholder intensification (Nkedianye et al., 2022).

In Kenya, socioeconomic factors are closely intertwined with land use dynamics. Education levels influence household capacity to adopt sustainable practices, with educated households less likely to engage in distress land sales or unsustainable land exploitation (Musyoka et al., 2021). Income and employment opportunities also play a central role, as off-farm activities and access to capital reduce pressure on land while shaping investment in housing and commercial agriculture (Otieno et al., 2022). Moreover, energy choices remain central to land degradation in Kenya, where rural reliance on firewood and charcoal contributes to forest depletion despite policy pushes for LPG and electricity adoption (Kiteme et al., 2023). Collectively, these socioeconomic factors mediate household decision-making and explain variations in land use trajectories across Kenya.

2.4.1 Household Income, Consumption, and Land Use Change

Income and household consumption dynamics are among the most significant socioeconomic drivers of land use change (LUC). Globally, rising household income levels increase demand for diverse food products and higher-value commodities, which exerts pressure on land systems through agricultural expansion (Doelman, 2018). Market prices remain the primary determinant

of household land use choices, as households weigh profitability in selecting farming or non-farming activities (Ahimbisibwe et al., 2019). In many rural contexts, access to off-farm income sources such as formal employment or private business ventures reduces dependence on subsistence agriculture and can either limit or accelerate LUC. For example, some households invest additional income into cash crop production, intensifying land use, while others diversify into non-agricultural livelihoods, reducing direct land pressure (Ahimbisibwe et al., 2019).

At the regional level, particularly in sub-Saharan Africa, capital constraints remain a major barrier to sustainable land investments. Households lacking sufficient capital often abandon land or shift to non-agricultural activities, leading to land fragmentation or underutilization (Tang et al., 2022). Conversely, better-endowed households, with access to labor, land, and physical capital, are more likely to make intensive land use decisions that increase productivity but also contribute to ecosystem strain (Doelman, 2018; Hettig et al., 2016).

In Kenya, the situation reflects a dual pattern. Off-farm income is increasingly becoming a critical livelihood strategy in rural areas, shaping land use choices and determining the opportunity costs of agriculture. Such income provides liquidity for initial investments in cash crops or non-farm enterprises (Hettig et al., 2016; Ahimbisibwe et al., 2019). However, this duality means that while some households reinvest in agriculture, leading to land intensification, others move away from farming altogether, resulting in land abandonment or informal land transactions.

The literature clearly shows a strong correlation between income, consumption, and land use outcomes, but it often overlooks the heterogeneity of household responses to income dynamics. The assumption that higher income automatically leads to agricultural expansion is problematic, as some households diversify away from farming. Similarly, most studies underplay the role of

institutional factors such as land tenure security, access to credit, and rural infrastructure, which mediate how income translates into land use decisions. Addressing these gaps would require a more nuanced approach that considers income inequality, livelihood diversification, and structural policy environments in explaining LUC.

2.4.2 Off-Farm Employment, Capital Access, and Labor Market Dynamics

Globally, the growth of better-paying off-farm opportunities has reshaped rural livelihoods, often reducing the reliance on agriculture but simultaneously placing pressure on local labor markets (Sabbagh & Neef, 2008). In many cases, this leads to a shift toward land use practices that are less labor-intensive, such as mechanized farming or land abandonment, depending on capital access. Increased household income from non-farm employment is frequently reinvested in agriculture, thereby intensifying production, or alternatively directed into non-agricultural enterprises that transform rural land into built-up areas (Sabbagh & Neef, 2008). This duality illustrates the complexity of the relationship between income diversification and land consumption, which is further linked to population growth, rising wealth, and increasing demand for housing and infrastructure.

In sub-Saharan Africa, the interplay between labor shortages and migration significantly influences land use patterns. Rural out-migration reduces agricultural labor availability, compelling households to either adopt less labor-intensive land uses or lease out land (Kleemann et al., 2017). At the same time, in-migration by productive workers increases local population densities, raising pressure on forests, farmland, and other natural resources (Putri et al., 2019). A common outcome has been land subdivision, as households sell parcels to private developers,

resulting in rapid land conversion from agricultural to residential and commercial uses (Owuor et al., 2019).

In Kenya, this process is particularly pronounced in peri-urban areas, where expanding towns and cities attract both migrants and investors. Households with access to off-farm income often finance land subdivision and speculative sales to developers, accelerating the growth of built-up areas (Owuor et al., 2019). Meanwhile, rural-urban migration has created localized labor shortages, forcing households to adapt through mechanization or land underutilization. Job mobility within Kenya further drives the construction of single-family dwellings, thereby increasing household numbers even in areas where overall population growth rates are declining (Sabbagh & Neef, 2008).

While the literature highlights the strong influence of off-farm employment and labor mobility on LUC, it tends to generalize outcomes without considering the role of institutional frameworks such as land tenure laws, inheritance systems, and urban planning policies. Moreover, much of the research emphasizes economic drivers but neglects the socio-cultural dimensions of land transactions, for instance, cultural values influencing whether land is sold, leased, or preserved for farming. A more nuanced understanding requires integrating economic opportunities with governance and cultural contexts to capture the full spectrum of how labor market dynamics shape land use outcomes.

2.4.3 Household Energy Choices and Land Use Change

Globally, household energy choices exert a direct influence on land use systems. Firewood and charcoal remain widely used in low- and middle-income countries due to their availability and affordability (Dickinson et al., 2019). While income and household size are often linked to the

adoption of modern fuels such as liquefied petroleum gas (LPG), studies also show that traditional perceptions and cultural preferences play a significant role in sustaining reliance on biomass energy, regardless of household wealth (Xing et al., 2018). For example, in many settings, households prefer charcoal or firewood for slow-cooking meals such as cereals, while LPG is used for convenience in quick food preparation (Nansaior et al., 2011).

At the regional level, particularly in sub-Saharan Africa, the continued demand for firewood and charcoal is a major driver of land use change. Widespread biomass extraction contributes to deforestation, farmland expansion, and land degradation. Firewood collection is closely linked with agricultural expansion and settlement development, which together exert immense pressure on natural vegetation (Kleemann et al., 2017; Munthali et al., 2019). The growing urban demand for charcoal has further intensified these pressures, as rural landscapes are increasingly transformed to meet energy needs of towns and cities.

In Kenya, household energy choices reflect similar dynamics. According to Mangeni et al. (2023), despite government campaigns promoting LPG and electricity for domestic use, a majority of households still rely on charcoal and firewood, particularly in rural and peri-urban areas where affordability and accessibility remain central determinants. Okore, Koske, and Letema (2022) further observe that household size, income, and perceptions about energy efficiency drive mixed fuel use, with wealthier families often adopting both LPG and charcoal depending on the type of food prepared. Mangeni et al. (2023) emphasize that this continued reliance on biomass fuels contributes to deforestation, farmland encroachment, and land subdivision for settlement, making energy use a significant driver of land use change.

The literature on household energy and land use change often emphasizes economic and cultural drivers of fuel choice but tends to underexplore the role of policy, governance, and enforcement. For example, while Kenya has instituted bans and regulations on charcoal production, weak enforcement undermines effectiveness, allowing continued deforestation. Furthermore, much of the research overlooks the feedback loop between energy demand and land tenure systems, such as whether communal forests or private woodlots are being exploited. Addressing these gaps would provide a fuller understanding of how household fuel choices intersect with broader demographic and land governance dynamics.

2.4.4 Education, Awareness, and Land Use Change

Globally, education has long been recognized as a key determinant of land use decisions. Higher levels of education increase household awareness, opportunity costs, and productivity across economic activities, thereby shaping how land is valued and utilized (Hettig et al., 2016; Tang et al., 2022). Education enhances household consciousness of resource use, enabling shifts from subsistence farming to more profitable and sustainable practices. It also influences adoption of technology and diversification of livelihoods, which in turn stimulates households to transition between land uses for maximum returns (Tran et al., 2018). Beyond economic outcomes, education shapes household attitudes and values toward land, often encouraging long-term planning and conservation.

At the regional level, particularly in sub-Saharan Africa, education has been found to play a pivotal role in shaping community perceptions of land use change and its drivers. Anwar et al. (2022) argue that higher educational attainment fosters behavioral change toward natural resource management in rural areas. Similarly, Munthali et al. (2019) emphasize that education is essential

for creating awareness about sustainable land use practices, particularly in contexts where traditional norms and cultural values dominate. Opiyo et al. (2022) further highlight that perceptions of activities such as fuelwood and timber production vary depending on education levels, landholding size, and length of residency, showing how education interacts with other socioeconomic factors to influence land transformation.

In Kenya, education has emerged as a critical factor in shaping land use outcomes. Studies have shown that household education levels affect choices regarding crop diversification, adoption of conservation technologies, and attitudes toward forest use (Onyango et al., 2021; Opiyo et al., 2022). For instance, households with higher educational attainment are more likely to adopt modern energy sources and sustainable agricultural practices, whereas less educated households often maintain traditional land use systems, contributing to forest clearance and soil degradation. At the same time, cultural practices such as land subdivision by household heads among their children continue to reduce farm sizes (Starke, 2005). This, combined with rising education levels, has paradoxically increased demand for more agricultural land, resulting in clearance of forest areas to meet food and livelihood needs.

While the literature clearly underscores education as a driver of land use change, there is limited focus on the quality of education and the link between curricula and environmental awareness. For example, although Kenya has expanded access to formal education, the extent to which school systems instill sustainable land management values remains underexplored. Moreover, existing research often assumes a positive correlation between education and sustainable land use, yet in practice, educated households may also contribute to unsustainable practices if economic incentives favor short-term gains (e.g., charcoal trade, speculative land subdivision). 2.4.5 Dietary Shifts, Population Growth, and Land Use Change

Globally, the relationship between population growth and dietary shifts has emerged as a critical driver of land use transformation. As populations expand, the demand for food rises, but more importantly, changes in diet linked to income growth significantly influence land consumption patterns (Alexander et al., 2015). Wealthier populations often transition from staple-based diets to those rich in animal protein, dairy, and processed foods, which require greater land, water, and energy inputs compared to cereals or legumes. Consequently, demographic change and dietary transitions are considered principal global forces shaping land use in the 21st century (Alexander et al., 2015).

Regionally, in sub-Saharan Africa, demographic expansion is placing pressure on agricultural systems to meet both subsistence and market-oriented food demands. While urban middle-class populations are increasingly adopting diets higher in meat, dairy, and processed foods, rural populations remain dependent on traditional staples. This duality intensifies land use change by expanding cropland to sustain staples while simultaneously increasing demand for pasture and feed crops (Njeru et al., 2016). However, the adoption of such diets remains constrained by income inequalities, meaning the pace of dietary-driven land use change is uneven across the region.

In Kenya, rapid urbanization and rising household incomes are gradually shifting dietary preferences. Urban households, in particular, are increasingly consuming more meat, dairy, and horticultural products compared to rural households that still rely on maize, sorghum, and other staples (KNBS, 2020). This shift has driven expansion of both commercial livestock production and irrigated horticulture, often at the expense of forests and rangelands. For instance, demand for dairy and poultry products has encouraged intensification of feed crop production, while the demand for horticultural exports has contributed to the conversion of arable land and wetlands into greenhouses and irrigated farms.

Even though the existing literature highlights the global and regional dietary transitions, there is insufficient attention to the trade-offs between food security and environmental sustainability. For example, in Kenya, promoting livestock and horticultural expansion may improve nutrition and incomes but also increases pressure on water resources and accelerates deforestation. Furthermore, much of the literature assumes that higher incomes automatically lead to dietary transitions; however, cultural preferences and food traditions can slow or modify these changes. More research is needed to understand how local cultural dynamics mediate the population–diet–land use relationship in Kenya.

2.5 Theoretical Framework

This study adopted theoretical perspectives that illuminate the linkages between demographic processes and land use change. The theories provided the conceptual lens for understanding the dynamics of population change, socioeconomic transformation, and their implications for rural land use. They were particularly useful in guiding the framing of research questions, data analysis, and interpretation of findings within the context of Rongo Sub-County.

2.5.1 The Demographic Transition Theory

The Demographic Transition Theory, first proposed by Warren Thompson in 1929 and later refined by Frank Notestein in 1945, explains the historical process of demographic transformation as societies move through stages of mortality and fertility decline influenced by industrialization, education, and urbanization (Thompson, 1929; Notestein, 1945; Caldwell, 2006; Kirk, 1996). The theory highlights how shifts from high birth and death rates to low birth and death rates reshape population size, structure, and distribution, thereby altering the demand for land and resources (Dyson, 2010; Bilsborrow & DeLargy, 1990).

In the context of this study, the Demographic Transition Theory was important in interpreting how changes in population growth, fertility levels, and household size influence land use trajectories in Rongo Sub-County. For instance, increasing literacy levels, declining mortality, and shifting economic opportunities are driving rural households to intensify land use for settlement, education facilities, and infrastructure. The theory therefore guided the analysis of demographic variables such as population growth rate, fertility, and migration by linking them to the observed land use changes in the study area.

2.5.2 Theory of Population and Environment

The Theory of Population and Environment, rooted in the demographic transition model, emphasizes the interdependence of population, environment, and development (Notestein, 1945; Ehrlich & Holdren, 1971; Cohen, 1995; Mishra, 1995). It postulates that demographic processes are shaped not only by natural resources and the biophysical environment but also by prevailing socioeconomic and cultural circumstances. According to the theory, changes in population size, consumption patterns, and technological development exert cumulative pressure on land resources, eventually triggering significant land-use change once ecological thresholds are exceeded (Turner, 1990; Bilsborrow & DeLargy, 1990).

This theory was particularly valuable in this study as it provided an analytical framework for examining how demographic and socioeconomic changes in Rongo Sub-County influence patterns of land use. It explained, for example, why the establishment of institutions such as Rongo University has transformed surrounding rural land parcels, why education levels and socioeconomic status affect household land use decisions, and why infrastructural developments such as roads, markets, and schools are reshaping rural landscapes. By integrating population

dynamics with environmental outcomes, the theory strengthened the study's capacity to analyze the reciprocal relationship between demographic change and land use change.

2.5.3 Relevance of the Theories to the Study

Together, these theories offered a coherent framework for this research. The Demographic Transition Theory helped in understanding how population growth and structural changes drive land use demands, while the Theory of Population and Environment explained why these demographic shifts translate into concrete land use outcomes through interactions with socioeconomic and environmental factors. Applying both theories was necessary for this study as they allowed a comprehensive analysis of the influence of demographic change on land use change dynamics in a rural setting. They also guided the interpretation of survey data, enabling the study to draw meaningful connections between demographic characteristics, livelihood patterns, and the observed trends in land use within Rongo Sub-County.

2.6 The Conceptual Framework

The conceptual framework of this study is anchored in the Population and Environment Theory, as modified from the Demographic Transition Theory. The framework posits that demographic transitions initially lead to gradual land use change (LUC). However, as population growth combines with increasing consumption, technological advancement, and industrial activities, the rate of land use change accelerates. The accumulated pressure on ecosystems may remain latent for some time but eventually reaches a threshold where abrupt and often irreversible changes in land use and environmental conditions occur.

Independent Variables (Demographic Processes)

The study identifies demographic processes as the independent variables driving land use change. These processes include fertility trends, which influence household size and land demand; mortality trends, which shape population structure and dependency ratios; and migration or immigration, which contribute to rural–urban linkages and increase land demand in peri-urban areas. Furthermore, these demographic processes are influenced by determinants such as marriage patterns, health and nutrition, employment opportunities, and famineIntervening Variables (Socioeconomic, Cultural, Technological, and Institutional Factors)

The effect of demographic processes on land use change is mediated by a set of intervening variables collectively referred to in this study as the "SOCT Complex." These include socioeconomic factors such as income levels, education, livelihood strategies, and market forces; organizational and institutional factors like governance structures, land tenure systems, planning regulations, and policy frameworks; cultural factors encompassing traditions, values, and land inheritance practices; and technological factors such as agricultural innovations, fertilizer use, mechanization, and infrastructure development. These intervening variables shape how population dynamics translate into specific land use outcomes. For example, population growth alone may not necessarily result in farmland expansion unless it is mediated by technological adoption, market access, or supportive infrastructure.

Dependent Variable (Land Use Change)

The dependent variable in this study is Land Use Change (LUC), which manifests in various forms. These include farmland expansion and intensification through practices such as fertilizer use and

mechanized agriculture; infrastructural development involving the construction of roads, markets, and schools; resource exploitation through activities like land mining, tree cutting, and quarrying; as well as settlement expansion evident in the growth of educational institutions such as Rongo University and the development of rural housingLinkages in the Framework.

Demographic processes (independent variables) create pressure on land resources. This pressure is filtered and shaped by the SOCT Complex (intervening variables). The combined effect produces observable land use change outcomes (dependent variable).

Thus, the framework demonstrates that land use change in Rongo Sub-County is not a direct outcome of demographic change alone but results from the interaction of demographic, socioeconomic, cultural, technological, and institutional factors.

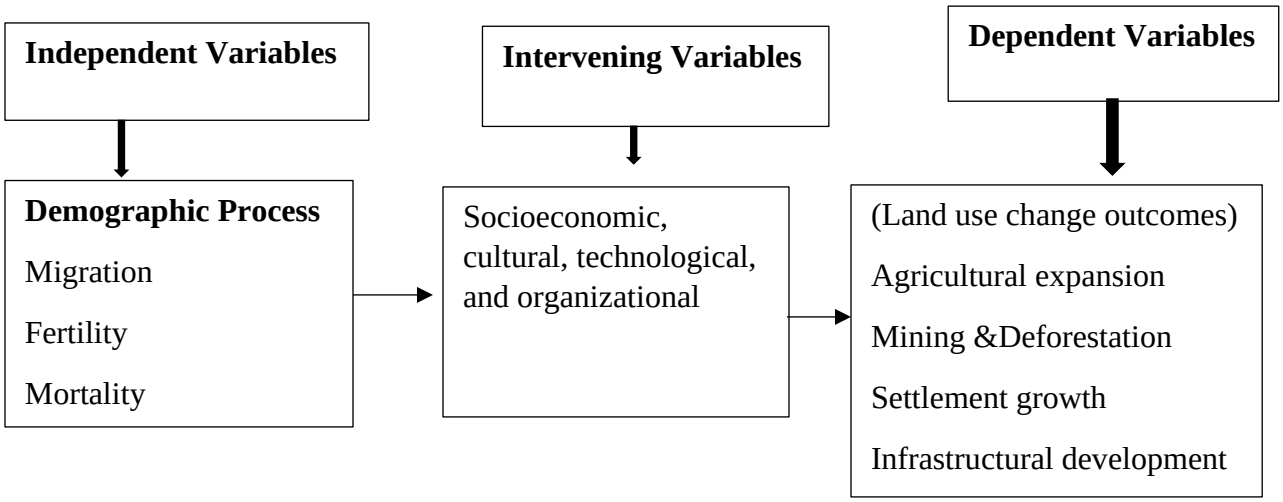

Figure 1: Conceptual Model

Source: Adopted from Vinod Mishra (1995)

2.7 Research Gap

Globally, demographic processes such as population growth, migration, income changes, education, and dietary shifts have been shown to significantly drive land use change (Alexander et al., 2015; Tang et al., 2022; Tran et al., 2018). These processes influence agricultural expansion, settlement development, and resource extraction, thereby shaping landscapes across the world. In sub-Saharan Africa, rapid population growth, urbanization, and the increasing demand for agricultural land and fuelwood are major contributors to land use transformation, often leading to deforestation, soil degradation, and declining ecosystem services (Munthali et al., 2019; Kleemann et al., 2017). However, regional studies have tended to emphasize urban and peri-urban settings, leaving rural areas less examined despite their dynamic demographic and land use interactions.

In Kenya, existing research has established that demographic pressures are a critical driver of land use change, particularly in urban and peri-urban areas such as Nairobi and its surrounding counties (Opiyo et al., 2022; Muhati et al., 2018; Muriithi, 2016). These studies highlight how population increase, settlement expansion, and shifting livelihoods alter agricultural and forest landscapes. Yet, rural contexts where livelihoods remain heavily dependent on land and natural resources have received limited attention. Rongo Sub-County, despite being predominantly rural, is currently experiencing uncontrolled expansion of settlements, mining activities, and conversion of agricultural plantations such as sugarcane into residential areas (Ochola, 2019; Owuor et al., 2019). This trend raises concerns about environmental sustainability, food security, and long-term rural development.

The key gap lies in the limited empirical evidence directly linking demographic change to land use change dynamics in rural areas such as Rongo Sub-County. While global and regional studies

establish demographic processes as major drivers of land use change, they seldom disaggregate these influences within rural contexts. Specifically, there is inadequate understanding of how demographic factors such as household size, fertility, migration, education level, and changing socioeconomic conditions interact to shape land use trajectories in rural landscapes.

Addressing this knowledge gap is critical for guiding sustainable land use policies in rural Kenya and beyond. This study therefore seeks to examine the influence of demographic change on land use change dynamics in Rongo Sub-County, thereby contributing to evidence-based decision-making for sustainable rural land management.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter outlines the research methodology adopted in the study. It presents the area of study, research design, sampling methods, sample size and sample distribution, data collection, and analysis procedures. To provide context for the methodological choices made, the discussion begins with the description of the study area, as its demographic, social, and environmental characteristics form the basis upon which the research was conducted.

3.2 The Study Area

3.2.1 Location and Area Characteristics

The study was conducted in the rural areas of Rongo Sub-County, Migori County, western Kenya**.** Administratively, these rural areas fall within Rongo Division and Chamgiwadu Division. The rural study area is further subdivided into six locations, namely: South Kamagambo, North Kamagambo, South West Kamagambo, West Kamagambo, East Kamagambo, and North East Kamagambo**.** Geographically, Rongo Sub-County lies within coordinates 00°39’12” S, 34°35’40” E and 00°59’16” S, 34°37’21” E (Mudereri et al., 2020), covering an area of approximately 213.4 km² (KNBS, 2019). The altitude ranges between 1,470-1,600 m above sea level**.** The Sub-County is bordered by Rangwe and Homa Bay Town Sub-Counties to the north, Ndhiwa and Awendo to the west, South Mugirango to the east, and Kilgoris to the south. Migori County itself lies along the Kenya-Tanzania border, with neighboring counties including Narok, Kisii, and Homa Bay**.**

Climatically, Rongo Sub-County experiences an average annual temperature of 20.6°C**,** with relative humidity ranging between 50-70%**.** Rainfall is bimodal, with long rains occurring between March-May and short rains between October-December, averaging between 900-1,833 mm annually. The climate is largely influenced by the Sub-County's proximity to Lake Victoria and the Kisii Highlands**.**

Topographically, the area is characterized by rolling terrain with gentle slopes, underlain by relatively fertile volcanic soils**,** while black cotton soils occur along some riverbanks. Beneath the landscape lie acidic parent rocks and granite formations known to contain gold, as well as Bukoban and Nyanzian rock systems**.** The Sub-County is also endowed with numerous water resources**,** including Kuja, Nyamador, Kira, Misadhi, Olando, Kichuri, and Odundu rivers, most of which originate from the Kisii and Narok highlands (County Government of Migori [MGR], 2023).

The rural nature of the study area is reflected in its land use patterns and livelihoods. Agriculture is the main economic activity**,** with smallholder farmers cultivating maize, beans, sugarcane, and horticultural crops, alongside livestock keeping. Forestry and small-scale mining also contribute to household income. Settlement patterns are typically scattered homesteads**,** and infrastructure such as roads, markets, and social amenities are less developed compared to urban centers. These rural characteristics, combined with the high population density making Rongo the second most densely populated Sub-County in Migori after Suna East (KNBS, 2019) have contributed to increasing pressure on land and rapid land use changes from agriculture to settlement (MGR, 2023).

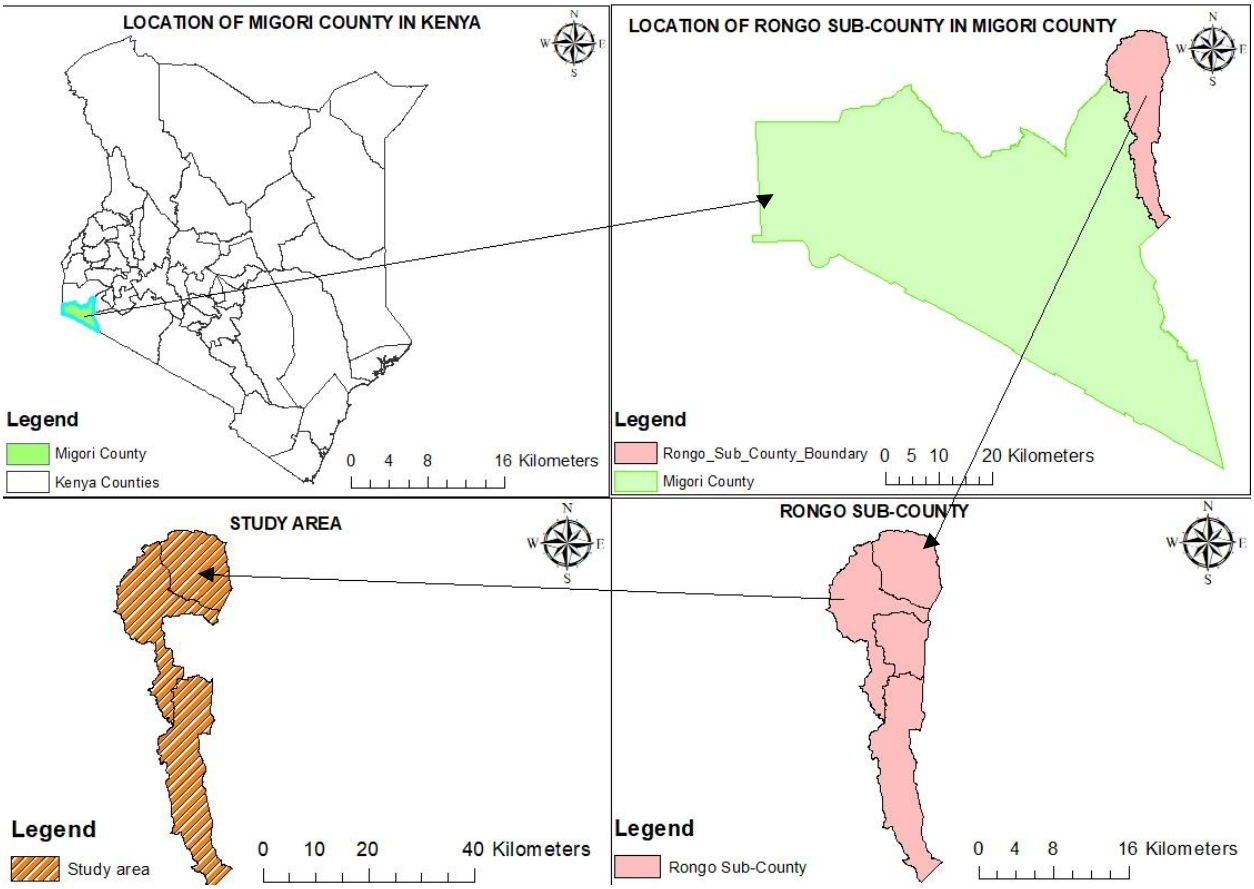

Figure 2: The Extent of the Study Area

Source: Author, 2024

3.3 Research Design

The main approach to this study was deductive as it was based on population and Environment theory from which the hypotheses were deduced. The study employed a descriptive design to help understand aspects of LUC and demographic change, mainly in terms of relationships, characteristics, and trends within the study area. Additionally, the study adopted the use of both qualitative and quantitative types of data which were analyzed by the study to comprehend all facets of LU and demographic change.

3.4 Target Population and Sampling Methods

The study employed a combination of probabilistic and non-probabilistic sampling methods to effectively capture the characteristics of the target population. The target population comprised rural households in Rongo Sub-County, who are directly engaged in and affected by demographic change and land use dynamics. Purposive sampling was used to select key respondents such as community leaders, agricultural officers, and local administrators, given their knowledge and direct involvement in land use management. In contrast, systematic random sampling was applied to select household respondents from the six rural locations, ensuring that every household had an equal chance of inclusion while maintaining geographical representation across the study area.

3.4.1 The Target Population

The target population for this study was twofold, comprising both the land parcels and the human population within the rural areas of Rongo Sub-County. First, the analysis of land use change (LUC) trends focused on land parcels located in the six rural locations of Rongo Sub-County, which served as the spatial units for examining changes in land use patterns over time.

Second, the study targeted the human population residing and undertaking business activities within these rural locations, since they are directly engaged in and affected by demographic change and land use dynamics. According to the 2019 Kenya Population and Housing Census (KNBS, 2019), Rongo Sub-County has a total population of 124,587 persons (59,257 males and 65,329 females) living in 29,087 households, with a density of 584 persons per square kilometer. Out of this, the rural locations collectively host a population of 86,260 individuals (41,243 males and 45,017 females) distributed across 19,210 households. This population formed the basis for assessing the influence of demographic and socioeconomic characteristics on land use change dynamics.

3.4.2 Sampling Procedure

3.4.2.1 Purposive Sampling

Purposive sampling was employed to obtain data from individuals within institutions directly linked to demographic change and land-use management in the six rural locations of Rongo Sub-County. This method was justified because the number of people in such roles was small and well-defined, and their positions provided specialized knowledge essential to the study. Respondents were drawn from the County Government of Migori (Departments of Lands and Physical Planning, Agriculture, Environment, and Economic Planning), the Department of Civil Registration, Rongo University, and Siala Institute of Technology.

The procedure involved identifying information needs, defining inclusion criteria, and compiling a sampling frame of eligible officials. Formal permissions were sought before contacting potential respondents. Selection ensured variation in roles across policy and operational levels. Key Informant Interviews were then conducted using a semi-structured guide, and interviews continued until thematic saturation was achieved. To ensure confidentiality, responses were anonymized, and data were reported in aggregate form.

3.4.2.2 Cluster Random Sampling

Cluster sampling was adopted in this study owing to the clustered settlement patterns characteristic of rural areas. The target population comprised 19,210 households drawn from the rural areas of Rongo Sub-County. To ensure that every household had an equal chance of selection, administrative Locations were treated as natural clusters.

The required sample size of 384 respondents was determined using Cochran's (1963) formula for proportions at a 95% confidence level and a 5% margin of error. A complete sampling frame of

the administrative rural Locations within the Sub-County was compiled, together with the distribution of households per Location. The sample of 384 respondents was then allocated proportionally to the different Locations based on the relative number of households in each cluster. This approach ensured that larger clusters contributed more respondents while smaller clusters contributed fewer, thereby preserving representativeness.

Within each Location, households were assigned numbers ranging from one up to the total households in that cluster. The required number of households was then selected using simple random sampling techniques, computer-generated randomization. In cases where a selected household had more than one eligible respondent, one individual was randomly chosen to participate, ensuring that all eligible members of the population had an equal chance of inclusion.

Data collection was undertaken by trained enumerators who administered household questionnaires to the selected respondents. Supervisors monitored the process, conducted daily checks of completed questionnaires, and revisited a proportion of households for verification in order to enhance data quality and reliability.

3.4.3 Sampling Size

Cochran's (1977) formula for the determination of sample size is given as

$$N_0 = \frac{z^2pq}{e^2}$$

working with;

95% confidence level (z) score of 1.960

The margin of error (e) is 0.05

The projected proportion of the trait present in a population (p) 0.5

The precision level (q) = 1-p = 1-0.5 =0.5

$N_0= (1.960)^2 (0.5) (0.5)/0.05^2$

=384. 16

This, thus, gave a calculated sample size of at least 384 respondents which were used to supplement and amplify secondary data that was gathered from different sources during data collection.

3.4.4 Sample Distribution

The sample was distributed in equivalent fractions to the population in the six rural locations within Rongo Sub-County as shown in Table 1;

Table 3–1: Study Sample Distribution

Division	Selected Location	Household No.	Sampled Respondents
Chamgiwadu	South Kamagambo	4429	88
	West Kamagambo	2868	57
	South West Kamagambo	2634	53
Rongo	North Kamagambo	4309	86
	East Kamagambo	2340	47
	North East Kamagambo	2630	53
TOTAL		**19210**	**384**

Source: Author, KNBS 2019.

The study used the formula $n_v=(N_V/N)\ x\ n$ in determining the number of samples to be picked per location

n_v = number of samples allocated to each location

N_v = household number in a location

N = sum number of households of the chosen locations

n = study sample size

3.5 Sources and methods of Data acquisition.

The study utilized both quantitative and qualitative data obtained from primary and secondary sources.

Quantitative data were mainly collected through Household Survey Questionnaires (HSQ), which provided numerical information on household demographics, land ownership, land use patterns, household size, agricultural production, and resource utilization. Quantitative data were also supplemented by secondary statistical records obtained from government reports, census data, and published research articles.

Qualitative data were collected to capture perceptions, attitudes, and contextual insights that could not be quantified. These data were gathered through Key Informant Interviews (KII) with County Government officials, community leaders, and institutional representatives, as well as Focus Group Discussions (FGDs) with selected community members. Additional qualitative information was generated through field observations (including photographic evidence) and literature review of past studies, policy documents, and development reports.

3.5.1 Sources of Data

3.5.1.1 Objective 1: Analysis of the Trends of Land Use Change.

To achieve the first objective, which sought to analyze the trends of land use change in Rongo Sub-County, the study employed a combination of remote sensing, household surveys, field observations, transect walks, and secondary sources of data.

Remote sensing and GIS analysis formed the core method for detecting land use change. Landsat images were obtained from the United States Geological Survey (USGS) Earth Explorer portal, and individual bands were extracted and processed. Image classification techniques were applied to distinguish between different land use/land cover categories (e.g., built-up areas, agricultural land, forest, bare land). Google Earth satellite images were also used to complement Landsat data by providing finer-scale visual interpretation of changes over time. The classified maps were compared across different periods to generate temporal land use change trends.

Secondary sources such as the Migori County Integrated Development Plans (2018–2022 and 2023–2027), land subdivision registers, and change-of-use records from the County Government provided official documentation on land allocations, approvals, and planning policies. These sources were analyzed to corroborate the patterns observed from satellite imagery and to provide institutional insights into land use changes.

Household Survey Questionnaires (HSQ) generated quantitative data on household-level land use practices, land ownership, agricultural activities, and land subdivision trends. These data were analyzed statistically (using frequencies and percentages) and compared with remote sensing results to assess the extent to which household-level practices aligned with observed land use change patterns.

Transect walks and field observations were conducted using a checklist and cameras along pre-defined routes traversing different land use zones. These methods provided direct visual confirmation of land use types (e.g., farmlands, settlements, commercial areas) and settlement patterns, including unplanned and haphazard structures. Photographs captured during these walks were used as qualitative evidence to illustrate specific cases of land use change. Field notes and photographic records were categorized thematically and compared with classified satellite images to validate remote sensing outputs.

Topography data, obtained from maps and field observations, was used to interpret the influence of terrain on land use distribution. Slope and elevation characteristics were analyzed to explain patterns such as concentration of settlements in relatively flat areas and agricultural use of fertile valley bottoms. This contextual analysis ensured that observed land use trends were not only mapped but also understood in relation to physical constraints.

Key Informant Interviews (KIIs) with officers from the Department of Physical Planning in Migori County provided expert insights on the rate of land subdivision, approvals for change of use, and emerging land use dynamics. These qualitative accounts were triangulated with household data and county records to enrich the analysis.

In summary, the integration of remote sensing, household-level data, field observations, transect walks, topographical analysis, and secondary records enabled a comprehensive analysis of both the spatial and temporal trends of land use change in Rongo Sub-County.

3.5.1.2 Objective 2: Examination of the influence of population size on Land use trends

Data on population size, household size, and number was obtained from the existing Government Surveys such as the population census data. Population Census data for the years 1999, 2009, and 2019 was obtained through desktop review and through organized interview schedules which were conducted with key informant persons. Similarly, data on population was obtained through the administration of household questionnaires regarding places of birth, age, gender, duration of residence, place of last residence, and number of children.

3.5.1.3 Objective 3: Determination of the influence of population socioeconomic status on land use trends.

Data on the socioeconomic status of the population was obtained from the most current government survey data including KNBS on the distribution of the population by socioeconomic activities (income status, occupation, education, tenure systems, age, and sex structure). This was reinforced by data acquired through the administration of questionnaires regarding household characteristics such as family monthly income, non-employment income, land tenure, tenure of dwelling units, number of people in a household, and the highest level of education. Data obtained through interview Schedules with key informants and FGD were also used to supplement the data obtained through the household survey questionnaire.

3.5.2 Piloting of Research Instrument (Reliability and Validity)

The research instruments were first subjected to content validation by the study supervisor, who reviewed them for accuracy, precision, phrasing, and structure. The supervisor recommended revisions to improve clarity and remove ambiguities, which were incorporated by the researcher before the instruments were piloted. This process ensured that the tools were free from improper directives, interviewer bias, and chance errors.

To further establish validity and reliability, a pilot study was conducted in Uriri Sub-County of Migori County. A group of eight respondents, selected to represent gender and geographical diversity, were asked to complete the household survey questionnaire under conditions similar to the actual study. Trained interviewers administered the questionnaire while observing and noting: areas where respondents hesitated, questions that were misunderstood or misinterpreted, and the consistency of responses across similar items.

The pilot data were analyzed descriptively, focusing on response patterns, frequencies, and the time taken to complete sections of the questionnaire. Instances of respondent hesitation, skipped questions, or inconsistent responses were treated as indicators of possible weaknesses in question design. Qualitative feedback from pilot participants was also coded and thematically analyzed to identify recurring issues in wording, sequencing, or interpretation.

Based on these analyses, the instruments were refined by rephrasing ambiguous questions, restructuring sections for logical flow, and adjusting items to reduce redundancy. This iterative process improved construct validity by ensuring that questions measured the intended concepts, and it enhanced reliability by increasing consistency and predictability of responses. The final version of the instruments was re-submitted to the supervisor for approval before being used in the main data collection.

The integration of both qualitative and quantitative data sources enabled triangulation, thereby strengthening the validity and reliability of the study findings.

3.5.3 Data Collection Methods

3.5.3.1 Primary Data Collection Methods

A questionnaire (Appendix I) which had both closed and open-ended questions was used to collect both qualitative and quantitative data on parameters such as family per capita income, non-employment income, salaries and wages, places of birth, duration of residence, place of last residence, number of household members, land tenure, tenure of dwelling units and other relevant information on rural LU in Rongo Sub-County. The questionnaire was administered face-to-face by a trained enumerator to 384 households in the study area.

A focus group discussion guide was used by trained facilitators to collect data on trends in land use change. The data that contained participants' feelings and thoughts (Acocella, 2012) was captured through audio and video recordings from 16 miners at kanga machine area in South Kamagambo, and 8 miners at Ndege Oriedo center in North Kamagambo. 11 business people at Kangeso in West Kamagambo, and 19 farmers at Kitere hills.

Observation Checklist (Appendix VII) was employed in the acquisition of real-time information, analysis of phenomena in land use change, and authentication of the information obtained through HSQ and KII. The study employed descriptive observation in the acquisition of the data relating to why, where, what, and how regarding the change in LU in the study area. the study observed the kind of development and where the developments were being undertaken within the rural areas. The study also used observation to confirm and authenticate the information obtained through survey questionnaires and Key Informants. Similarly, observation was used in understanding specific phenomena in land use. For instance, the study used observation to analyze the cause of vegetation clearance where forest areas were found cleared.

Interview schedules (Appendix II, III, IV, V, and VI) were employed in data collection from 8 different vital informers that had been identified regarding specific data on demographic change and trends in land use change. An interview guide was used to acquire information on the trends of the population increase during intakes from the management representatives of institutions of higher learning (RU and SIT). Other key informants included the small-scale gold mining team leaders in 2 mining sites at (Aloidi and Kochieng' Omollo) where information on the number of immigrant employees in their sites and the impact of the income accumulated from Artisanal Small-Scale Gold Mining (ASGM) on the LU was gathered, the Rongo sub-county bureau of statistics and registration of person offices where the study obtained specific information on the composition of the population precisely in terms of characteristics such as immigrants and ethnicity, County Director of Lands, Housing, and Physical planning where the number and the rate of approvals of buildings and other development in the area was obtained, Rongo Sub-County department of trade where the certainty of the improvement in the number of businesses registered within the study area was verified, Department of Education where the number of learning institutions was established, and finally the rate of compliance with environmental management regulations was sought from the County National Environment Management Authority (NEMA) office.

3.5.3.2 Secondary Data Collection Methods

Data from secondary sources was obtained by retrieving documents through desktop review and physical retrieval from the relevant National and County government offices. Population Census data for the years 1999, 2009, and 2019 was obtained through desktop review to gather information on the population size, household size and number, socioeconomic status, and trends in population growth in the study area. Secondary data was also retrieved from the relevant documents obtained from the county Government offices and specific entries recorded. National and County Governments' publications, administrative records, and project records were analyzed to obtain data demographic characteristics of Rongo Sub-County. The County Integrated Development Plans (CIDP) for the years 2018-2022 and 2023-2027 were appraised to gather information on land use and land tenure. The County Physical and Land Use Development Plan (CPLUDP) for Rongo Municipality and the County Spatial Plan (CSP) for the year 2019 were reviewed to obtain information on land use, land tenure, and average land holding in the study area.

3.6 Data Analysis

3.6.1 The Use of Geographical Information System

Land use change in Rongo Sub-County rural areas was analyzed from the year 2002 to the year 2022 at intervals of five years. This was actualized by studying five remotely sensed Landsat images for the period between the year 2002 and the year 2022. The year 2002 was taken as a reference year during the analysis. The study period was divided into four sub-periods, an interval of five years. Analysis was then conducted at the end of every sub-period using Arc Map 10.4.1, where land classification maps were created by classifying Landsat images using the spectral signatures obtained from training samples. Using level 2 Landsat images, Landsat 7 Enhanced

Thematic Mapper (ETM), Landsat 4-5 Thematic Mapper (TM), Landsat 8-9 Operational Land Imager (OLI) and Thematic Infrared Sensor (TIRS), Land uses were classified into agricultural, Built-up/ settlement, wetland, bare farmland, and forest land. Landsat images were obtained in a way that ensured images had less cloud cover.

Table 3–2: Landsat Images and their Characteristics

YEAR	SENSOR	SPATIAL RESOLUTION	BAND
2002	Landsat 7 Enhanced Thematic Mapper (ETM)	30 Meters	7
2007	Landsat 4-5 Thematic Mapper (TM)	30 Meters	7
2012	Landsat 7 Enhanced Thematic Mapper (ETM)	30 Meters	7
2017	Landsat 8-9 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRs)	30 Meters	7
2022	Landsat 8-9 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRs)	30 Meters	7

Source: Author, 2024

Landsat images corresponding to different sub-periods were imported into the Arc Map 10.4.1 Using the Arc Map 10.4.1 data management tool, composite bands were created for each sub-period. Nevertheless, the first two sub-periods, that is the year 2002 and the year 2007 had the area of study consisting of two scenes of different rows and a single path that necessitated the concatenation of the two scenes. The scenes consisted of the same path of 170 and different rows of 061 and 060.

First, a composite band for each scene was created, then after confirming the number of bands and other band characteristics and using the Arc Map data management tool, a mosaic of the two composite bands was created. The area of Interest (AOI) was extracted by mask using the study area boundary. Using a supervised Image classification, training samples were developed by

drawing polygons on selective representative samples of pixel values of different land uses. The polygons for each land use were merged to form one land use class. Subsequently, signature files were then created from the training samples. Using the maximum Likelihood classification tool, the image of the AOI was classified using the signature files. The land use classification map was presented for different sub-periods in Figure 4.

Arc Map 10.4.1 was also used to analyze the correlation between different land uses of amenities including infrastructure, education management facilities, local amenities such as shops, and other social amenities such as hospitals, and the demographic change in the rural areas of Rongo sub-county. Data containing different amenities was imported into the Arc Map 10.4.1 then using the geoprocessing clip tool, the amenities were clipped by the study area boundary to remain only with the amenities within the AOI. Using the training samples of the built-up/settlement that were saved, other training samples for other land use classes were deleted and a supervised classification was performed using the signature file containing only the land use class for the built-up/settlement. A map was then prepared showing the correlation between the built-up areas and the different amenities as shown in Figure 12.

3.6.2 Change Detection Analysis

Using the attribute tables of the classified maps of the AOI, a new field in the attribute table was added and all the different land use classes were added. The maps which were still in raster format were converted into vector format using a conversion tool to calculate the area covered by each land use at every sub-period. A new field of the area was then added to the attribute tables of the vector format maps and named area. Using the calculate geometry tool in the attribute table, the area of each attribute was calculated in Hectares. Subsequently, the data in the attribute tables were

exported into the Excel spreadsheet in dBase table format. Using the pivotal table, the data on each land use was merged and the area and percentage coverage of each LU class in every sub-period was calculated. Additionally, the LUC and corresponding percentage changes were calculated using the formula below;

Total LUC in hectares calculated by:

Total LUC = Area of LU classes in the final year in a sub-period – Area of Initial Year in the same sub-period

Percentage LUC calculated by:

$$\frac{\text{Area of Final year in a sub-period} - \text{Area of Initial Year in a sub-period}}{\text{Area of Initial Year in a Sub-period}} \times 100$$

Where area was used to refer to the individual area of LU classes. The negative value signified a decrease in the extent and the positive value signified an increase in the area. The data was then presented in a line graph to show the trend in land use change in Rongo Sub-County.

3.6.3 Accuracy Assessment

Remotely sensed data are sometimes associated with geo-location errors and limitations owing to the complexity of the earth's surface features, atmospheric effects, and issues of clarity of the spectral signatures (Ozcanli et al., 2014). It is against this backdrop that the study undertook some verification to ensure the accuracy and reliability of the remotely sensed data. The study relied on training and reference information obtained through a systematic and detailed review of the land use reports, publications, and the use of high-resolution time-series imagery of Google Earth besides change detection analysis in the authentication of flawed classes.

3.6.3 Qualitative and Quantitative Data Analysis

Qualitative and quantitative data were generated during the study using the mixed-method approach. Data from the open-ended questions in the questionnaire, observation, FGDs, and Key Informant interviews constituted the qualitative data. Similarly, data from the closed-ended questions from the questionnaire and observations formed the quantitative data for the study. To analyze the qualitative data, the researcher, first of all, identified the common themes by reading the study transcripts and notes while labeling (coding) important phrases about the activities and opinions. Data was then classified and sub-categories in conformity with the themes already identified.

Quantitative data were also cleaned, coded, and analyzed on a thematic basis using both the Statistical Package for Social Sciences (SPSS) version 25.0 software and Excel spreadsheet. The study opted for this software because of its advanced and instant analysis programs capable of producing descriptive statistics for huge amounts of data. The descriptive statistics were presented in tables and graphs for easier visualization and interpretation. Correlation coefficient analysis was employed in determining the strength and direction of the correlation between the population size and LUC. Additionally, the study employed a regression analysis to establish the significance of the relationship between population size and LUC. Further, a paired t-test was conducted to compare the means between the LUC between 2002 and 2022.

The variables were renamed to X and Y and then X^2 and Y^2 and their sums were calculated. This task was finalized by the calculation of the Pearson correlation coefficient *(r)* and a P-value. A correlation coefficient value ranging between 0 to +0.5 signifies a weak positive correlation and +0.5 to +1 denotes a strong positive relationship. Similarly, a coefficient lying between 0 to -0.5

symbolizes a weak negative relationship whereas -0.5 to -1 signifies a strong negative correlation. The value 0 means that there is no relationship between the variables, thus the null hypothesis is accepted. A low P-value is between 0 to 0.49 and a high P-value is between 0.5 to 1.0. A low P-value indicates that the observed difference between the sample and the population is statistically significant.

3.7 Ethical Requirement

Appendix 8 contains a research permit that was obtained from the National Council for Science and Technology (NACOSTI). The study equally sought permission from the Sub-County Deputy County Commissioner through a brief inception meeting. The study took a deliberate and great consideration of the privacy and anonymity of all study respondents. Assurance of concealment of the information provided was also given to the study participants.

CHAPTER FOUR: RESEARCH FINDINGS AND DISCUSSION

4.1 Introduction

This chapter discusses the research findings based on appraised data that focuses on the Demographic change and its impacts on rural land use change dynamics in Rongo Sub-County. Discussions in all the sections are founded on the research objectives of the study as outlined below:

1. To analyze the land use change trend in Rongo Sub-County between 2002 and 2022.
2. To examine the influence of population size on the trend in land use change in the Rongo Sub-County.
3. To determine the influence of the socioeconomic status of a population on trends in land use change.

4.2. Analysis of the Land Use Change Trend in Rongo Sub-County Between 2002 and 2022.

4.2.1 Land Use Change in Rongo Sub-County Between 2002 and 2022.

Analysis of remotely sensed data showed that in the year 2002, the Built-up area/Settlement had an area of 213ha (1.1%), while agriculture had an area of 9171.5ha (48.3%) of the entire area of the study area. Further, forest occupied 9509.9ha (50%) whereas the area that had wetland had an insignificant area of 61ha which was 0.3% of the total land area.

Table 4–1: 2002 Land Use Classes Area Coverage

The year 2002		
Land Use Class	**Area (ha)**	**Percentage**
Agriculture	9171.5	48.4
Built-up/Settlement	213	1.1
Forest	9510	50.2
Wetland	61	0.3
Total land Area	**18955.5**	

Source: Author, 2024

This finding shows that in the year 2002, most lands were used for forest activities in the greatest parts of the study area. Similarly, residential land use and local amenities had not claimed most land perhaps because the population had not grown to the extent of putting more pressure on agricultural and forest lands for settlement.

In the year 2007, agricultural land had an area of 10835.3ha constituting 57.1% of the overall land area. The area of land under agriculture increased by 1653.8ha (8.8%) between 2002 to 2007 signifying significant changes in LU between the year 2002 and 2007. The changes impacted the forest land thereby reducing it by 1952.5ha (10.3%).

Table 4–2: 2007 Land Use Classes Area Coverage

The year 2007	**Area (ha)**	%	**Sum area change (ha)**
Agriculture	10835.3	57.1	1653.8
Built-up/Settlement	503.3	2.7	290.3
Forest	7557.4	39.9	-1952.5
Wetland	59.1	0.3	1.9
Total Land Area	**18955.1**		

Source: Author, 2024

This finding indicates that forest land was converted to agricultural use and settlement. Residential area increased by 290.3ha during this period. The wetland showed insignificant change between

2002 and 2007. It is therefore a clear manifestation that there were land use changes between the years 2002 and 2007 signified by the increase in agricultural land and Built-up area comprising residential, commercial, and infrastructural land uses as well as a decrease in forest land in the year 2007.

Despite the land under agricultural activities reducing by 802.3ha in the year 2012, it still had the largest area of 10033ha constituting 57.1% of the entire land area. Built-up area/Settlement occupied 842.4ha constituting 4.4% of the total land area. Further, it increased by 1.9% of the whole land area between 2007 and 2012. Forest land increased by 422.2ha during this period while Wetland occupied the smallest area of 93.7ha (0.5%). The findings, therefore, show that there were LU changes between 2007 and 2012 demonstrated by the change of agricultural land into forest land and settlement areas.

Table 4–3*:* 2012 Land Use Classes Area Coverage

The year 2012	**Area (ha)**	%	**Sum area change (ha)**
Agricultural Land	10033	53	-802.3
Built-up/Settlement	842.4	4.4	339.1
Forest Land	7980	42	422.6
Wetland	94	0.5	34.9
Total Land Area	**18949.4**		

Source: Author, 2024

In 2017, the land under agricultural activities was the largest with an area of 11795.37ha which was 62% of the overall land area. Furthermore, 1616ha of land formerly under forest was transformed into agricultural land between 2012 and 2017. Residential, commercial, infrastructural, and industrial areas occupied 763.6ha (4%) of the entire land area. Additionally, the Built-up area/Settlement decreased by 78.4ha. Forest land occupied 6364ha constituting 33.5%

of the total land area. During this period, the forest land was reduced by 1616ha. Wetland occupied the least area of 32ha which was 0.2%.

Table 4–4: 2017 Land Use Classes Area Coverage

The year 2017	**area (ha)**	%	**Sum area change (ha)**
Agricultural Land	11795.4	62	1762.4
Built-up/Settlement	764	4	-78.4
Forest Land	6364	33.6	-1616
Wetland	32	0.2	-62
Total Land Area	**18955.4**		

Source: Author, 2024

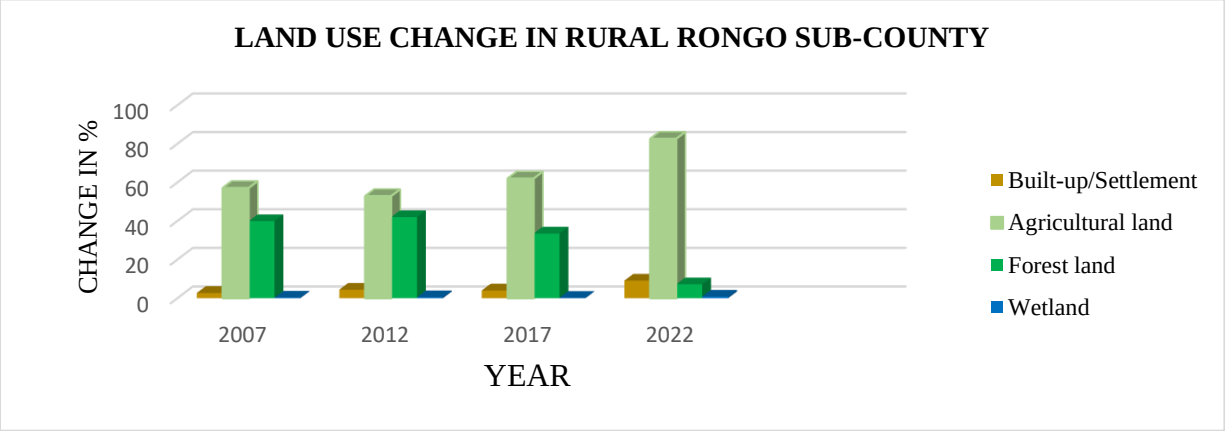

Figure 3: Changes in Land Use for Different Land Use Classes in an Interval of Five Years Between 2002 and 2022.

Source: Author, 2024

In the year 2022, agricultural activities were practiced in the largest area constituting 15674ha which was 83% of the total land area. The area under forest activities was 1382ha which was 7.2% of the total land area. There was equally a substantial decline in the forest land area by 4982ha. Wetland areas including fishponds occupied the least area of land 165ha. Nevertheless, there was a small increase in the area occupied by wetlands between 2017 and 2022. Similarly, during this

period, a large area of forest land was modified into farmlands and settlements. This shows that there were some demographic changes thus influencing the consumption rate and need for more residential, commercial buildings, infrastructural, and industrial activities.

Table 4–5: 2022 Land Use Classes Area Coverage

Year 2022	**Area (ha)**	%	**Sum area change (ha)**
Agricultural Land	15674	83	3878.6
Built-up/Settlement	1733	9.1	969
Forest Land	1382	7.2	- 4982
Wetland	165	0.8	133
Total Land Area	**18954**		

Source: Author, 2024

The result for the period that ended 2022 revealed that massive land modification took place between 2017 and 2022 where significant portions of forest land were converted to agricultural, residential, commercial, infrastructural, and industrial areas. The analysis of the remotely sensed data revealed that there was a massive LUC between the years 2002 and 2022 (Figure 4). Further, it revealed that the overall change in various land use classes between 2002 and 2022 was 86% (Table 8) signifying the intense LUC in the study area.

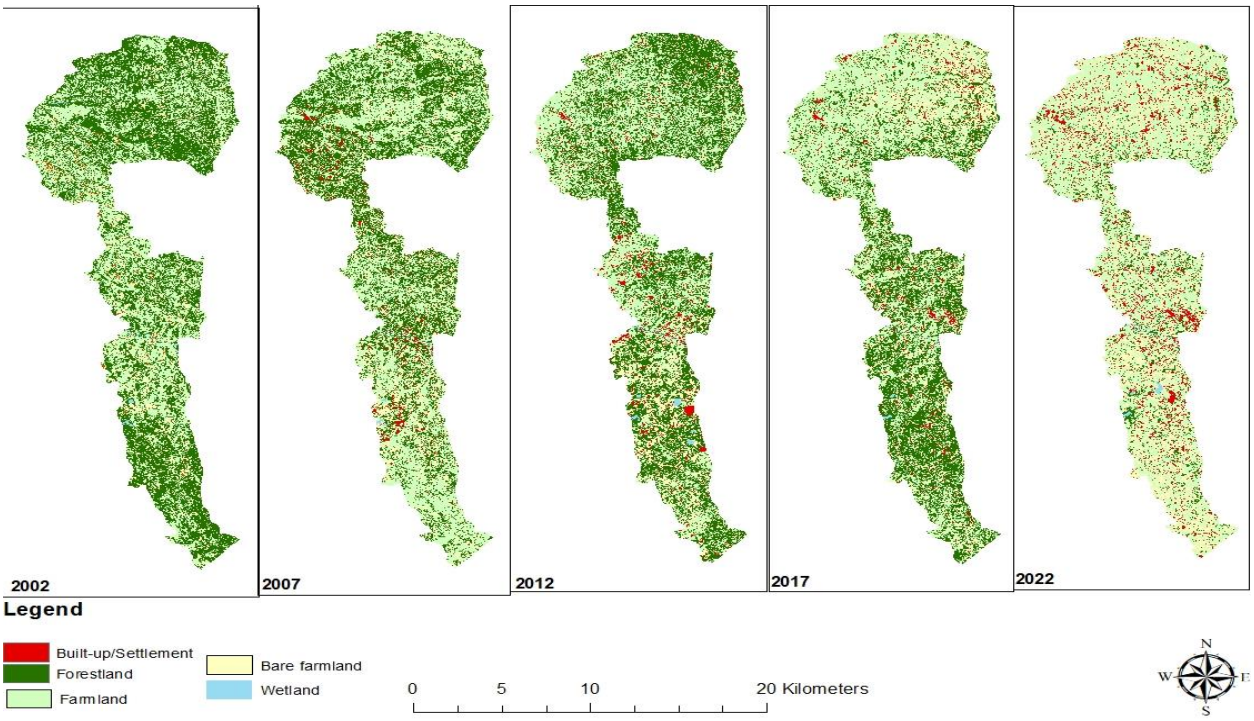

Figure 4: Land Use Change Between 2002 and 2022

Source: Author, 2024

Table 4–6: Total Percentage Change in Land Use Between 2002 and 2022

	2002	2022	change	Overall % positive change	Overall % negative change
Agricultural Land	9171.5	15674	6502.5	34%	
Built-up/Settlement	213	1733	1520	8%	
Forest Land	9510	1382	-8128		43%
Wetland	61	165	104	1%	
				Total	**86%**
Total Land Area(ha)	18955				

Similarly, the information obtained from field observation and Household survey questionnaire (HSQ) established that 61% of the people living in the study area converted their agricultural lands to residential while 85% indicated that their farmlands were formerly forest lands as demonstrated in Table 9 below.

Table 4–7: Respondents' Original Use of Homestead Land and Farmland

LAND USE	RESPONDENT	PERCENTAGE
Original Use of the Homestead Land		
Forest	126	33%
Agriculture	235	61%
Residential	5	1%
Wetland	4	1%
Not aware	14	4%
Respondent No.	**384**	
Original Use of the Farmland		
Residential	17	4%
Forest	327	85%
Wetland	2	1%
Mining	1	0.26%
Not aware	37	10%
Respondent No.	**384**	

Source: Author, 2024

Information obtained from FGD supported by field observation equally showed that the majority of the residences/homesteads are built on agricultural lands. The study through the data obtained from FGD equally revealed that the idea of establishing homesteads in farmlands is associated with and strongly perpetuated by the ethos of the Luo community where a mature man is allowed to move out of his parent's homestead and establish his own at a place identified and customarily sanctified by the father. Given the dominance of agricultural activities in the study area, limited spaces outside farmlands are usually available for such establishments thereby making farmlands to be impacted by such establishments.

4.2.2. Trend in Land Use Change in Rongo Sub-County Between 2002 and 2022.

The summed area changes for each land use kept changing every five years within the study period (Table 10), with the areas under agricultural activities and settlement experiencing positive changes while the area under forest consistently demonstrated a decline every five years except for the period between 2012 and 2017. The study findings have also demonstrated that agricultural land increased by 8.8% between 2002 and 2007 (Table 10). However, between 2007 and 2012, agricultural land was reduced by 802.3ha (4.2%). Nevertheless, in 2012, the use of land for agricultural activities increased undeviatingly and growingly up to the year 2022 (Figure 5). The impact of the increase in land area under agricultural activities in the first five years is mirrored by the decline in forest land in the same period (Figure 5). Similarly, the slight decrease in agricultural land between the years 2007 and 2012 is reflected by the upsurge in the area occupied by Built-up/settlement and forest land in the same period.

Forest land decreased between the years 2002 and 2007 due to the extension of the settlement and agricultural land in the same period. Additionally, the constant decline of the forest land between 2012 and 2022 is mirrored by the continuous increase in agricultural and settlement lands during the same period. The slight increase in forest land between 2007 and 2012 is reflected by the slight decrease in agricultural land in the same period. The wetland remained undisturbed from the years 2002 and 2012. Nevertheless, between the years 2012 and 2017, it experienced a colossal decrease due to the high rate of agricultural LU.

Table 4–8: Trend in Land Use Change in Rongo Sub County Between 2002 and 2022

Land Use Class (2002)	**Area (ha)**	**%**			
Agricultural Land	9171.5	48.3	0	0	0
Built-up/Settlement	213	1.1	0	0	0
Forest Land	9510	50	0	0	0
Wetland	61	0.3	0	0	0
Land Use Class (2007)	**Area (ha)**	**%**	**Sum area change**	**Positive % Change**	**Negative% Change**
Agricultural Land	10835.3	57,1	1663.8	8.8	
Built-up/Settlement	503.3	2.7	290.3	1.5	
Forest Land	7557.4	39.9	-1952.6		10.3
Wetland	59.1	0.3	-1.9		0.01
Land Use Class (2012)					
Agricultural Land	10033	53	-802.3		4.2
Built-up/Settlement	842.4	4.4	339.1	1.9	
Forest Land	7980	42	422.6	2.2	
Wetland	94	0.5	34.9	0.9	
Land Use Class (2017)					
Agricultural Land	11795.4	62	1762.4	9.3	
Built-up/Settlement	764	4	-78.4		0.4
Forest Land	6364	33.5	-1616		8.5
Wetland	32	0.2	-62		0.3
Land Use Class (2022)					
Agricultural Land	15674	83	3878.6	20.5	
Built-up/Settlement	1733	9.1	969	5.1	
Forest Land	1382	7.2	-4982		26.3
Wetland	165	0.8	133	0.7	

Source: Author, 2024

Built-up/settlement increased slowly and continuously up to the year 2022. However, there was a much greater increase in the built-up/settlement between 2017 and 2022 which was equally reflected in the exponential decrease in forest land in the same period. From the foregoing analysis, the trend in LUC in the study area between 2002 and 2022 involved a consistent modification of forest land into agricultural land and settlement as shown in Figure 5 below.

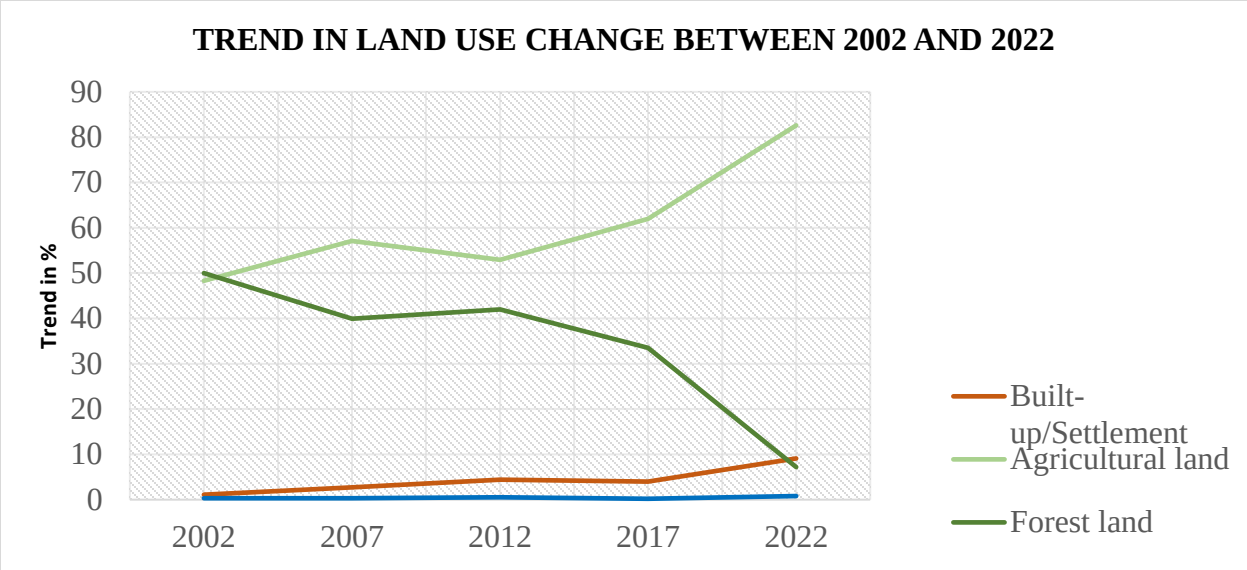

Figure 5: The Trend in Land Use Change in the Study Area

Source: Author, 2024

Data from HSQ supported by qualitative data from FGD and Field observation equally revealed that the trend in land use change in rural areas of Rongo Sub-County involves the change of forest land into agriculture and agricultural lands to settlement. The majority of the respondents (44%) described the land use trend as from agriculture to settlement, 21%, forest to agriculture, agriculture to mining was mentioned by 3%, agriculture to forest 4%, 2% mentioned agriculture to road, and 24% of the respondents were not aware of the trend in LU change (Table 11). Nevertheless, wetland to agriculture and wetland to settlement were never mentioned by any respondent. This finding is in concurrence with the data obtained from remotely sensed images that showed massive modification of forest land into farmlands and negligible change in wetland areas between the years 2002 and 2022. Table 11 below describes the discernment of the respondents as regards the LU trend in the study area;

Table 4–9: Respondent's Description of Trends in Land Use Change in their Area of Residence

LAND USE TREND	RESPONDENTS	PERCENTAGE
Agriculture- Residential	169	44%
Agriculture -Mining	13	3%
Forest-Agriculture	82	21%
Agriculture-Forest	17	4%
Residential-Commercial	5	1%
Wetland-Agriculture	0	0%
Agriculture-Education	8	2%
Wetland-Settlement	0	0%
Residential-Education	0	0%
Agriculture-Road Infrastructure	9	2%
Not Aware	81	24%
Total =	**384**	

Source: Author, 2024

4.2.3 Hypothesis Testing

A Paired t-test (also known as correlated t-test) was employed in testing the first null hypothesis; *there is no significant increase in land use change in the study area between 2002 and 2022*. The study used the land use classes in the first sub-period and the last sub-period, where the mean (in hectares) of LUC in the first sub-period (between 2002 and 2007) and the mean of LUC in the sub-period between 2017 and 2022 were used to conduct the paired t-test. A P-value of 0.999, t (3) =0.0002 (Table 12) was realized. The P-value of 0.999 was found to be significantly greater than 0.05 thus providing evidence that there is significant land use change in the study area between 2002 and 2022. Consequently, the null hypothesis was rejected.

Table 4–10*:* There is a Significant Increase in Land Use Change in the Study Area Between 2002 and 2022.

t-Test: Paired Two Sample for Means

	2002-2007	*2017-2022*
Mean	-0.1	-0.35
Variance	2221718.287	13606837.16
Observations	4	4
Pearson Correlation	0.998024741	
Hypothesized Mean Difference	0	
Df	3	
t Stat	0.000226949	
P(T<=t) one-tail	0.499916584	
t Critical one-tail	2.353363435	
P(T<=t) two-tail	0.999833169	
t Critical two-tail	3.182446305	

4.3 Influence of Population Size on the Trend in Land Use Change

4.3.1 Population Growth

Information obtained from the KNBS through desktop review established that the population of the study area has been rising steadily from the year 1999 to the year 2019. The study established that it has increased by 45.5% (Table 13) since 1999. The growth in population impacts the household size and the rate of consumption in the study area consequently influencing the need for settlement as demonstrated by the increasing households since the year 1999 (Table 14). This finding is in line with a study conducted by Bradbury et al. (2014) that also showed households as significant aspects in the analysis of the impact of the human population on the environment.

Table 4–11: Population Census for the Years 1999, 2009, and 2019 and their Respective Changes

Location	Population						
	1999	**% Change**	**2009**	**% Change**	**2019**	**overall change 1999-2019**	**%Change**
South Kamagambo	12573	5.6	15895	5.1	18898	6325	10.7
East Kamagambo	14140	7.1	18340	6.6	22249	8109	13.7
West Kamagambo	19187	4.7	21982	5.5	25264	6077	10.2
North Kamagambo	13391	5.4	16574	5.5	19850	6459	10.9
Total	**59291**	**22.8**	**72791**	**22.7**	**86261**	**26970**	**45.5**

Source: KBNS., 2000, 2010, and 2019

The study equally revealed that the number of households in the study area is increasing even with the gradual population growth rate (Table 14). For instance, the population of the study area increased by 22.7% between the year 2009 and 2019 while the households increased by 34.7% during the same period. This finding equally aligns with a similar study by Gu et al. (2017) that indicated an increase in households as a driver of the growing household number.

Table 4–12: Households in the Area of Study in the Years 1999, 2009, and 2019

	Household						
Location	**1999**	**change**	**% Change**	**2009**	**change**	**% Change**	**2019**
South Kamagambo	2645	584	4.6	3229	1200	9.5	4429
East Kamagambo	3182	658	5.2	3840	1130	8.9	4970
West Kamagambo	3814	564	4.4	4378	1124	8.9	5502
North Kamagambo	3036	330	2.6	3366	943	7.4	4309
Total	**12677**	**2136**	**16.8**	**14813**	**4397**	**34.7**	**19210**

Source: KBNS., 2000, 2010, and 2019

Information obtained from HSQ revealed that the average household size in rural areas of Rongo-Sub-County is 4.8 (Table 15). This finding aligns with the data obtained from the census of 1999, 2009, and 2019 where the average household size was 4.7, 4.9, and 4.5 respectively (Table 16). Considering the finding on the average household size in the study area, it means that their high consumption rate thus necessitates the expansion of farmlands in the study area to facilitate more food production.

Table 4–13: Respondents Average Household Size

HOUSEHOLD NO. 384	No of Household members	Percentage
MALE	811	44%
FEMALE	1033	56%
Total number of household members	1844	
Average Household size	4.8	

Source: Author, 2024

Table 4–14: The Average Household Size in the Years 1999, 2009, and 2019

Year	Population	Household	Average Household number
1999	59291	12677	4.7
2009	72791	14813	4.9
2019	86261	19210	4.5

Source: KBNS., 2000, 2010, and 2019

4.3.2 Demographic Characteristics.

4.3.2.1Age and Gender Distribution

Information obtained from HSQ established that 62% of the households are male-headed (Table 17), a typical characteristic of the households of the Luo community in rural areas. Data gathered from FGD equally revealed that the Luo- community is the dominant tribe in the study area, a finding that aligns with the data obtained from the desktop review of the County CIDP 2023 showing the Luo community as the dominant community in the study area. Further, 38% of the households are headed by females. This finding indicates that most land use decisions are influenced by the male gender which thus agrees with a related study conducted by Kieran et al. (2015) that also showed most land ownership and decisions regarding land use are associated with the male gender.

Table 4–15: Respondents Distribution by Age and Gender

AGE BRACKET	HOUSEHOLD HEAD	PERCENTAGE	MALE	FEMALE
Below 20	2	1%	0	2
20-29	20	5%	11	9
30-39	90	23%	54	36
40-49	129	34%	85	44
50-59	72	19%	46	26
60-69	49	13%	28	21
Above 70	22	6%	14	8
Total No. of Respondents	**384**	**Distribution by Gender**	**238**	**146**
		Percentage	**62%**	**38%**

Source: Author, 2024

The study has similarly shown that the majority (56%) of the household members are female and 44% are male (Table 18). This finding aligns with the KNBS (2019) data on population distribution by gender where the study area population was 52% female and 48% male.

Table 4–16: Household Members Distribution by Gender

HOUSEHOLD NO. 384	No of Household members	Percentage
MALE	811	44%
FEMALE	1033	56%
Total number of household members	1844	

Source: Author, 2024

Additionally, the household members who are dependent on the household heads are 32% and fall within the age bracket of 10-19 (Figure 6). This high dependency in the study area is influencing LU decisions to enhance the standards of living and conditions. The finding aligns with related studies that show household decisions as a key driver of land use change (Ahimbisibwe et al., 2019). Further, as the population within the aforementioned age bracket increases, the dependency ratio will similarly increase thereby impacting the consumption rate and settlement demand which eventually influence the household decisions on LU. This finding is supported by the information from the FGD where the majority of the participants indicated high reliance on land resources for the enhancement of household livelihood.

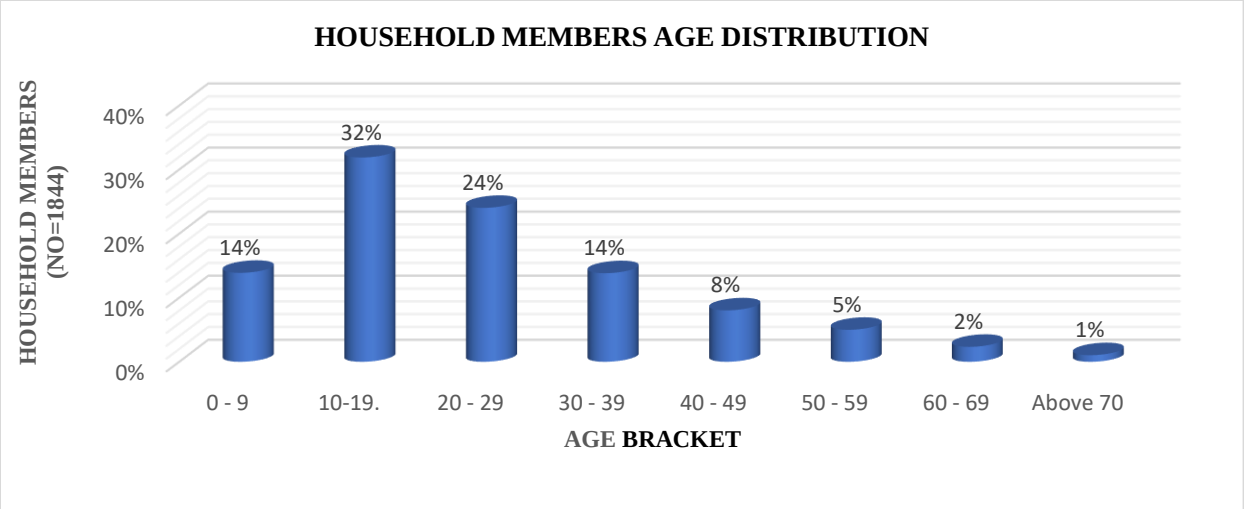

Figure 6: Household Member's Age Distribution

Source: Author, 2024

Information obtained from HSQ established that there is a high fertility rate in the rural population of Rongo Sub-County due to the high number of household members falling within the age bracket (20-59). Given the fact that the female population forms 56% (Table 18) of the household members, it means they are the majority within the bracket. This age bracket is generally a productive age for women, and in the findings, it contains 51% of the household members (Figure 7). The high population of women within the productive age is reflected in the constant household size within the study area thus influencing the consumption rate. This finding aligns with a related study by Vander Borght & Wyns, (2018) that also showed the age of the female partner as a factor influencing the spontaneous probability of conception. Similarly, the same age bracket contains an economically active population thus influencing the decisions on land use as they struggle to enhance their livelihood from land resources.

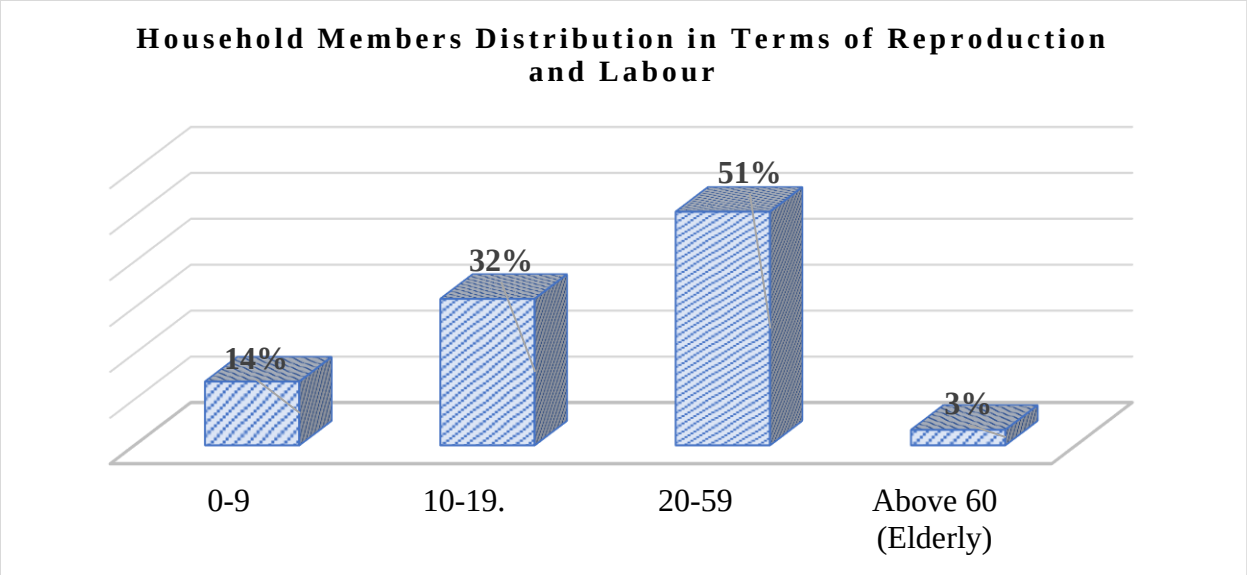

Figure 7: Household Member's Distribution In terms of Reproduction and Labour

Source: Author, 2024

4.3.2.2 Distribution of Native and Migrant Population

Information obtained from HSQ exhibited that the majority (94%) of the respondents are natives and only 6% are non-native (Table 19).

Table 4–17: Distribution of Natives and Non-natives among Respondents

Description	Respondents	Percentage
Native population	361	94%
Non-native population	23	6%
Total No of Respondents	**384**	

Source: Author, 2024

Further, the information obtained from FGD and KII showed that the study area hosts all tribes of Kenya when the students of the University and other institutions of higher learning are in session. Data obtained from HSQ also revealed that the majority (43%) of the (23) non-native people who

stay in rural areas of Rongo sub-county stay because of education, 22% business, for 17% mining, 13%, formal employment, and 6% Construction works (Table 20).

Table 4–18: Factor Influencing -Migration in Rongo Sub-County

Influencing Factor	Respondent	Percentage
Business	5	22%
Civil servants	3	13%
Construction works	1	6%
Education/student	10	43%
Mining	4	17%
Total	**23**	**100%**

Source: Author, 2024

The inclusion of non-natives was guided by purposive sampling, since this group was of specific interest due to its demonstrated influence on land use, food consumption, and housing demand in the area. The criteria for selection focused on individuals who had migrated to Rongo Sub-County for education, employment, or business purposes. Information from FGDs and KIIs indicated that the establishment of Rongo University and other institutions of higher learning had significantly triggered in-migration, particularly among students and staff seeking education and related services.

The sampled non-natives were further categorized based on their duration of stay in the area, providing an opportunity to analyze both recent and long-term migrant experiences. Results showed that 39% had lived in Rongo for less than five years, 26% for more than five years, 13% for over 15 years, and 13% for more than 30 years, while 9% did not indicate their length of stay. This distribution ensured that the perspectives captured reflected both short-term migrants

(principally linked to education) and long-term settlers (involved in farming, trade, and social integration).

Although the non-native respondents were selected purposively, their socioeconomic roles and livelihood practices intersected with those of the native population. For instance, while recent migrants largely influenced food and housing markets, long-term migrants engaged in agricultural and commercial activities similar to the natives. As such, the purposively sampled non-native population provided representative insights into how in-migration shapes land use and service demand alongside the native population, thereby enriching the overall analysis of demographic dynamics in the study area.

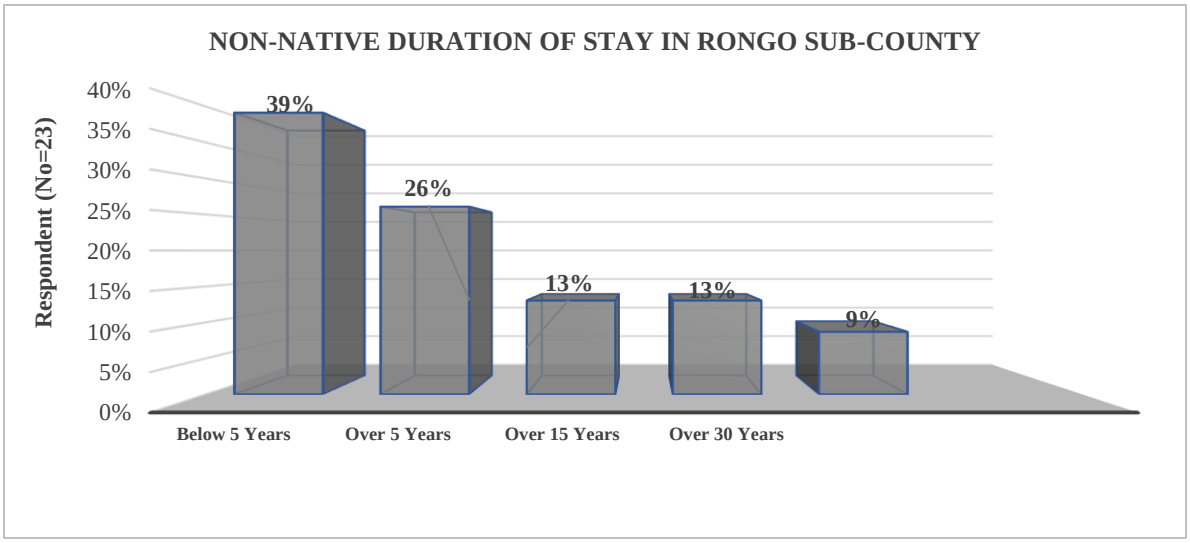

Figure 8: Showing Non-native Duration of Stay

Source: Author, 2024

4.3.3 Hypothesis Testing

The null hypothesis, *that land use trend in the study area is not significantly influenced by population size* was tested by calculating the Pearson's correlation coefficient where the total change in various LU between the years 2002 and 2022, population size, household size, and the average household sizes between 1999 and 2019 were used as the variables. The calculated Pearson's product moment revealed that there is a strong positive correlation between population size and LUC. Similarly, there is a strong positive correlation between the number of households and LUC in the study area where r is 0.837 and 0.929 respectively. Further, the coefficient correlation between the average household size and the change in LU is -0.891 (Table 21). A regression analysis between the land use change and the average household size was conducted where a P-value of 0.299 (Table 22) was obtained thus providing evidence that population size significantly influences Land Use trend and based on the foregoing, the null hypothesis was rejected.

Table 4–19: Land Use Trend in the Study Area is Significantly Influenced by Population Size

	Land use Change	Population size	Number of Households	Average Household size
Land use Change	1			
Population Size	0.837442103	1		
Number of Households	0.928534465	0.980489579	1	
Average Household size	-0.891736042	-0.499443723	-0.65999799	1

Table 4–20: Regression Statistics

Regression Statistics						
Multiple R	0.891736					
R Square	0.7951932					
Adjusted R Square	0.5903863					
Standard Error	2312.4					
Observations	3					
ANOVA						
	Df	*SS*	*MS*	*F*	*Significance F*	
Regression	1	20761279.2	20761279.2	3.8826496	0.298975	
Residual	1	5347193.6	5347193.6			
Total	2	26108472.8				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	81511.317	38448.357	2.12002074	0.280588	-407021	570044
Average Household size	-16109.5	8175.5684	-1.9704440	0.298975	-119990	87770.9

4.4 Influence of the Socioeconomic Status of a Population on Trends in Land Use Change.

4.4.1 Distribution of Population by Occupation

4.4.1.1Agriculture

Data obtained from the HSQ revealed that 43% of the respondents practice agriculture as their main source of livelihood, followed by business 25%, formal employment 13%, Mining 8%, Retired 1%, and 2% unemployed. Some of the respondents (3%) recorded none (Table 23).

Table 4–21: Distribution of Respondents by Main Occupation

OCCUPATION	Respondents	Percentage
Agriculture	167	43%
Business	97	25%
Civil Servant	49	13%
Unemployed	6	2%
Mining	30	8%
Retired	4	1%
Construction Works	19	5%
None	12	3%
Total	**384**	**100%**

Source: Author, 2024

Qualitative data from FGDs and field observation revealed that maize, sugarcane, beans, banana sweet potatoes, and vegetables are the dominant crops in the study area. Data from observation equally revealed that Sugarcane is the main cash crop in Rongo Sub-County. Most of the lands in all the selected locations are covered by sugarcane and maize plantations. However, the study also discovered the disappointment of farmers with sugarcane farming due to the poor prices and delayed payments by the cane millers. South Nyanza Sugar Company which has been their main buyer of mature cane has been dwindling in terms of operation in the last decade, a situation that the farmers indicated has rendered sugarcane farming unsustainable.

Similarly, Qualitative data from the FGD corroborated by data from KII showed that the establishment of institutions of higher learning in the rural areas of Rongo Sub-County has improved agricultural activities due to the increased rate of consumption. The study also noted that livestock farming is practiced by the majority of the households, however, they only rear traditional breeds used for ploughing agricultural lands**.** Few households rear exotic breeds for milk business as was shown by the data obtained from FGD. This finding is in line with the information obtained from the land use classification map that showed agricultural land with the largest area. The practice of agriculture as a source of income by the majority (43%) of the therefore influences LUC in the study area due to the pressures of livelihood enhancement. This finding agrees with related studies by Omuruli, (2022) that indicated population pressure as the driver behind the expansion of farmlands.

4.4.1.2 Small and Medium Business Enterprises.

The study revealed that 25% of the respondents are involved in small and medium business enterprises as their main occupation (Table 23). Information obtained from FGD and KII revealed that the study area has several small market centers where goods and services are exchanged. The markets include Riosir, Chamgiwadu, Kanga School, Rakwaro, Okusu, Ngere, Nyamuga, and Opapo. Information gathered from KII exhibited that there has been a steady rise in business registration in Rongo Sub-County due to the intensifying demand for goods and services. The study noted that the rise in small and medium businesses has necessitated the County Government to plan for the upgrading of old rural market infrastructures and the construction of new ones to enable and guarantee the growth of rural enterprises. This demonstrates that market-oriented SMEs are a driver of land use change as land that was previously agricultural or residential is now being converted into trading and commercial spaces.

Data from field observation corroborated by information from FGD equally revealed that most areas within the rural areas that used not to be market centers have since been turned into market centers due to the upward demand for goods and services closer to the rural areas. The conversion of such areas into market centers is a direct indicator of land use change where traditional land uses such as farming are replaced by commercial and service-oriented land uses to meet the growing rural demand.

Information from field observation supported by data from KII and FGD revealed that the Motorcycle Taxi (MT), locally known as the Boda-boda business, has also grown in the study area due to the high number of people who use MT for travel and movement from one point to the other for business and other services. The study also noted that the high number of students from institutions of higher learning depend on the boda-boda as a means of movement to class from their residences and also to other places for other services. Additionally, data from KII revealed that the majority of the MT operators have formed groups where they conduct table banking and some have ventured into other businesses such as farming, leasing land, planting sugarcane, and opening fuel filling stations among others. This finding on the MT business and preference by the rural dwellers aligns with a related study recognizing MT as the most preferred means of movement by rural dwellers (Afukaar et al., 2019). The boda-boda industry has therefore contributed to land use change as roadside areas, junctions, and other open spaces have been transformed into boda-boda stages, fueling stations, and support businesses that were previously non-existent in rural landscapes.

According to the data acquired from FO and FDG, the establishment of Rongo University and Siala Institute of Technology within the rural areas has impacted the available housing facilities

within Rongo Sub-County due to the influx of students who require accommodation during the study period. Consequently, this has triggered the rise in property rental business within the study area. Building rental houses has become a key economic activity and a great source of income for those endowed with land resources around such institutions of higher learning. The discoveries agree with related studies indicating the high perception of the neighborhoods of high-income accumulation from rental and other apartment facilities (Owuor et al., 2019). This illustrates that educational expansion and SME growth in rental housing has driven land use change through the conversion of agricultural and idle land into built-up residential zones.

Data from FGD equally revealed that this lucrative source of income has attracted even non-local investors, mostly from the neighboring County of Kisii. Further, information obtained from KII revealed that the rate of application development approval is growing due to the high demand for accommodation facilities. Residential development is the most predominant type of development in Rongo Sub-County as revealed by data from KII. Despite the high income accrued from the property rental business, the study established that the business has immensely impacted the agricultural lands that are found around the institutions. Information obtained from field observation and FGD exhibited that most lands that were formerly agricultural lands have now been converted into residential areas to cater to the growing number of students who require accommodation. Additionally, the rate of land subdivision has also increased around these institutions as many investors buy land for the construction of hostels and other services. Information from FGD similarly indicated that some of the residents sell their land to acquire capital for constructing their own rental houses. According to the data obtained from KII, the University in most instances gives priority to the first years in the allocation of the hostel rooms. Owuor et al. (2019) showed that there is a high rate of land subdivision as most households tend

to sell their lands to private developers to acquire funds to also carry out development, thereby leading to more land being converted into built-up areas. These findings clearly demonstrate that SMEs in property rental and housing have fundamentally changed land use by accelerating subdivision and converting farmland into dense residential developments.

The study established that in all the six Locations, the market centers have attracted several businessmen and women who trade in either farm produce or retail shops, provision of cyber services, hotel, beauty, and design services among others. Information obtained from FGD similarly showed that the majority of the businesswomen regard trading in farm produce as their sole source of income and livelihood in rural areas. This further illustrates that the proliferation of SMEs not only supports livelihoods but also transforms rural land use patterns by creating and expanding commercial hubs within formerly non-commercial spaces.

4.4.1.3 Artisanal Small Scale-Gold Mining (ASGM)

The study through the data from HSQ revealed that 8% of the respondents practice ASGM as their main occupation (Table 23). The study findings noted the activity as a source of employment to the locals, predominantly to the youths and even to those who come from beyond the sub-county. Similarly, Information obtained from FGD showed that miners come as far as Tanzania and China depending on the level of expertise required. There is involvement of several expatriates in mining activities within the study area. The study established that the expatriate miners come in handy with new mining technologies thus boosting the level of income to the local miners. Information obtained from KII and observation equally revealed that ASGM promotes economic multiplier effects by enabling the local businesses to thrive including food vending and trading in other goods and services. Additionally, data from field observation revealed that ASGM has resulted in land

degradation thus impacting the agricultural lands by leaving unrehabilitated open trenches and dredged-out pits in most mining sites thus rendering the sites unsuitable for agriculture, which in most cases was the original use of most sites. Data obtained from field observation and FGD also established the high rate of conversion of agricultural lands into mining sites to enhance the economic status of the population.

The findings are in line with other related studies that noted ASGM as an integral facet of economic growth for the people of Rongo Sub-County (Mwango, 2010). Additionally, the activity is a principal driver of land use change as many agricultural lands are converted into mining sites. Adhiambo & Simiyu (2020) noted that ASGM is a primary livelihood strategy for the residents of Rongo Sub-County. However, the study further underscored the urgent need for regulatory measures to guarantee environmental safety and resource sustainability.

4.4.2 Population Distribution by Income

Information from HSQ showed that the majority (41%) of respondents earn a monthly income ranging from 10000 to 40000 from the main occupation. 16% of the respondents earn a monthly income of below 10,000, 33% are within the range of 40,000-70,000, and only 3% earn above 100,000 from the main occupation (Figure 9).

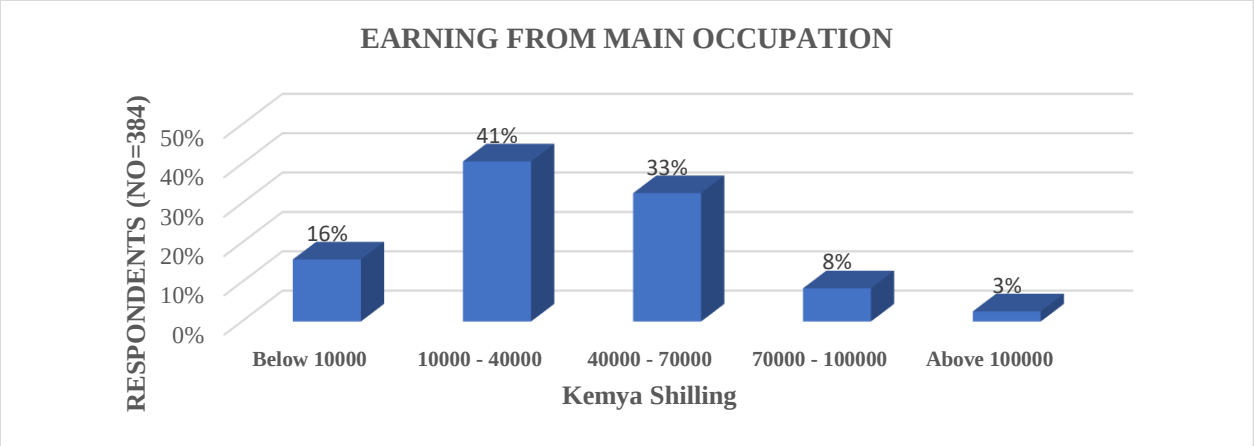

Figure 9: Distribution of Respondents by Income levels

Source: Author, 2024

The study also established that those with employment and business income maximize their monthly earning by venturing into other businesses and agriculture. Further, they either acquire new agricultural spaces or apply land use intensification on their lands to maximize the income from farm produce. Information obtained from FGD supported by data from HSQ indicated that the majority of the civil servants and business respondents have access to extra sources of income.

Information obtained from FGD further indicated that access to employment income and business income influences rural land use decisions due to high eligibility to secure loans from banks for investment. Data from HSQ supported by data from FGD showed that those earning a monthly income within the range of 70000-100000 and above 100000 practice extensive agriculture and run business enterprises. Further, information from FGD revealed that those with high income own most of the accommodation facilities for university students. This finding is in line with related studies showing access to income sources such as teaching, and private business as a driver of LUC decisions in most households (Ahimbisibwe et al., 2019).

4.4.3 Educational Status

Information gathered through HSQ showed that 9% of the respondents have attained a university education, 17% middle a level college education, 45% have secondary education, and 29% have primary education (Figure 10). The finding shows that the majority of the respondents have gone above the primary level in education. It equally shows that there is a great investment in education by the people living in the rural areas of Rongo Sub-County. Information obtained from FGD showed that the majority of the participants rely on land resources to educate their children either by leasing a portion of land for sugarcane or maize plantations or by land intensification practices to maximize farm produce for sale.

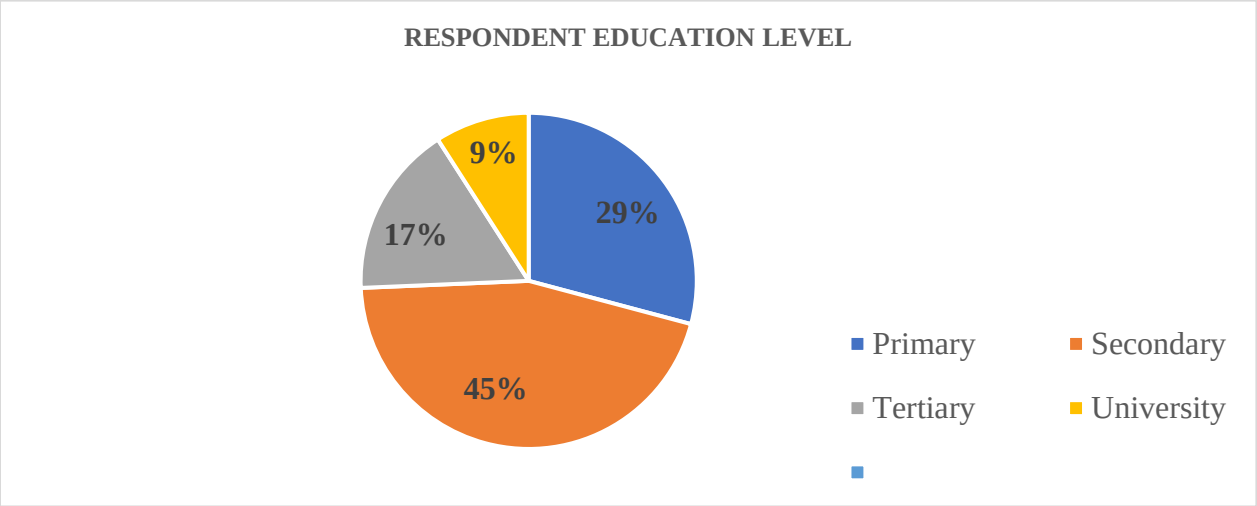

Figure 10: Respondents Distribution by Level of Education Attainment

Source: Author, 2024

Information obtained from FGD indicated that most people in the rural areas of the Sub-County are endowed with the necessary knowledge of agricultural practices. The rural population is aware

of the available varieties of maize and bean seeds which are suitable for the type of soil found in the area hence allowing them to maximize their yields from the farms. The information obtained from FDG also revealed that the majority of the rural farmers now use artificial fertilizer during planting season and later undertake top dressing of the plants to maximize the yield from their firms. Additionally, information from FGD demonstrated that the level of education in the study area has made it easier to disseminate information on the best agricultural practices to the rural farmers the county government, and other organizations such as One Acre Fund. The findings thus show that education level enhances the level of understanding of the rural farmers as regards the changing agricultural technologies and practices that are used to advance farming activities. The finding corresponds to a similar study that indicates that underscored the importance of knowledge as a factor contributing to land utilization (Makate et al., 2019).

Similarly, data from HSQ revealed that all the respondents who are civil servants have acquired education up to the level of the college and the university. This finding indicates that education level offers the rural population a chance to have several employment opportunities hence inspiring them to advance and change their decision regarding land use for the enhancement of the income earning.

4.4.4 Development of Local Amenities

Information obtained from field observation corroborated by data from FGD exhibited that the study area has several infrastructural developments including road networks, communication, education management facilities, health facilities, and markets among others. The development of these social amenities has significantly contributed to the change in land use patterns within the rural areas of Rongo Sub-County.

Data acquired from KII and FGD showed that the establishment of RU triggered the upgrading of Kanga-Kitere Road to bitumen standards. Additionally, Riosiri–Rongo University–God Jope Road and Junction Nyarach–Nyaburu–Oboke–Rangwe Road are also being upgraded to bitumen standards. Such infrastructural developments have enhanced accessibility, which in turn has stimulated settlement and commercial activities along these road corridors, thereby transforming agricultural land into built-up areas.

Data from field observation equally indicated that the remaining roads are gravel and earth roads which are in good condition and are regularly maintained as revealed by the data obtained from KII. Information from KII further indicated that the earth roads continue to be maintained to ease the movement of the MT operators. These improved transport networks have attracted more population settlement and business activities in the rural areas, accelerating the conversion of farmland into residential and trading spaces.

Information from KII similarly showed that the majority of the secondary schools in Rongo Sub-County are situated within the rural areas except two, Nyarach Secondary School which is in the suburban areas of Rongo town, and St. Paul's Day Secondary School which is within the Central Business District (CBD) of Rongo town. Information obtained from FGD and KII showed that the increasing school-going population is impacting the available education facilities thus necessitating the need for more facilities within the rural areas of the sub-county. Data from field observation and FGD revealed that most schools (private and public) that were established between 2002 and 2022 were established on agricultural lands, indicating direct land use conversion from farming to institutional use.

Similarly, Information from field observation and data obtained from remotely sensed images as regards the trend of settlement and the available local amenities revealed that settlements tend to be concentrated around the schools, or along the roads leading to market centers as demonstrated in (Figure 11). This shows that the development of social amenities such as schools, roads, and markets has acted as a major driver of land use change by attracting population settlement and the growth of trading centers, thereby reducing the extent of agricultural land.

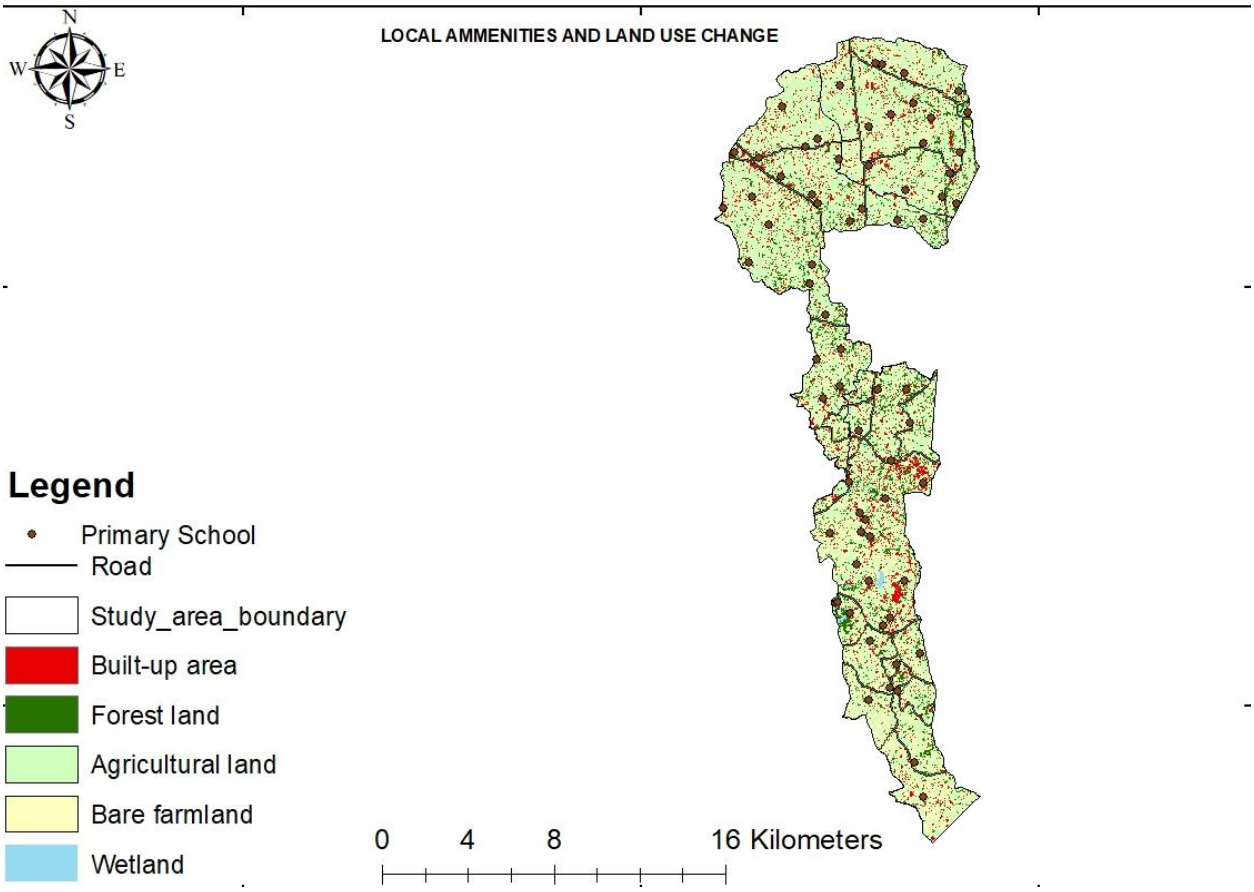

Figure 11: Trend of Settlement and the Availability of Social Amenities such as Schools

Source: Author, 2024

Information gathered from KII supported by data from FGD exhibited that the study area has 6 major markets that have specific market days within the week including Riosiri, Okusu, opapo, Ngere, Nyamuga, and Rakwaro. The data further showed that the traders in the markets majorly trade in agricultural products. The fact that the markets have specific market days has triggered the construction of certain structures and other permanent buildings that serve as stores for certain goods and spaces for providing specific services as revealed by information obtained from field observation and FGD. These findings equally align with other related studies showing the availability of local amenities as a driver of rapid urbanization and increasing change of use of structures and land to serve the needs of the rising population (Ochola, 2019).

4.4.5 Sources of Fuel for Cooking and Water

The study revealed that the majority (49%) of the respondents rely on streams, 34% on rivers, and 16% on boreholes for domestic water (Table 24).

Table 4–22: Distribution of Respondents by Source of Water

Source of Water	Number of Respondents	Percentage
Tap water	0	0%
Stream	189	49%
River	133	34%
Borehole	62	16%
Total	384	100%

Source: Author, 2024

Information obtained from FGD showed that every village has its preferred source of water which is protected from any pollution or encroachment by the village members. This finding reflects the information obtained from the remotely sensed images showing insignificant change in riparian and wetlands between the years 2002 and 2022.

The data acquired through HSQ also exhibited that 71% of the respondents rely on wood fuel for cooking, 19% use charcoal, 8% use Liquefied Petroleum gas (LPG), and 2% use paraffin (Table 25). This finding equally reflects the information obtained from the remotely sensed images showing a decline in forest land. Similarly, data from field observation and FGD showed most trees have been cut by those looking for firewood thereby turning forestlands into bare land which is later converted into agricultural lands.

Table 4–23: Distribution of Respondents by Source of Energy for Cooking

SOURCE OF ENERGY	RESPONDENT	PERCENTAGE
Firewood	278	72%
Charcoal	73	19%
LPG gas	31	8%
Paraffin	2	1%
Electricity	0	0%
Total	384	

Source: Author, 2024

4.4.6 Tenure System and Settlement

The study survey data showed private land ownership as the most common land tenure system in Rongo Sub-County. (89%) of the respondents indicated having private land ownership, 10% leasehold, and 1% under public ownership (Table 26).

Table 4–24: Distribution of Respondents by the Land Tenure System

Land Tenure	**Respondent**	**Percentage**
Public	4	1%
Private	322	89%
Leasehold	35	10%
Non-Native without land	23	
Total	**384**	**100%**

Source: Author, 2024

Information obtained from FGD has established that the fact that most lands are owned privately has increased the rate of land selling in the study area. This is because one does not require anyone's permission to sell his or her land, provided there is a mutual agreement among family members and the buyer. This finding aligns with similar studies showing the introduction of private land ownership as a driving factor and opportunity for most land owners to sell their lands and those without land to acquire land for different land uses (Miganda, 2019). Data from field observation and KII showed the high rate of land sub-division around the institutions. Additionally, information from FGD showed that agricultural lands have also been subdivided into smaller portions due to the increasing number of households thus leading to the decline in the rural extensive sugarcane farming. This finding is in line with other related studies, for example, according to Ndeda (2019), land subdivision impacts rural economies as it denies the rural farmers an opportunity to maximize their potential in farming business. Similarly, data obtained from FGD has revealed that most of the agricultural lands have been sold to external investors thereby leaving the natives with portions that cannot support sugarcane farming a predominant cash crop in the area.

Additionally, information obtained from KII indicated that private land ownership is one of the challenges faced by the County Government in the attempt to regulate land use in rural areas. furthermore, data from KII underscored the influence of the land tenure system on the trends in LUC with specific reference to residential and commercial land use. Similarly, Private land ownership influences ASGM in the study area where mineral deposit is present. As revealed by the information obtained from KII, the landowners do not need any authorization from the community members to proceed with the activity once the gold prospect result turns positive on his/her land.

Data acquired through KII supported by literature review exhibited that land holding in the rural Rongo Sub-County is up to 3 acres for small-scale farmers who largely practice subsistence farming and 7 acres for large-scale farmers for cash crop farming. Further, the data from KII revealed that 65% of the lands in Rongo Sub-County have title deeds with very minimal cases of landlessness owing to the social structure of the communities within the study area.

Information gathered from FGD noted that the customs of the Luo community, the dominant tribe in the study area, allow every clan man a right to use the land for farming as long as he maintains it. This norm is a great boost to the agricultural production of the area thus influencing the clearance of forestlands to meet the demand for agricultural land. Similarly, the polygamous custom of the Luo community is as well another factor influencing land sub-division as each co-wife has to be given her portion of the land, this implies that if one man has five wives, he has to divide the land into equal five portions for the wives.

The study similarly revealed that 93% of the respondents own dwelling units, 6% rented, 1%, purchased the dwelling unit, and that no respondent has inherited the dwelling unit (Figure 12).

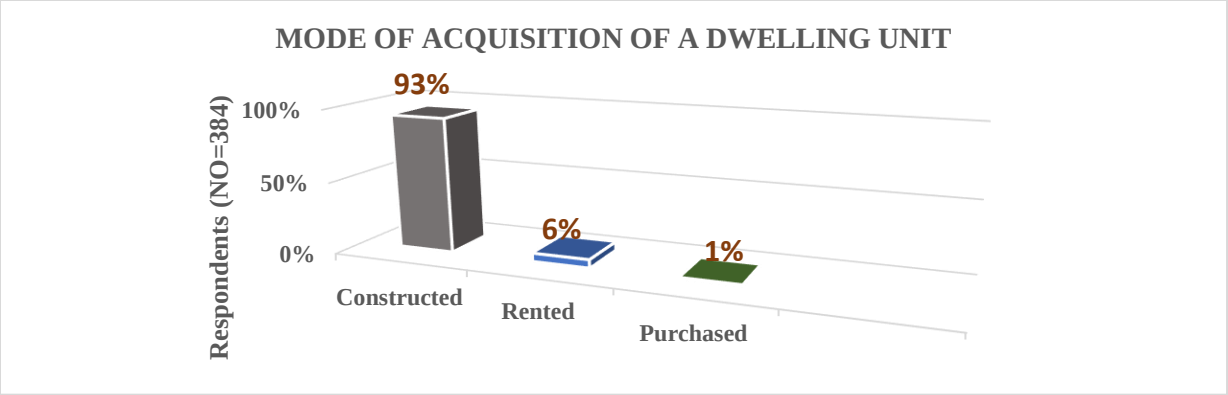

Figure 12: Distribution of Respondents by Mode of Acquisition of the Dwelling Unit

Source: Author, 2024

Information from FGD and KII showed that the most of the households who have rented the dwelling units are students, miners, non-native workers of the County & National Government, and other employees of private sector businesses. The findings have been corroborated by the data from the KNBS (2019) on household distribution and tenure status showing 75.8% of households are living in their own houses while 24.1% dwell in rented units.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter discusses a summary of study findings, conclusion, and recommendation on Demographic change and its impact on rural land use change dynamics in Rongo sub-county. The summary is divided into paragraphs guided by a specific study objective

5.2 Summary of Findings

The first objective of the study was *to analyze the land use change trend in the study area*. The results in Tables 9, 10, and Figure 5 demonstrate that the trend in rural LUC in the study area involves the modification of Forest lands into farmlands and settlements between the years 2002 and 2022. The results equally showed insignificant change in wetlands in the aforementioned period. The overall percentage change in land use between 2002 and 2022 is 86%. Agricultural land had an overall positive change of 34%, Settlement 8%, and wetland 1% while forest land recorded an overall negative change of 43%. The increase in agricultural land and settlement areas is mirrored in the decline in forest land over the study period. The t-test conducted to validate the null hypothesis; that *there is no significant increase in land use change in the study area between 2002 and 2022* resulted in a P-value of 0.999, consequently, the null hypothesis was rejected.

The second objective of the study was *to examine the influence of population size on the trends in land use change in Rongo Sub-County.* The results have demonstrated that the study area's population has increased by 45.5% over the study period. The increased population size impacted the consumption rate in the study area consequently leading to the expansion of farmlands for the production of food as shown in the supervised classification. The increased population also resulted in an increase in households by 51.5% over the study period (Table 14). The increased households are mirrored by the increased settlement in the study area. Agricultural lands are being

subdivided into smaller portions due to the growing number of households thus leading to the decline in the rural extensive sugarcane farming.

The results have equally established that the majority of the population falls within the age bracket of (10-19) which is characterized by the population who still depend on the household heads for basic needs. This high dependency in rural areas of Rongo Sub-County impacts most of the decisions by household heads on land use to enhance the provision of basic needs to the household members. Similarly, the results have also demonstrated that the majority (51%) fall within the age bracket of 20-59, which contains the economically active population thereby influencing most of the household LU decisions in the study area. Further, the age bracket is a productive age for most women thus contributing to a high birth rate which in turn impacts the consumption rate and development in Rongo Sub-County. The null hypothesis that the *Land use trend in the study area is not significantly influenced by population size* was rejected after a correlational analysis employed for the verification resulted in r =0.837 and a P- value of 0.299.

The third objective was *to determine the influence of the socioeconomic status of a population on the trend in land use change.* The results have revealed that the majority (43%) of the people in the study area practice agriculture as the chief source of livelihood. This is corroborated by the growing demand for farmlands which has affected forest land in the study area. Similarly, 25% of the people in the area rely on small and medium-scale businesses as a source of income. As a result, areas that used not to be market centers are being turned into market centers as people look for trading spaces. Further, the rise in property rental business in the area has resulted in a rise in the rate of land subdivision as many investors who are attracted to the business buy land from the local people who are endowed with land around the institutions. The results have equally shown

that 8% of the people in the study area rely on mining as their main occupation. The study has shown that there is a high rate of conversion of agricultural and forest lands into mining sites in the study area to enhance the economic status of the rural population. The study similarly established that those with employment income maximize their monthly earning by venturing into other businesses and agriculture.

The growing school-going population in rural areas of Rongo Sub-County is influencing the intensified school infrastructure development in the study area. The study revealed that several primary and day secondary schools have been established within the rural areas to take care of the increasing school-going population. The study also revealed that most of these establishments are undertaken on agricultural lands. The majority (49%) rely on streams as the source of domestic water. Similarly, 71% of the population rely on firewood as their source of fuel for cooking. The study showed that the land tenure system in rural areas of Rongo Sub-County influences the sale of land. Private land ownership which the study revealed to be the common type of land ownership (89%), is one of the main drivers of land sale in the study area. This is because one does not require anyone's permission to sell his or her land, provided there is a mutual agreement among family members and the buyer. The study equally demonstrated that the majority (45%) of the respondents have attained education up to the level of secondary school thus influencing the maximization of the agricultural land use as most people are endowed with necessary knowledge on the changing agricultural practices.

5.3 Conclusion

The following conclusions can be derived from the study findings based on the study objectives.

i. The trend in rural LU change in Rongo Sub-County involves the modification of Forest land into farmlands and settlements. This was shown by the change in the area coverage for each LU class every five years from 2002 to 2022. The data equally showed a minimal change in wetland during the study period.

ii. Population size influences the trend in LUC in the rural areas of Rongo Sub-County. This influence is triggered by the growth in population that impacts the household size, number of households, and the rate of consumption, consequently influencing the need for settlement and expansion of farmlands. Similarly, the high number of dependent household members and economically active population influence household LU decisions and the maximization and intensification of the use of land.

iii. The socioeconomic status of a population influences the trends in land use change due to the continuous effort by the majority of the households to enhance their livelihoods and conditions of living. Enhancement of rural livelihood in the rural areas of Rongo Sub-County greatly depends on land resources thus encompassing the expansion of farmlands, sale of land, land maximization, and modification of business enterprises which all require land spaces.

5.4 Recommendations

The study makes the following recommendations based on the study findings

i. Policy Development on Land Use Transition

Since forest land in Rongo Sub-County has been increasingly converted into farms and settlements (2002–2022), the County Government of Migori, in collaboration with the Ministries of Lands and Environment, should regulate this trend through land use zoning, afforestation/reforestation, and community-based forest management. Integration into existing county land use plans and the National Land Use Policy (2017).

ii. Guidelines for Rural Settlements and Sustainable Farming

Population growth was found to drive farmland expansion and settlement. To address this, the County Government (Department of Agriculture and Rural Development) with the Ministry of Agriculture should implement rural settlement plans, strengthen farmer training in sustainable intensification (climate-smart agriculture, agroforestry, irrigation, improved seeds/fertilizers), and promote farmer cooperatives. These measures can be mainstreamed into ongoing extension programs, ensuring practical implementation.

iii. Capacity Building on Alternative Livelihoods

Socioeconomic pressures influence land use change through farmland expansion, land sales, and land-based enterprises. The County Government, together with the Ministry of Trade,NGOs, and CBOs, should promote alternative livelihoods such as non-farm enterprises, agro processing, vocational training, microcredit access, renewable energy, and eco-tourism. These initiatives are achievable through existing national funds (Youth Fund, Women Fund) and donor-supported livelihood programs.

5.5 Areas for further study

i. There is a need for further investigation to establish the impeding factors to the use of technological innovations in controlling rural land use change trends.

ii. Further studies should be conducted on the potential for ecological restoration and land management in rural areas.

REFERENCES

Acocella, I. (2012). The focus groups in social research: advantages and disadvantages. *Quality & Quantity*, *46*, 1125-1136.

Adhiambo, O. L., & Simiyu, R. (2020). Exploring Livelihood Strategies Pursued by Households in Rongo Sub-County, Migori County, Kenya. *Academia.edu*

Afukaar, F., Damsere-Derry, J., Peters, K., & Starkey, P. (2019). Rural Transport Services

Indicators: Using a new mixed-methods methodology to inform policy in Ghana.

Transportation Research Interdisciplinary Perspectives, *3*, 100074.

https://doi.org/10.1016/j.trip.2019.100074

Ahimbisibwe, V., Auch, E., Groeneveld, J., Tumwebaze, S. B., & Berger, U. (2019). Drivers of household decision-making on land-use transformation: An example of woodlot establishment in Masindi District, Uganda. *Forests*, *10*(8), 619.

Alexander, P., Brown, C., Rounsevell, M. D. A., Finnigan, J., & Arneth, A. (2021). Dietary change and its implications for land use, biodiversity and climate change. Nature Food, 2(10), 747–754. https://doi.org/10.1038/s43016-021-00320-6

Anwar, Z., Alam, A., Elahi, N., Shah, I., 2022. Assessing the trends and drivers of land use land cover change in district Abbottabad lower Himalayan Region Pakistan. Geocarto Int., 1–16

Bilsborrow, R. E., & DeLargy, P. F. (1990). Land use, migration, and natural resource deterioration: The experience of Guatemala and the Sudan. *Population and Development Review, 16*(Supplement), 125–147. https://doi.org/10.2307/2808064

Bradbury, M., Peterson, M. N., & Liu, J. (2014). Long-term dynamics of household size and their environmental implications. *Population and Environment*, *36*, 73-84.

Briassoulis, H., & Ph, D. (2020). Analysis of Land Use Change: Theoretical and Modeling Approaches Table of Contents. *Morgantown: West Virginia University*, 4–6. https://researchrepository.wvu.edu/rri-web-book (accessed on 26 June 2022.

Caldwell, J. C. (2006). *Demographic transition theory*. Dordrecht: Springer. https://doi.org/10.1007/978-1-4020-4498-4

Ceddia, M. G. (2019). The impact of income, land, and wealth inequality on agricultural expansion in Latin America. *Proceedings of the National Academy of Sciences*, *116*(7), 2527-2532.

CELI, G., & VITI, D. (2018). Land Use, Internal Mobility and External Immigration in Italy. *Annals of Spiru Haret University. Economic Series*, *18*(3), 23–43. https://doi.org/10.26458/1832

Chrisendo, D., Krishna, V. V., Siregar, H., & Qaim, M. (2020). Land-use change, nutrition, and gender roles in Indonesian farm households. *Forest Policy and Economics*, *118*, 102245.

Cohen, J. E. (1995). *How many people can the Earth support?* New York: W. W. Norton & Company.

Colsaet, A., Laurans, Y., & Levrel, H. (2018). What drives land take and urban land expansion? A systematic review. *Land Use Policy, 79,* 339-349. https://doi.org/10.1016/j.landusepol.2018.08.017

County, M. (2018). County Integrated Development Plan. *County Government of*

County, M. (2019). Rongo Municipality Integrated Development Plan. *County Government of.*

County, M. (2020). Rongo Municipality Strategic Plan. *County Government of.*

County, M. (2022). County Annual Development Plan. *County Government of.*

County, M. (2023). County Integrated Development Plan. *County Government of.*

Dabor et. al., A. O. (2015). Challenges facing women accountants in Nigeria. The Arabian Journal of Accounting, 18(01), 129-146. https://doi.org/10.12785/aja/180105

Davis, S.H. (2021). The World Bank and indigenous peoples. *Social Development in the World Bank*, 191.

Deng, X., Lin, Y., & Seto, K. C. (2014). Land-use competition between food production and urban expansion in China. *Rethinking Global Land Use in an Urban Era*, 71-85. https://doi.org/10.7551/mitpress/9780262026901.003.0005

Dickinson, K. L., Piedrahita, R., Coffey, E. R., Kanyomse, E., Alirigia, R., Molnar, T., Hagar, Y., Hannigan, M. P., Oduro, A. R., & Wiedinmyer, C. (2019). Adoption of improved biomass stoves and stove/fuel stacking in the REACTING intervention study in Northern Ghana. Energy Policy, 130, 361–374. https://doi.org/10.1016/j.enpol.2018.12.007.

Dibaba, W. T., Demissie, T. A., & Miegel, K. (2020). Drivers and implications of land use/land cover dynamics in Finchaa catchment, northwestern Ethiopia. *Land*, *9*(4), 113.

Doelman, J. C., Stehfest, E., Tabeau, A., van Meijl, H., Lassaletta, L., Gernaat, D. E., ... & van Vuuren, D. P. (2018). Exploring SSP land-use dynamics using the IMAGE model: Regional and gridded scenarios of land-use change and land-based climate change mitigation. *Global Environmental Change*, *48*, 119-135.

Dyson, T. (2010). *Population and development: The demographic transition.* London: Zed Books.

Ehrlich, P. R., & Holdren, J. P. (1971). Impact of population growth. *Science*, *171*(3977), 1212–1217. https://doi.org/10.1126/science.171.3977.1212

Gu, D., Andreev, K., & E. Dupre, M. (2021). undefined. *China CDC Weekly*, *3*(28), 604-613. https://doi.org/10.46234/ccdcw2021.160

Haase, D., Seppelt, R., & Haase, A. (2008). Land use impacts of demographic change – lessons from eastern German urban regions. *Use of Landscape Sciences for the Assessment of Environmental Security*, 329-344. https://doi.org/10.1007/978-1-4020-6594-1_19

Hassan, Z., Shabbir, R., Ahmad, S. S., Malik, A. H., Aziz, N., Butt, A., & Erum, S. (2016). Dynamics of land use and land cover change (LULCC) using geospatial techniques: a case study of Islamabad Pakistan. *SpringerPlus*, *5*, 1-11.

Hersperger, A. M., & Bürgi, M. (2009). Going beyond landscape change description: Quantifying the importance of driving forces of landscape change in a Central Europe case study. *Land Use Policy*, *26*(3), 640-648.

Hettig, E., Lay, J., & Sipangule, K. (2016). Drivers of households' land-use decisions: A critical review of micro-level studies in tropical regions. *Land*, *5*(4), 32.

Hoffmann, J. (2021). Demographic Change and Land Use. In *Sustainable Land Management in a European Context* (pp. 63-74). Springer, Cham.

Hoffmann, J. (2020). Demographic change and land use. *Human-Environment Interactions*, 63-74. https://doi.org/10.1007/978-3-030-50841-8_4

Hussain, M., & Bhat, N. (2018). World population statistics: Some key findings. *Res. J. Soc. Sci*, *9*, 16-25.

Iwasaki, E., Shalaby, A., Elbeih, S. F., & Khedr, H. S. (2021). Development of land use and groundwater in Rashda village (Dakhla oasis), 1960s–2018. *Sustainable Water Solutions in the Western Desert, Egypt: Dakhla Oasis*, 219-240. https://doi.org/10.1007/978-3-030-64005-7_13

Jayne, T. S., Muyanga, M., Wineman, A., & Yeboah, F. K. (2021). Changing farm size distributions and agricultural transformation in Sub-Saharan Africa. Applied Economic Perspectives and Policy, 43(1), 56–78. https://doi.org/10.1002/aepp.13102

Jebiwott, A., Ogendi, G. M., Agbeja, B. O., Alo, A. A., & Kibet, R. (2021). Mapping trends of forest cover change and associated drivers in the Mau Forest, Kenya. Remote Sensing Applications: Society and Environment, 23, 100586.

Jones, J. P., Mandimbiniaina, R., Kelly, R., Ranjatson, P., Rakotojoelina, B., Schreckenberg, K., & Poudyal, M. (2018). Human migration to the forest frontier: Implications for land use change and conservation management. *Geo: Geography and Environment*, *5*(1), e00050.

Juniyanti, L., Purnomo, H., Kartodihardjo, H., Prasetyo, L.B., 2021. Understanding the driving forces and actors of land change due to forestry and agricultural practices in Sumatra and Kalimantan: A systematic review. Land 10 (5), 463. https://doi.org/10.3390/land10050463

Kanda, R., Sang, C., & Letema, S. (2022). Spatio-Temporal Dynamics of Land Use and Land Cover in Elgeyo Escarpment, Kenya. *East African Agricultural and Forestry Journal*, *86*(3 & 4), 15-15.

Kamwi, J.M., Chirwa, P.W., Manda, S.O., Graz, P.F., Kätsch, C., 2015. Livelihoods, land use, and land cover change in the Zambezi Region, Namibia. Popul. Environ. 37(2), 207–230.

Kieran, C., Sproule, K., Doss, C., Quisumbing, A., & Kim, S. M. (2015). Examining gender inequalities in land rights indicators in Asia. *Agricultural Economics*, *46*(S1), 119-138.

Kiprotich, E., Kogo, B. K., Koech, R., & Kumar, L. (2022). Accelerating agricultural expansion in the greater Mau Forest Complex, Kenya. Remote Sensing Applications: Society and Environment, 25, 100701.

Kirk, D. (1996). Demographic transition theory. *Population Studies, 50*(3), 361–387. https://doi.org/10.1080/0032472031000149536

Kiteme, B. P., Gicheru, P., & Mutua, J. (2023). Socioeconomic dynamics, land use change and sustainable livelihoods in rural Kenya. Land Use Policy, 126, 106573. https://doi.org/10.1016/j.landusepol.2023.106573

Kizgin, H. (2011). The phenomenon of immigrants' consumer behavior: Immigrants' value differences and similarities: a home versus host comparison. *Journal of Islamic Marketing*.

Kleemann, J., Baysal, G., Bulley, H. N., & Fürst, C. (2017). Assessing driving forces of land use and land cover change by a mixed-method approach in north-eastern Ghana, West Africa. *Journal of Environmental Management*, *196*, 411-442.

KNBS. (2019). Kenya population and housing census volume 1: Population by County and sub-county. In *Kenya National Bureau of Statistics: Vol. I* (Issue November). https://www.knbs.or.ke/?wpdmpro=2019-kenya-population-and-housing-census-volume-i-population-by-county-and-sub-county

KNBS. (2019). Distribution of Population by Administrative Units. In *2019 Kenya Population and Housing Census: Vol. II*. http://www.knbs.or.ke

Kogo, B. K., Kumar, L., & Koech, R. (2021). Climate change and variability in Kenya: Impacts on agriculture and food security. Environment, Development and Sustainability, 23(1), 23–43.

Kroll, F., & Haase, D. (2010). Does demographic change affect land use patterns? *Land Use Policy*, *27*(3), 726-737. https://doi.org/10.1016/j.landusepol.2009.10.001

Lambin, E. F., Turner, B., Geist, H. J., Agbola, S. B., Angelsen, A., Bruce, J. W., Coomes, O. T., Dirzo, R., Fischer, G., Folke, C., George, P., Homewood, K., Imbernon, J., Leemans, R., Li, X., Moran, E. F., Mortimore, M., Ramakrishnan, P., Richards, J. F., … Xu, J. (2001). The causes of land-use and land-cover change: Moving beyond the myths. *Global Environmental Change*, *11*(4), 261-269. https://doi.org/10.1016/s0959-3780(01)00007-3

Livi-Bacci, M. (2017). *A concise history of the world population*. John Wiley & Sons.

Makate, C., Makate, M., Mutenje, M., Mango, N., & Siziba, S. (2019). Synergistic impacts of agricultural credit and extension on adoption of climate-smart agricultural technologies in Southern Africa. *Environmental Development*, *32*, 100458. https://doi.org/10.1016/j.envdev.2019.100458

Mangeni, J. N., Menya, D., Mwitari, J., Shupler, M., Anderson de Cuevas, R., Sang, E., & Puzzolo, E. (2023). Household cooking fuel choice and associated factors in a rural and peri-urban community in Western Kenya. *Environmental Research: Health, 1*(2), 025004. https://doi.org/10.1088/2752-5309/acd46c

Marchant, R., Richer, S., Boles, O., Capitani, C., Courtney-Mustaphi, C. J., Lane, P., Prendergast, M. E., Stump, D., De Cort, G., Kaplan, J. O., Phelps, L., Kay, A., Olago, D., Petek, N., Platts, P. J., Punwong, P., Widgren, M., Wynne-Jones, S., Ferro-Vázquez, C., … Wright, D. (2018). Drivers and trajectories of land cover change in East Africa: Human and environmental interactions from 6000 years ago to present. *Earth-Science Reviews, 178*, 322-378. https://doi.org/10.1016/j.earscirev.2017.12.010

Mekuria, A., (2014). *Forest conversion - soil degradation - farmers' perception nexus: Implications for sustainable land use in the southwest of Ethiopia*. G ttingen: Cuvillier.

Meyfroidt, P., Chowdhury, R. R., de Bremond, A., Ellis, E. C., Erb, K. H., Filatova, T., ... & Verburg, P. H. (2018). Middle-range theories of land system change. *Global environmental change*, *53*, 52-67.

Meyfroidt, P., Roy, J., Lambin, E. F., & others. (2022). Socioeconomic drivers of land use change and their implications for sustainability. Annual Review of Environment and Resources, 47, 1–28. https://doi.org/10.1146/annurev-environ-120920-042538

Miganda, M. O. O., Kandagor, D. R., & Ntabo, M. (2019). Pre-colonial Luo land tenure systems and agricultural practices in Awendo sub-county, Kenya. http://repository.rongovarsity.ac.ke/handle/123456789/2146

Mishra, V. (1995). A conceptual framework for population and environment research. *Pure.iiasa.ac.at*

Mishra, V. K. (1996). *Population, land use, and environment in India*. University of Hawai'i at Manoa.

Msofe, N. K., Sheng, L., & Lyimo, J. (2019). Land use change trends and their driving forces in the Kilombero Valley Floodplain, Southeastern Tanzania. *Sustainability*, *11*(2), 505.

Mudereri, B. T., Dube, T., Niassy, S., Kimathi, E., Landmann, T., Khan, Z., & Abdel-Rahman, E. M. (2020). Is it possible to discern striga weed (Striga hermonthica) infestation levels in maize agroecological systems using in-situ spectroscopy? *International Journal of Applied Earth Observation and Geoinformation*, *85*, 102008. https://doi.org/10.1016/j.jag.2019.102008

Muhati, G. L., Olago, D., & Olaka, L. (2018). Land use and land cover changes in a sub-humid montane forest in an arid setting: A case study of the Marsabit forest reserve in northern Kenya. *Global Ecology and Conservation*, *16*, e00512. https://doi.org/10.1016/j.gecco.2018.e00512

Munthali, M.G., Davis, N., Adeola, A.M., Botai, J.O., Kamwi, J.M., Chisale, H.L., Orimoogunje, O.O., 2019. Local perception of drivers of land-use and land-cover

change dynamics across Dedza District, Central Malawi Region. Sustainability 11 (3), 832.

Muriithi, F. K. (2016). Land use and land cover (LULC) changes in semi-arid sub-watersheds of Laikipia and Athi river basins, Kenya, as influenced by expanding intensive commercial horticulture. *Remote Sensing Applications: Society and Environment*, *3*, 73-88. https://doi.org/10.1016/j.rsase.2016.01.002 land use patterns? *Land Use Policy*, *27*(3), 726-737. https://doi.org/10.1016/j.landusepol.2009.10.001

Musyoka, M., Muriithi, B., & Ndiritu, S. (2021). Household education, vulnerability and coping strategies in rural Kenya. Development Studies Research, 8(1), 216–228. https://doi.org/10.1080/21665095.2021.1974918

Mwangi, H., Oduor, N., & Wandiga, S. O. (2020). Drivers of wetland conversion and degradation in Kenya. Journal of Environmental Management, 267, 110662.

Mwango, O. K. (2010). Impact of open pit artisanal gold mining a case study of Rongo constituency. *Ir-library.ku.ac.ke*

Nansaior, A., Patanothai, A., Rambo, A. T., & Simaraks, S. (2011). Climbing the energy ladder or diversifying energy sources? The continuing importance of household use of biomass energy in urbanizing communities in Northeast Thailand. Biomass and Bioenergy, 35(10), 4180–4188. https://doi.org/10.1016/j.biombioe.2011.06.046.

Nkedianye, D., Radeny, M., Kristjanson, P., & Herrero, M. (2009). Assessing returns to land and changing livelihood strategies in Kitengela. *Staying Maasai? Livelihoods, Conservation and Development in East African Rangelands*, 115-149.

Nkedianye, D., Radeny, M., & Kristjanson, P. (2022). Livelihood diversification and land use dynamics in East African drylands. Land, 11(8), 1254. https://doi.org/10.3390/land11081254

Notestein, F. W. (1945). International population readjustments. *Proceedings of the Academy of Politica*

Ochola, G. O. (2019). How University establishment influences land use and land cover. *International Journal of Environmental Sciences & Natural Resources*, *21*(5). https://doi.org/10.19080/ijesnr.2019.21.556075

Ogola, P. T. (2018). *Human Population Growth and its Implications on the Use and Trends of Land Resources in Migori County, Kenya* (Doctoral dissertation, Doctoral dissertation, Kenyatta University).

Okore, L. M. K., Koske, J. K., & Letema, S. (2022). Household-based determinants of cooking and heating fuel mixes in informal settlements of Kisumu City, Kenya. *African Journal of Environmental Science and Technology*, *16*(7), 229–241. https://doi.org/10.5897/AJEST2022.3030

Ole Koissaba, C. (2021). Pastoral land use change in Kenya's drylands: Infrastructure, conservancies, and sedentarization. Land Use Policy, 109, 105679.

Omuruli, M. S. (2022). *The Impact of Human Population on Land Cover Changes in Gwassi Hills Water Tower, Homabay County* (Doctoral dissertation, University of Nairobi).

Onyango, D.O., Ikporukpo, C.O., Taiwo, J.O., Opiyo, S.B., 2021. Monitoring the extent and impacts of watershed urban development in the Lake Victoria Basin, Kenya, using a combination of population dynamics, remote sensing, and GIS techniques. Environ. Socio-econ. Stud. 9 (2), 11–25.

Opiyo, S. B., Opinde, G., & Letema, S. (2022). Dynamics and drivers of land use and land cover changes in Migori River Watershed, western Kenya region. *Watershed Ecology and the Environment*, *4*, 219–232. https://doi.org/10.1016/j.wsee.2022.11.008

Otieno, G., Okello, J., & Nyikal, R. (2022). The role of education in enhancing household food security in Kenya. Environmental Research Letters, 17(9), 094011. https://doi.org/10.1088/1748-9326/ac8be8

Owuor, J. B., Nyamai, D. O., & Ochola, G. O. (2019). Impacts of Land Use and Land Cover Changes on the Environment Associated with the Establishment of Rongo University in Rongo Sub-County, Migori County, Kenya. http://repository.rongovarsity.ac.ke/handle/123456789/2146

Ozcanli, O. C., Dong, Y., Mundy, J. L., Webb, H., Hammoud, R., & Victor, T. (2014). Automatic geo-location correction of satellite imagery. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition Workshops* (pp. 307-314).

Park, C. Y., Shin, K., & Kikkawa, A. (2022). Demographic change, technological advance, and growth: A cross-country analysis. *Economic Modelling*, *108*, 105742.

Putri, R. F., Wibirama, S., Giyarsih, S. R., Pradana, A., & Kusmiati, Y. (2019). Land use change monitoring and population density analysis of Penjaringan, Cengkareng, and Cakung urban area in Jakarta Province. In *E3S Web of Conferences* (Vol. 76, p. 03004). EDP Sciences.

Republic of Kenya (2001). *Kenya Population and Housing Census.* Kenya National Bureau of Statistics Vol. I. http://www.knbs.or.ke

Republic of Kenya (2019). *Kenya Population and Housing Census.* Kenya National Bureau of Statistics Vol. III. http://www.knbs.or.ke

Republic of Kenya (2019). *Kenya Population and Housing Census.* Kenya National Bureau of Statistics Vol. IV. http://www.knbs.or.ke

Sabbagh, J., & Neef, M. (2008). The consequences of demographic change in Rhineland-Palatinate: Scenarios of landscape consumption for settlement and transportation areas. *Use of Landscape Sciences for the Assessment of Environmental Security*, 345-356. https://doi.org/10.1007/978-1-4020-6594-1_20

Sadeh, A., Radu, C. F., Feniser, C., & Borşa, A. (2020). Governmental intervention and its impact on growth, economic development, and technology in OECD countries. *Sustainability*, *13*(1), 166. https://doi.org/10.3390/su13010166

Soby, S. (2017). Thomas Malthus, Ester Boserup, and agricultural development models in the age of limits. *Journal of Agricultural and Environmental Ethics*, *30*(1), 87-98.

Starke, L. (Ed) (2005). State of the world 2005, A world watch institute report on progress toward a sustainable society, Norton and company limited. Washington, USA:

Starke, L. (Ed.). (2006). *State of the World 2006: A Worldwatch Institute report on progress toward a sustainable society*. Worldwatch Institute.

Statistics, K.N.B.O. (2010). The 2009 Kenya population and housing census. http://www.knbs.or.ke

Stehfest, E., van Zeist, W. J., Valin, H., Havlik, P., Popp, A., Kyle, P., ... & Wiebe, K. (2019). Key determinants of global land-use projections. *Nature communications*, *10*(1), 2166.

Tang, H., Liu, J., Dai, X., Zhang, Y., He, W., Yin, Q., ... & Liu, Y. (2022). Household Groups' Land Use Decisions Investigation Based on Perspective of Livelihood Heterogeneity in Sichuan Province, China. *International Journal of Environmental Research and Public Health*, *19*(15), 9485.

Thompson, W. S. (1929). Population. *American Journal of Sociology*, *34*(6), 959–975. https://doi.org/10.1086/214874

Tran, H., Nguyen, Q., & Kervyn, M. (2018). Factors influencing people's knowledge, attitude, and practice in land use dynamics: A case study in Ca Mau province in the Mekong Delta, Vietnam. *Land Use Policy*, *72*, 227-238.

Turner, B. L. (1990). *The Earth as transformed by human action: Global and regional changes in the biosphere over the past 300 years.* Cambridge: Cambridge University Press.

United Nations. (2019). World Population Prospects 2019. United Nations. United States Census Bureau. https://www.census.gov.

Vander Borght, M., & Wyns, C. (2018). Fertility and infertility: Definition and epidemiology. *Clinical biochemistry*, *62*, 2-10.

Villamor, G. B., Akiefnawati, R., Van Noordwijk, M., Desrianti, F., & Pradhan, U. (2015). Land use change and shifts in gender roles in central Sumatra, Indonesia. *International Forestry Review*, *17*(4), 61-75.

Villamor, G. B., van Noordwijk, M., Djanibekov, U., Chiong-Javier, M. E., & Catacutan, D. (2014). Gender differences in land-use decisions: shaping multifunctional landscapes? *Current Opinion in Environmental Sustainability*, *6*, 128-133 (a).

Villamor, G. B., Desrianti, F., Akiefnawati, R., Amaruzaman, S., & van Noordwijk, M. (2014). Gender influences decisions to change land use practices in the tropical forest margins of Jambi, Indonesia. *Mitigation and Adaptation Strategies for Global Change*, *19*, 733-755 (b).

Weith, T., Barkmann, T., Gaasch, N., Rogga, S., Strauß, C., & Zscheischler, J. (2020). A knowledge-based European perspective on sustainable land management: Conceptual approach and overview of chapters. *Human-Environment Interactions*, 1-13. https://doi.org/10.1007/978-3-030-50841-8_1

White, L. K., & Weeks, J. R. (2020). Population: An introduction to concepts and issues. *Contemporary Sociology*, *8*(1), 86. https://doi.org/10.2307/2064921

World population prospects 2019: Data booklet. (2019). *Statistical Papers - United Nations (Ser. A), Population and Vital Statistics Report*. https://doi.org/10.18356/3e9d869f-en

Xing, R., Hanaoka, T., Kanamori, Y., & Masui, T. (2018). Achieving zero emission in China's urban building sector: opportunities and barriers. Current Opinion in Environmental Sustainability, 30, 115–122. https://doi.org/10.1016/J.COSUST.2018.05.005.

Yaser,M.M., & Saba, M. (2016). Impact of Population Growth on Land Use Changes in Wadi Ziqlab of Jordan between 1952 and 2008. International Journal of Applied Sociology 6(1), 7-14

APPENDICES

Appendix I: Household Questionnaire

Name of Interviewer: _____ Date of Interview: _____

My name is Fredrick Nicholas Mwai, a Master's student from Kenyatta University. I am researching ***Demographic Change and its Impact on Rural Land Use Change Dynamics in Rongo Sub-County, Migori County.*** *The information shared will only be used for purposes of research and will be treated with the greatest concealment.*

1. Fill in the information required in the table;

Respondent Name	
Gender	
Age (Yrs)	
Education Level	
Main Occupation	
Ward Name	

2. Household Characteristics

Household Members	**Age(yrs.)**	**Gender**	**Education Level**
1.			
2.			
3.			
4.			
5.			
6.			
7.			

3. What other Occupation/business do you engage in……...
4. Please Indicate the total monthly income of your household

Below 10,000	10,000 – 40,000	40,000– 70,000
70,000 – 100,000	Above 100,000	

5. Where is your place of birth?.....

   If not Rongo Sub-County, please indicate the main reason for migrating into this area

   …….

6. How long have you been a resident of Rongo Sub-County?

   Below 5 years ( ) Over 15 Years ( )

   Over 5 years ( ) Over 30 years ( )

7. What is your source of energy for cooking?

   Firewood ( ) Charcoal ( )

   LPG Gas ( ) Electricity ( )

8. What is your main source of water for domestic consumption?

   Tap water ( ) River ( )

   Stream ( ) Borehole ( )

9. What is Land your change from your understanding

   ……

10. How would you describe land use change trends in your area of residence?
    a) Agriculture-Residential
    b) Agricultural- Mining
    c) Forest/Afforestation- Agriculture
    d) Agriculture–Forest/Afforestation
    e) Residential- Commercial
    f) Wetland -Agriculture
    g) Wetland -Settlement
    h) Agriculture – Education
    i) Agriculture -Road Infrastructure
    j) Residential -Education
11. How has your household size affected how you use your land?

    ……..……

Are you the owner of the house you are residing in? YES ( ) NO ( )

If yes, please state the mode of acquisition……

12. What was the original use of the section of your land where you built your house?

Agriculture ( ) Residential ( )

Forest ( ) Wetland ( )

13. What was the original use of your current farmland?

Forest ( ) Wetland ( )

Residential ( ) Others (specify)

14. What type of land tenure system is your land?

Private ( ) Public ( )

Leasehold ( ) Communal ( )

Appendix II: Interview Schedule to Institutions of Higher Learning

Name of Interviewer: _____ Date of Interview: _____

My name is Fredrick Nicholas Mwai, a Master's student from Kenyatta University. I am researching ***Demographic Change and its Impact on Rural Land Use Change Dynamics in Rongo Sub-County, Migori County.*** *The information shared will only be used for purposes of research and will be treated with the greatest concealment.*

1. when was the institution established?
2. What was the original use of the land where the school was established?
3. What is the current number of student enrolments in your school?
4. What is the percentage of non-local students?
5. Do you offer accommodation for all the students? YES or NO
   If NO, where do the non-resident students stay as they progress with their studies?
6. What is the current number of non-local employees?
7. Do you offer accommodation for the staff from other sub-counties?
8. Does your school have any other investment within Rongo Sub-County? YES or NO
   If YES, specify what type of land use
9. Do you provide food to students in school? YES or NO
   If YES, where do you buy food, you provide to students
   If NO, where do the students get food?
10. How do the current trends in land use change affect the growth of the institutions within Rongo Sub-County?
11. What challenges do you face as an institution?

Appendix III: Interview Schedule to the Mining Management

Name of Interviewer: _____ Date of Interview: _____

My name is Fredrick Nicholas Mwai, a Master's student from Kenyatta University. I am researching ***Demographic Change and its Impact on Rural Land Use Change Dynamics in Rongo Sub-County, Migori County.*** *The information shared will only be used for purposes of research and will be treated with the greatest concealment.*

1. When was this mining site started?
2. Who manages the site?
3. How many non-local miners do you have?
4. Where do the non-local miners reside?
5. What was the original use of the mining site?
6. In your own opinion, why was it changed from its original use?
7. How have you and other miners benefited from the mining activity?
8. Are there other potential benefits of small-scale gold mining that have not been realized? YES ( ) NO ( )
    a) If YES, indicate measures that need to be put in place to realize the benefits.
9. How do the current trends in land use change affect Mining activities in the Rongo Sub-County?
10. What is the role of National and County Governments in small-scale Gold Mining in Rongo Sub-County?
11. What kind of land tenure system is found in most gold mining sites?
12. How does the land tenure system influence small-scale gold mining?
13. What are the challenges faced by small-scale gold miners in Rongo Sub-County?
14. What has the National/County Government done to mitigate these challenges?

Appendix IV: Interview Schedule to the Department of Physical Planning

Name of Interviewer: _____ Date of Interview: _____

My name is Fredrick Nicholas Mwai, a Master's student from Kenyatta University. I am researching ***Demographic Change and its Impact on Rural Land Use Change Dynamics in Rongo Sub-County, Migori County.*** *The information shared will only be used for purposes of research and will be treated with the greatest concealment.*

1. How would you describe the trends in land use changes within Rongo Sub-County?
2. What is the main cause of the current trends in land use change?
3. What are some of the predominant types of development applications you have been encountering for the last decade?
4. What is the rate of development plan approval in Rongo Sub-County? HIGH or LOW
    a) If high, what is the reason behind the rise?
    b) If Low, what is the reason behind the low rate?
5. What is the rate of land sub-division and change of use application within Rongo Sub-County?
    a) If high, what is the reason behind the rise?
    b) If Low, what is the reason behind the low rate?
6. What is the rate of compliance with other Government regulations in development?
7. What is the most common land tenure system in Rongo Sub-County?
    a) What would be influencing the existence of the "most common" land tenure system mentioned above?
    b) What is the influence of the existing land tenure system on land use change trends in Rongo Sub-County?
8. What are the challenges faced by the department in regulating the current trends in land use change?
9. What measures has the County Government put in place to curb the current trends in land use change?

Appendix V: Interview Schedule to the Department of Trade, Industrialization and Cooperative Development

Name of Interviewer: _____ Date of Interview: _____

My name is Fredrick Nicholas Mwai, a Master's student from Kenyatta University. I am researching ***Demographic Change and its Impact on Rural Land Use Change Dynamics in Rongo Sub-County, Migori County.*** *The information shared will only be used for purposes of research and will be treated with the greatest concealment.*

1. How would you describe the rate of business permit applications within Rongo Sub-County in the last 10 years?
    a) What factors do you think are the cause of the rate described above
2. How would you describe industrial development and growth in Rongo-Sub-County?
   If Industrial growth is on the rise, what factors in your opinion do you think are behind the rise?
   How many industrial development initiatives has your department facilitated in Rongo Sub-County in the last 10 years?
3. What challenges do you face in your efforts to facilitate trade infrastructure development and industrial development within the Rongo sub-county?
4. How would you describe the growth of cooperative societies within Rongo Sub-County?
5. What factors do you think are the main contributors to the changes experienced in the cooperative development in Rongo Sub-County?
6. How has the land tenure system within Rongo Sub-County impacted industrial development?

Appendix VI: Interview Schedule to the Department of Civil Registration

Name of Interviewer: _____ Date of Interview: _____

My name is Fredrick Nicholas Mwai, a Master's student from Kenyatta University. I am researching ***Demographic Change and its Impact on Rural Land Use Change Dynamics in Rongo Sub-County, Migori County.*** *The information shared will only be used for purposes of research and will be treated with the greatest concealment.*

1. What is the average number of births registered in Rongo Sub-County a year?
2. What is the average number of deaths registered in a year?
3. How would you describe the birth rate in Rongo Sub-County in the last 20 years?
4. In your own opinion, what factors do you think are behind the rise or decline in the birth rate within Rongo Sub-County in the last 20 years?
5. How would you describe the death rate in Rongo Sub-County in the last 20 years?
6. What is the average percentage of births belonging to immigrant parents registered in Rongo-Sub-County in a year?

Appendix VII: Field Observation Checklist

Indicator	Sub-Indicator	Sign of encroachment to other land use	Ward (Village)	Remarks
Type of Activity	Farming			
	Mining			
	Settlement			
	Forest/natural vegetation			
	Wetland/Riparian			
Amenities	Public schools			
	Public market			
	Community centers			
Utilities	Boreholes			
	Electricity lines			
	Water lines			
Accessibility	Motorable roads			

Appendix VIII: Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

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Date of Issue: 16/January/2024

RESEARCH LICENSE

This is to Certify that Mr.. FREDRICK NICHOLAS MWAI of Kenyatta University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Migori on the topic: Demographic Change and its Impact on Rural Land Use Dynamics in Rongo Sub-County, Migori County. for the period ending : 16/January/2025.

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