# Impacts of Rongo University Establishment and Development on Land Use and Land Cover Changes in Rongo Municipality, Migori County, Kenya

**George Ouma Ochola**

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## DECLARATION

This thesis is my original work and has not been presented for a degree award by anybody else in any University.

Signature……
Date……

**George Ouma Ochola**

**Reg. No: PEPM/6001/2015**

## APPROVAL

This thesis has been submitted for examination with our approval as university supervisors.

Signature…….
Date……

**Prof J.B. Okeyo Owuor**

Signature……
Date……

**Prof Daniel Nyamai**

## DEDICATION

This thesis is dedicated to my beloved wife Merine Ouma, my father Hezron Ochola and mother Penina Ochola for having given me moral support.

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## ABSTRACT

In the last two decades, there has been an exponential expansion in terms of the geographic distribution and demographic expansion of Universities in Kenya. The expansion of universities in space and time needs to be well planned in order to minimize adverse environmental effects such as mushrooming of informal settlements and slums caused by land use and land cover (LULC) changes. Rongo University has seen rapid increase in human population and development of infrastructure since its establishment in 2011. Except this study, the impact of such development in and around the university and in deed in Rongo Sub-County at large has not been well investigated. This lack of information hinders proper environmental planning and management of the mushrooming developments in this sub-county even as environmental degradation continues. The study's specific objectives were: i. to assess how the national policies and regulations have guided establishment of universities in Kenya; ii. to examine the nature and extent of LULC changes in Rongo University's local environment with reference to establishment and development of the university; iii. to assess the local environmental impacts resulting from LULC changes influenced by Rongo University and finally iv. to develop a spatial and environmental management plan to mitigate negative impacts of the University presence on the local environment. The study adopted mixed design method which relied on primary data from key informant interview, focus group discussions, field observations, geographic information system and remotely sensed imagery. Remotely sensed data was acquired through downloading the Landsat images from United States Geological Survey website. Supervised classification method was used where a shape file was created and Areas of Interest determined. The images were classified for the time interval that was 2010-2013 by drawing polygons with the help of colour key on the image using interactive supervised classification. Secondary data was gathered from already published literature through review. Thematic content analysis technique was used to analyze qualitative data from focused group discussions and key informant interviews. Quantitative data was analyzed by use of statistical package for social scientists. Remotely sensed data was analyzed by use of IDRISI Selva 17.0 in which the classified images in Arc map 10.3.1 were converted to ASCII for image display. The study established an increase of 48.52% in settlement from 2010 to 2018. Significant loss of 48.86% in plantation/farmland was also noted and open land decreased by 12.87% between 2010 and 2018. Similarly, the study has shown that there is greater need for public sensitization considering that 64% of the respondents contended that the state of the environment is changing from bad to good implying a change from a natural environment to a built up environment is preferable. The study concluded that there is inadequate compliance with existing legal framework and policy on land use and land cover resulting in mismatching development and environmental sustainability as demonstrated by environmental degradation. In this respect, the study recommends sustainable development which is informed by compliance to legal framework, monitoring and evaluation of environmental policy and regulations guiding land use and land cover changes. Similarly, Rongo University should showcase environmentally sustainable development initiatives in partnership with relevant authorities for instance, Rongo Municipality and Migori County government through outreach and information dissemination system.

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| | |
|---|---|
| CBO | Community Based Organization |
| CGoM | County Government of Migori |
| EA | Environmental Audit |
| EIA | Environmental Impact Assessment |
| EMCA | Environmental Management and Coordination Act |
| ERDAS | Earth Resources Data Analysis System |
| FGD | Focus Group Discussion |
| GIS | Geographic Information System |
| GoK | Government of Kenya |
| GPS | Global Positioning System |
| KII | Key Informant Interviews |
| LC | Land Cover |
| LCM | Land Use Change Modeler |
| LU | Land Use |
| LULC | Land use land cover |
| MCIDP | Migori County Integrated Development Plan |
| NEMA | National Environment Management Authority |
| NGO | Non-Governmental Organization |
| PPA | Physical Planning Act |
| RMB | Rongo Municipality Board |
| RU | Rongo University |
| RUMB | Rongo University Management Board |
| SPSS | Statistical Packages for Social Science |
| UNDP | United Nations Development Programme |
| WHO | World Health Organization |

## OPERATIONAL DEFINITIONS

**LU change:** This refers to the conversion or alteration of the original use of land in a spatial location to some other uses that addresses the needs of the developers.

**LU pattern:** This is the appearance and/or the design of development on a given parcel of land in form of structures.

**Quick fix:** Refers to the immediate response to provide urban services like housing, parking, market place or others to address the immediate need.

**University slums:** This refers to the haphazard development and sporadic placement of buildings and structures in the upcoming centre without following any planning designs. It implies settlements which do not meet housing standards set in the Physical Planning Handbook 1996.

**Urban planning:** This is the careful designing of urban LU to systematically serve the interests of the people. It involves stakeholder engagement in setting activities in space for development.

**Urban rush:** This is the hurried development of support services to augment the market demands especially housing and other utilities.

# CHAPTER ONE: INTRODUCTION

This chapter contains information of development of the universities globally and in Kenya. It gives a background on emergence of universities, their expansion and benefits which accrue from them.

## 1.1. Background of the Study

Many countries consider universities as institutions that spur their socio-economic, environment and physical developments and characteristics. Among other things universities offer education services that attract population's influx. In Kenya, the number of chartered public universities has risen from one (1) i.e. the University of Nairobi in 1970 to the current (2019) thirty seven excluding the private ones (Okong'o, 2014). The expansion of the university infrastructure remain a key factor which pulls large number of people especially students, business people and residents and call for accommodation and other basic services in the areas where they are located (Dindi, 2013). This situation is not only an important issue in Kenya but also the United States of America. For instance, the development of Boston city has closely been influenced by the establishment of two Universities; Cambridge and Harvard universities, founded in 1636.

According to Burton (1996) establishment of universities like Harvard have contributed immensely to community development through provision of financial support for local economic expansion. They have improved public health as a result of establishment of the health facilities which not only cater for service provision to the university employees but also to the neighborhoods. Other corporate social responsibilities that are enjoyed by the community around universities include transformative project, local roads, street-tree side walk improvements, meeting-houses, outreach programs and development programs such as creating a permeable campus that removes existing impediments to pedestrian circulation and includes street-facing, community-activating uses and schools (Akpan, 2006).

Similarly, Rowan University whose growth has revitalized enhanced and fueled economic development for towns such as the Glassboro town. New Jersey, United States is also a good example with new research centres, housing, small and medium enterprises, hotels,

among other developments as a result of partnering between the town management and the university as was contended by Okong'o (2014). Steinacker (2004) argued that among other contributors to city's economy, institutions of higher education such as urban colleges can be valuable in other ways. He considered them immobile institutions which are fairly resistant to business cycle fluctuations. As such, they are a steady presence in the community with immediate revenue coming from endowment funds, tuition and state tax allocations. It also creates significant human capital, students and employees, from a national and international markets leading to a growing economy.

In Kenya, Jomo Kenyatta University of Agriculture and Technology (1994), Kenyatta University (1985), Moi University (1984), Egerton University (1987) and Maseno University (2001) were all established in rural settings. These institutions have since attracted large populations of students and immigrants who now populate the areas leading to rapid changes in LULC changes and degradation of environmental conditions (Okong'o, 2014). During the establishment and development of various universities there also accrues their negative impacts, some of which are neither noticed nor recorded immediately. The general expansion of the university translates to general increase of its populace and upsurge of many small and medium enterprises. Bondinuba *et al.* (2013) asserted that current increase in enrollment of students in institutions of higher learning has become a major concern with issues of accommodation provision to students as well as other facilities within and/or off the campus. Private participation in housing provision for universities in developing countries has greatly contributed to urbanization process within and around the Universities.

Oanda & Jowi (2012) noted that the quest for education has risen based on development requirements and socio-economic demands causing increased enrollment of students in such institutions. This has also been instigated by competing for job opportunities especially in Kenya. Education support provided by the Kenyan government through Higher Education Loans Board (HELB) to universities and college students has improved access to university education by many and led to establishing more universities across the country.

Florian and Norma (2019) acknowledged a number of benefits provided by higher education institutions. However, they contended that these institutions are sometimes linked with negative environmental impacts as they are associated with sprawling development in their neighbourhoods. The sprawling developments have their externalities/negative impacts. The negative impacts posed to the surrounding environment in various ways include compromising the ecological roles in places that would be otherwise environmentally pristine and valuable such as aesthetic value. This in turn impact sustainable development of a region these institutions are established. Haphazard settlements around some Kenyan Universities created by such establishments give rise to slums leading to changes in land use and land cover (LULC) types as more areas fall to built-up facilities. Sustainable environmental planning and management is an essential element to reduce such negative impacts created by new and expanding universities and associated infrastructure.

According to sessional paper No.1 of 2017, Kenya's lack of a well-defined LU policy after years of independence had caused a haphazard approach to managing the diverse LU practices and policy responses. This policy notes that LU continues to be addressed through numerous uncoordinated legal and policy frameworks which have done little to unravel the many problems that affect LU management. In this regard, the study falls within the major goal of sessional paper No.1 of 2017 in striving to provide legal, institutional, administrative and technological framework for optimal utilization and productivity of land related resources in a sustainable and appropriate manner at community, county and national levels. The study intended to determine ways of realizing environmental sustainability, social responsibility, economic productivity and cultural conservation while establishing and developing university.

### 1.2. Problem Statement

The Kenya's Sessional paper No. 1 of 2017 (LU policy) asserted that besides labour and capital, land is the most important factor of production in Kenya. Further, it noted that a part from being a critical resource, land is also the foundation of economic development for the country. With this consideration and being an environmental resource, its sustainable use and management is crucial. Anything that disrupts, damages or degrades the

environment will negatively impact the very survival of all life forms as they depend on environment. Despite the positive impacts that accrue from universities, their establishment lead to LULC changes (Nyangau, 2014). In RU's local environment, the continued clearance of vegetation to give way for built up structures can cause changes in LC, cause soil erosion and also interferes with water and nutrient cycles. Equally important is over withdrawal of underground water due to increased water demand. Similarly, haphazard structures lead to development of slums around the university and is characterized by problems of both solid waste and effluents management. Kenya's LU policy (2017) acknowledged lack of a well-defined LU policy after years of independence. This caused a haphazard approach to managing the diverse LU practices and policy responses. As development activities continue, there is lack of adequate information that could quantify and qualify the temporal and special changes in LU and cover caused by the built up development in Rongo University neighbourhood. Rongo University was established in 2011 in a rural setting but the rate of development around it is high and lack supporting studies that can help in its proper environmental planning and management. For instance, Kitere market which is adjacent to the university is fast developing and informal settlements are evident in the area. There is no data related to this development even as other structures are being modified to suit different purposes. The university is located in a typical farm-lands environment but the ongoing transformations due to its existence are leading to changes in LU and cover as well as new infrastructure development. This situation requires proper planning an issue which has not been well studied. Similarly, there is a gap in policy specification for the externalities that are associated with establishment of the Kenyan universities such as RU because of lack of data that would relate the university establishment and the dynamics of LULC changes. Therefore, the study sought to address the existing knowledge gaps in order to realize university benefits without compromising environmental sustainability.

## 1.3. Objectives of the Study

### 1.3.1. General Objective

To determine ways of realizing environmental sustainability, social responsibility, economic productivity and cultural conservation while establishing Rongo University.

### 1.3.2. Specific Objectives

The study sought to achieve the following objectives:

i. To assess how the national policies and regulations have guided university establishment process as applicable to development of Rongo University.
ii. To examine the nature and extent of LULC changes in Rongo University and its local environments within Rongo Municipality.
iii. To assess the local environmental impacts associated with Rongo University's influence on LULC changes.
iv. To propose a spatial and environmental management plan for RU and its local environment in order to help mitigate existing or potential adverse effects resulting from the university development.

## 1.4. Research Questions

The study was guided by the following questions:

i. What are the policies guiding university establishment in Kenya and how do they apply to establishment of RU?
ii. What is the nature and extent of LULC changes caused by establishing RU in the local environment?
iii. What are the local environmental impacts associated with Rongo University's influence on LULC changes?
iv. What appropriate environmental spatial and management plan can be adopted in order to help mitigate adverse effects of the university on the local environment?

## 1.5. The Scope of the Study

The study was confined within RU's local environment within Rongo municipality covering 50.7sq kilometres. The areas included North Kanyajuok sub-location, Kanyawanga, West Kanyamamba and Koderobara in Rongo Sub-County, Kenya. It was limited to analyzing relevant environmental policies and legislative frameworks governing the university establishment at national and county levels and how these policies spurred the development of RU and ecological changes. It also examined the nature and extent of

LULC changes in RU's local environment since its establishment. Further, the study sought to establish associated environmental impacts of RU establishment and its influence on LULC changes in the study area. Finally, the study sought to determine opportunities that enable proper environmental planning and management in RU's local environment by proposing a spatial and environmental management plan for RU in order to mitigate any adverse environmental effects.

### 1.6. Justification of the Study

Environment is the major source of various natural resources that human beings and other organisms rely on. The roles played by natural environment such as air purification cannot be overstated. According to Melaku (2016), LULC changes result into modification of the area or a region's climate and biodiversity conservation. For instance, forests play multiple roles such as soil protection, purification of air, provision of raw and building materials, have medicinal value, and recharge the atmospheric moisture among others. Water, soil and minerals are also resources provided by the environment whose value to all life-forms cannot be understated. Therefore, lack of or inadequate environmental protection and proper management can result in negative impacts on the environment. Changes in LULC may lead to environmental degradation which not only impact negatively on humans but also other living organisms (Cheruto *et al.*, 2016). Appropriate measures are therefore required to mitigate possible negative impacts associated with LULC changes. This study therefore investigated the drivers, nature and extent of land use and cover changes which have taken place as a result of RU establishment so as to inform the development of sustainable LU management and environmental planning. It also filled the existing knowledge gaps in this hitherto not studied in RU and its surrounding.

### 1.7. Significance of the Study

The study contributed critical knowledge and information/ data needed for sustainable physical and environmental planning based on these accounts:

- Provides information/data for LU policy making at County and National level which will be used for designing a more effective and appropriate plans for LULC management within the university neighbourhoods.

- Contributes to the improvement in environmental management in developing urban centres around universities hence enabling community access improved services.
- Provides opportunities to the private sector to engage in delivery of environmental resource management.
- Valuable decision processes by volunteers willing to support developing urban centres like Kitere shopping centre with financial and technical support make informed choice.
- Exposes issues for further research in related fields, for instance delivery of similar urban services.

# CHAPTER TWO: LITERATURE REVIEW

This chapter presents information gathered from secondary sources including books, maps, physical plans and survey records, journals, reports, charts, government documents and other relevant documents relating to policies guiding development activities such as establishment of universities, LULC, LU planning, and impacts of land use and land cover changes.

## 2.1. Policies and Legislative Frameworks governing urban development in Kenya

Several sessional papers and control processes governed by various pieces of Legislation are embraced for urban development in Kenya. These include: the Constitution of Kenya 2010, the Physical Planning Act 2012 Cap 286, The Physical and land use Act of 2019, Urban Areas and Cities Act No. 3 of 2011, Environment Management and Coordination Act 1999, Land Control Act Cap 302, National Land Commission Act 2012, the Land Registration Act 2012 and the Land Act 2012, and the Sessional Paper No.3 of 2009 on the National Land Policy, among others. According to Dindi (2013), establishment and development of institutions of higher learning such as universities in most cases are linked to transformation of their surroundings/neighbourhoods into informal settlements. Akpan (2006) also had a similar view when he examined the impacts of urbanization and institutions of higher education on Houston Texas. Similar concern was also reported by Florian and Norma (2019) while they were assessing the impacts of higher education institutions of sustainable development. This is due to unplanned for sprawling development influenced by these institutions. This has been witnessed in areas occupied by Kenyatta University, Baraton University of East Africa and Rongo University whose neighbouring Kitere shopping centre is developing into a university unplanned town/slum. The structures coming up in these centres have little to do with planning and hence rise of haphazard developments. This type of development is contrary to the provision of Urban Areas and Cities Act, Physical planning Act and Environmental Management and Coordination Act of 1999 and reviewed 2015.

NEMA, through Environmental Management and Coordination Act (EMCA) of 1999 provides that all new projects should be subjected to Environmental Impact Assessment (EIA) before it is given an approval for initiation. Article 42 of the Constitution of Kenya

(2010) entitles every person the right to clean and healthy environment. This includes having the environment protected for the benefit of the present and future generations through legislatives and other measures. Article 69 of the same constitution provides obligations under which the environmental resources should be protected. Clauses 184 and 176 (2) of the Constitution of Kenya 2010 provide for regulation of urban areas and cities. Clause 200 (2) outlines the governance of the capital city, other cities and urban areas. Similarly, Vision 2030 advocates for a nationwide urban planning and development. Considering these provisions, if sustainability of urban development is to be realized, then planning should be proactive.

Nabutola (2012) argued that rapid increase of urban population is not an issue to be whispered since it is evident to all humanity. Unfortunately, the rapid growth is taking place without corresponding capacity of the cities and towns planning and management institutions to guarantee sustainable urban livelihoods. The existing urban planning and implementation tools have not adequately provided an orderly and attractive urban environment in Kenya (Dindi, 2013). Among the examples he highlighted included environmental problems such as poor waste management, squatter's settlements, the proliferation of slums, incessant collapse of buildings, competing LUs, traffic congestion urban sprawls and ribbon pattern of development.

Haphazard development comes as a result of the settlement drawn by the establishment of universities which in turn leads to unplanned changes in LULC that generally impact on the environment. According to Njiru (2016), urban areas play a critical role in national development. It is estimated that urban areas contribute 70 percent of the Gross Domestic Product (GDP). It is important therefore to harness the huge potential of urbanization as a vehicle for growth and development while at the same time fully addressing the challenges caused by such growth. Kenya has faced a lot of challenges in terms of urban development owing to inadequate follow up activities in implementation of a comprehensive national urban policy framework. There has been a challenge since the past sector policies failed to adequately address the nature of evolving urbanization system that could foster development and economic growth (Okong'o, 2014). The policies failed to integrate urban

and rural development in a mutually beneficial relationship hence leading to challenges being realized today.

The Physical Planning Act of 1996 and now repealed Local government Act CAP 265 have been guiding the urban centres' development in Kenya. These Acts have right provisions and stipulations but follow up in their implementation had proven to be a nightmare. Thus they have not adequately addressed the myriad urbanization challenges. Streamlining, implementation and proper follow up of Urban Areas and Cities Act of 2011, the physical Planning Act Cap 286 of 1996 and the Constitution of Kenya 2010 may help realize proper management, governance and sustainable urbanization. The revised Physical Planning Act 2012 CAP 286 has not provided clear reference to the plan users but stipulate the preparation of physical development plans which is a preserve of the regional or local director.

Despite the availability of the Urban Areas and Cities Act of 2011, development of urban centres still lags behind in terms of adoption of what they envisage. As stipulated by the Act, the development should bring better social infrastructures and services that integrate both rural and urban development, improved opportunities and increased choices of survival but little is being realized especially with reference to recent universities' proliferation in Kenya. The Acts lack provisions for prior plans to designate areas where a university is to be established. As such what is referred to 'urban rush' cannot be avoided. This situation is characterized by 'quick fixing' development as a mean of tapping the overwhelming demands for various goods and services (Okong'o, 2014). Consequently, realizing the sustainable urban development whose features are highlighted by the United Nations Development Programmes of 2011 to address thematic areas such as urban governance and management, national and county urban planning, social infrastructure and services, urban housing, urban finance, urban safety and disaster risk management physical infrastructure and services, environment and climate change, and marginalized and vulnerable groups and urban economy still remains a challenge whose resolution is yet to realized.

In the framework of the National Urban Development Policy, there are several provisions including development and management of education and health facilities, planning, public

open spaces, parks and recreational facilities, including sports amenities. Planning and development of the much-needed physical infrastructure and services are major priorities in the policy for sustainable urbanization (Njiru, 2016). This notwithstanding, university towns grow short of these planning guidelines despite them being important pull factors to urban development. This leads to rise of informal settlements even though the policy recommends mechanisms to deliver affordable housing of acceptable quality as a way of responding to housing demands.

### 2.2. The Establishment and Accreditation of Universities in Kenya

Previously, establishment of universities was done through the Acts of parliament. The new dawn came in 2012 when the Universities Act was passed. This took over from the Acts of parliament and since then establishment is under the Act, i.e. Kenya Gazzette Supplement No. 192 (Acts No. 42) Universities Act 2012. Establishment is done through a charter as provided in section 13 of this Act. The growth of university in Kenya can be traced back to colonial government period before the year 1963 when Kenya got its independence. The study noted that until 1970, there was no specific Act guiding university establishment in Kenya.

University education in Kenya has its origin from the colonial government's plan of 1947 which sought to put in place a commercial and technical institute in Nairobi with the aim of boosting knowledge and skills (Bailey *et al.,* 2013). The plan was altered in 1949 where a decision was made that the institute was to combine the three territories of East Africa that is Tanzania, Kenya and Uganda in provision of higher technical education. Royal Charter for this concept was only received in 1951, naming the institution as Royal Technical College of East Africa (RTCEA) initially intended to provide instructions in the courses which could lead to the Higher National Certificate accessible in Britain as was noted by Ngome (2003). The college was also to prepare enlisted students for various university degrees in engineering and commercial courses which were not offered in Makerere, Uganda.

In 1956 the RTCEA made its first intake and became the first institution of higher learning in Kenya (Bailey *et al.* 2013). They noted that in 1958, the party which was in power made a proposal which was endorsed by the East African governments that the college be

transformed into the East African second Inter - Territorial University College. This took effect in 1961 when the RTCEA was transmuted into the second university college of East Africa and was retitled the Royal College of Nairobi (RCN). In 1963 when Kenya attained its independence, the RCN was elevated and became a University College of Nairobi in 1964. This was due to the establishment of the University of East Africa with three constituent colleges that is Nairobi, Dar-es-Salaam and Makerere. Accordingly this became the first step in the introduction and development of university education in Kenya.

In 1970 the University of East Africa became the University College of Nairobi and by the Act of Parliament (1970 University of Nairobi Act) was transformed into the University of Nairobi (Nyangau, 2014). In 1972 a teacher training institution, Kenyatta College became a constituent college of University of Nairobi. The Kenyan government produced a blue print after her political independence in 1963 to help guide or provide direction in development in the country.

This document was known as ***'African Socialism and Its Application to Planning in Kenya'***. This blue print acknowledged training and education to enable skilled manpower form part of the development process pillars of Kenya. This blue print underscored the need for sufficient trained, skilled, and experienced manpower supplies for economic growth to be realized. Based on this fact, training and education provision to all Kenyans became a necessity and was considered fundamental to the realization of government's overall success in development strategy (Bailey *et al.* 2013). The long term objective for higher education policy document of 1963 was to enhance the Kenyans' ability in preserving and utilizing the environment for sustainable livelihoods and productive gains. Therefore it is important to note that since independence in 1963, the Kenya government has placed a lot of importance to the quality human resources as it was considered crucial in attaining the national development goals and industrial development.

To enhance growth of universities in Kenya, the government appointed Presidential Working Party in 1981 which recommended and oversaw the establishment of Moi University as a second university in 1984 as was established by Ngome (2003). This was followed by elevation of Kenyatta and Egerton University colleges to full universities in 1985 and 1987 respectively. In 1985, Kenya enacted a University Act Cap 210B through

parliament. This Act was to enhance provisions for the advancement of University education in Kenya and for connected purposes. In the same year, University of Nairobi Act was enacted by parliament to amend and consolidate the law providing for the establishment of the University of Nairobi and its control, government and administration; and for connected purposes. A further growth in number of public universities in Kenya was registered after 1990 due to increased demand in access to university education as was noted by Nyangau (2014). By the year 2007, the number of fully fledged public universities in Kenya had gone up to seven from four in 1987 including Jomo Kenyatta University of Science and Technology in 1994, Maseno University in 2000 and Masinde Muliro University of Science and Technology in 2007, Jaramogi Oginga Odinga University of Science and Technology (JOOUST) in 2013. Rongo University was established as a Constituent College of Moi University through RU College Order 2011 (Legal Notice No. 70, of 17th June, 2011). It was inaugurated and handed over to the University College Council on July 23rd 2012 by the then Ministry of Higher Education Science and Technology and chartered on 7th October, 2016.

As highlighted in the Kenyan University Act Cap 210B of 2012, it is clear that university establishment guidelines have an omission in consideration of the spillover effects arising from sprawling development and externalities that normally come with university establishment. Lack of cooperation between the universities and their surroundings in the policy guidelines has led to recurrence of unplanned changes in LULC which come as a result of rapid slum development within the environs of the universities (Okong'o, 2014). Consequently, proper and adequate planning should not fail to include anticipated human activities and other developments attracted by the establishment of the universities.

### 2.3. University Establishment and Land Use Changes

Cheshire &Sheppard (2002) and Walsh (2007) were in agreement that regulation of LU can take various forms. In their argument, density regulation, zoning and other direct LU controls fall under the traditional command and control approach. Substantial social welfare loss may still be realized despite the effectiveness of LU policies as regulatory tools. This may be seen in smaller houses, higher housing prices and inefficient LU patterns.

In order to influence private LU decisions, some governments have resorted to use of incentive-based policies which may comprise purchases of development rights (PDRs), direct conservation payments, development impact fees and preferential property taxation. For instance, Trust for Public Land of 2007 indicated that from 1998 to 2006, there was an approval of 1,197 conservation initiatives in local and state referenda in the United States by voters which provided a total $34 billion for land and open space preservation. According to the U.S. Environmental Protection Agency report of 2007, locally based, long-term conservation plans should be emphasized, implemented and touted as a critical element in achieving smart growth.

Wu & Irwin (2008) emphasized the overwhelming advantages of the incentive-based approach which has direct LU control. Taking a development impact fee for example, they argued that this can be used to achieve both pattern of land development and the optimal pace which is a shortcoming of zoning regulations. Nevertheless, preference can be given to zoning in cases where the environmental costs of land conversion are highly uncertain. Junjie (2008) recorded that non-linear and threshold dynamics are likely to exist in situations where human and the natural systems interact in complex ways. Under such conditions, very high environmental costs and sensitivity to additional development are recorded. Zoning is necessitated in such cases. The Kenya development policy omissions remain a challenge in realizing sustainable environmental management in various institutional neighborhoods.

Despite the increased expenditure on LU conservation related programmes over the last two decades, a clear vision of LU management is yet to be articulated by the governments as was suggested by Daniel *et al.* (2002). There remains considerable variation in the level of control across the counties and municipalities as most LU controls still rely on the hands of local governments with some having fewer LU controls while others are overwhelmed in active planning and regulation for LU.

As was articulated by Njiru (2016) in most communities experiencing rapid urbanization, regulation of LU has become a contentious issue. It is imperative that through proper planning of LU is when wildlife habitat, water quality, farmland, open space, and forests are protected. Equally, human health and property value are also improved. It has been

established that destruction of the natural environment is also realized due to uncontrolled development. Greed should be shunned for the protection of our environment. Instituting stringent LU regulations that may hinder the function of market forces is therefore imperative for policymakers. Similarly, policy makers should resist at all costs the temptation to attribute all irregular LU patterns to market failures. Identification of the sources of market failures that cause excessive development should be the central role of policy makers so as to help address problems at their roots. In LU regulations, there should be an equilibrium point where rights of private property balance public interest (Akpan, 2006).

### 2.4. LULC Changes

According to Meyer and Turner II (1996), LU is described as the use to which the land is assigned. This could be agriculture, grazing, mining, urban development and logging among others. Turner II *et al*. (2007) defined LC as the biophysical state of the earth's surface and immediate subsurface. This definition was acknowledged by Briassoulis (2006). In 1995, Meyer asserted that LC comprises cropland, forest, wetland and pasture. Melaku (2016) defined LC change as the modification of the existing LC or complete conversion of the LC to a new cover type. LULC changes are closely related terms which are frequently being used interchangeably or in some cases one can be easily confused with the other. They associate LC with the purposes for which lands are being used. That is whether the land is used for agricultural, as forest, residential, or industrial. The causes and consequences of LULC change are linked with the understanding of relationship of the two terms since LU change is the proximate cause of LC change. Meyer and Turner II (1996) established that LU change may directly affect LC whereas change in LC might not alter LU.

The existing linkage between land-use and LC changes is that both impact negatively on the environment which in turn contributes to local, regional and global climatic changes. Thus need for emphasis in the inter-linkage and their analysis which necessitates examination on how they relate at various levels of spatial and temporal detail. According to Chiwa (2012), local level LU change may not produce significant local LC change and consequently, no significant environmental impact nevertheless they may accumulate

across space or over time and produce significant LC change at higher (e.g. national regional, or global) levels. A good example of such is turning agricultural land to serve urban uses which involves various individual land owners who convert their farmland to non-farm uses (Musa and Odero, 2015).

Manal and Patil (2017) described LULC change as changes in structure and function (qualitative) and change in the areal extent (quantitative) of a given type of LU or cover. Different scholars have postulated that there are two distinct LC change (Cheruto, 2017). These include conversion and modification. The former means a change or replacement of one cover type to another while the latter implies alteration of structure, function or composition without changing its overall classification or the type. According to Skole (1994), Minal & Patil (2017), modification could comprise change in productivity, biomass, or phenology. Lambin (2004) stated that technological, scenic, demographic and economic are some of the driving forces in LULC changes. Specific human activities that lead to LC change include agriculture, transportation, settlement, manufacturing, recreation uses, infrastructure, parks, fishery and mining, among others. Gonzales (2009) asserted that LU change encompasses conversion from one type of use to another. According to Jones & Clark (1997), modification of a particular LU may involve change in the intensity of this use as well as alteration of its characteristics qualities/attributes. This could comprise extensification, marginalization, intensification and abandonment as qualitative typologies in agricultural land-use.

Qian *et al.* (2007) posited that with regards to global environmental concern, LULC change is critical. Growth in human population, expansion of urban centres, need for more productive land, scarcity of land, changing technologies constitute drivers of LULC change in the world (Cheruto *et al.,* 2016). This was also asserted by Barros (2004). Masek *et al*., (2000) established that demographic and environmental conditions together with cultural, socio-economic, political, and other forces which are associated with high human population form major drivers of LULC changes. Cheruto *et al* (2016) affirmed in their study that LULC changes have informed a number of researches and has also become a major concern for both decision makers and researchers globally.

Ginblett (2006) study supports the findings of the previous researches which posited that changes in LULC has informed a global debate. The previous studies linked these changes with human activities on the environment. An example is construction of a residential structure on agricultural land that not only leads to LU change but impact also on LC. The implication of this is that cumulative impacts may lead to climate change considering that the vegetation are contributors to atmospheric moisture recharge and also act as carbon sinks (Ginblett, 2006). Steffen and Tyson (2001) posited that increasing concentration of carbon (iv) oxide in the atmosphere, conversion and fragmentation of natural vegetation areas, biodiversity loss, and accelerated emission of greenhouse gases are some of the indicators of LULC changes that are evident in the current major global concerns.

Agarwal *et al* (2002) also argued that the dynamics of LULC changes are widespread. They postulated the changes are processes that are accelerating, significant and are majorly driven by human actions. They articulated that as a result of these LULC changes, human livelihood is also affected. Bruijnzeel (2004) argued that the availability of natural resources such as water, vegetation and soil are being modified by LULC changes.

Integrity of natural resources and the ecosystems has been compromised due to the rapid increase in population over the years. Kenya for instance has only 20 percent of arable land and approximately 75 percent of the Kenyan population relies on agriculture. As a consequence, pressure has been imposed on land resources to help meet the needs of the rising population. More land is being cleared for cultivation especially in the wetter margins of rangelands. Decline in grassland and deforestation, charcoal burning, overgrazing, have been witnessed. These directly imply unsustainable use of land resources (Campbell *et al.*, (2003). Depending on the context of the use and purpose for application, description and definition of land-use or land cover and their changes vary (Gonzales, 2009). He defined LU as the purposes for which humans exploit or immediate actions modifying or converting the land and its resources/covers.

Understanding of LULC change is imperative as it enables the comprehension of the earth's surface and immediate subsurface changes (Tumebo, 2017). That is, the magnitude, pace, and spatial reach due to human impact. Major LULC changes are human induced even though natural processes also impact. This was asserted by Mwathi (2016). Volcanic

eruptions, rise in sea level, change in river channels together with climatic variations are some of the natural processes that underpin LC changes. The human actions cause alteration of the earth's surface and are unprecedented (Lambin, 2004). Human prompted changes in LULC started with his multiplication existence on earth. LULC change leads to degradation of land since it enhances exposure of land to erosion hazard. Generally the human factors that lead to LC changes are agriculture and settlement as was postulated by Turner II *et al.* (2007).

Gonzales (2009) postulated that over the past 50 years, human LU has changed ecosystems more rapidly and extensively than in any comparable period of time in human history. The change in LULC is directly linked to rapid growth in demand for natural resources as was observed by Watson & Zakri (2003). Degradation of the natural ecosystem functions is a clear evidence of LC change since ecological roles are compromised resulting in LULC change. It is therefore imperative to understand the implication of the two for environmental conservation and protection. Similarly, recognition of the services provided by the natural ecosystem is equally critical (Melaku, 2016).

Bossel (1999) argued that studying environmental functioning and human impacts on it still remains a challenge since the development of appropriate indicators capable of providing the required information on a system's viability and its changing rate and how that influences the overall system's sustainable development is a critical issue whose achievement is yet to be established.

Almost every individual knows the benefits that accrue from land in terms of support to human activities and other living organisms. It supports growth of crops which human depend on and it is also a resource where minerals are extracted. Other benefits include waste assimilation and regulatory services that it offers. Influence and interaction of human needs and environmental processes and features are the two sets of forces that dynamically shape LU. Argawal *et al*. (2007) argued that LU changes occur at various spatial and temporal levels and these changes are at certain times beneficial while may be detrimental at other times. Their being detrimental affect the structure and functioning of ecosystems and ultimately, the earth system as well as the human well-being as was established by Turner II *et al*. (2007).

The accumulation of LULC change impacts may be at global scale and status though not physically connected through a globally operating system FAO (2016). Meyer & Turner II (1996) stated that biodiversity loss, land degradation, deforestation, desertification, and wetland drainage have all amounted to a globally significant alteration of the LC class involved. While analyzing LU change, it is imperative to determine their causes and drivers, socio-economic and environmental impacts (Tumebo, 2017). Biophysical and socio-economic are the two main categories widely accepted drivers of LU changes Framer-Browers *et al.* (2006). They asserted that the biophysical drivers are characterized by landform, climate variation, plant succession and geomorphic process, soil process and types, drainage pattern among others. On the other hand, the socio-economic determinants encompass economic, social, demographic, political, technological, market and institutional factors and their processes. Further, he argued that environmental and socio-economic categories of LU changes impacts are interlinked. The environmental impacts cause socio-economic impacts which then feedback to the environmental impacts potentially causing succession rounds of LU change.

### 2.5. Causes of LULC Changes

According to Rudel *et al. (*2005), factors that underpin LULC changes are specific to a location. Framer-Browers *et al* (2006) asserted that these factors fall into two categories which include mega driver and environmental factors. We might not have control over the environmental drivers of factors that cause LULC changes. The mega driver may include farm practices like sugar cane plantation and other related agricultural activities carried out on large tracks of land. On the contrary environmental factors include the poor soils, the migration of various living organisms such as birds and other wild animals. In general, the mega factors are human activities that impact LC as a result of changes in use on the land. A good example is the conversion of agricultural land to residential areas which translates to loss of vegetation cover as vegetation is cleared to create space for establishment of various structures (Musa and Odero, 2015).

### 2.6. Land Use Planning

Land use planning is a regulatory process aimed at achieving the desired environmental and social outcomes in the use of land by a central authority. It is also done in order to realize a

more efficient use of environmental resources. According to Nabutola (2012), the purpose of planning LU is to help ascertain alternatives for LU which can be selected and adopted for the best options. It aims at allocating LUs to meet the people's economic and social needs while safeguarding resources for future use. Physical and LU planning exercises provide a forum in which the interests of multiple stakeholders as well as the physical, social, and economic constraints on LUs can be debated and balanced. According to Okon'go (2014), LU and physical planning have an integrative function. The United Nations (2010) in its Handbook for Reconstructing after Natural Disasters, provided that LU plan should incorporate Environmental Planning, Infrastructure and Services Delivery. Other things it should incorporate include Housing Cultural Heritage Conservation and Design and Construction Technology. These must be addressed comprehensively during any meaningful planning process. Zacharias *et al.* (2013) argued that decision makers are often discouraged from attempting a planning process by lack of institutional capacity. Even though a planning process usually presumes both the existence of a legal and institutional framework to mandate the process and the professional capacity to implement the prepared plans, in some cases these presumptions are overlooked since they are not absolute prerequisites. Similarly, lack of information is frequently put forward as a reason to forgo planning.

Akpan (2006) posited that rural development through dispersal of universities to the remote areas should transform the village locality into a nascent urban centre with improved socio-economic, cultural, environmental and physical characteristics that impact positively on the village. They stated that regeneration of urban-village space by the villagers themselves and by educational development projects initiated by the government and private entities need the attention of academicians, policy makers, and the media. According to them, the rapid build-up in the small towns accompanied by substantial population increase transforms local economy, and the extreme densification of inhabited village space.

### 2.7. Impacts of LULC Change on the Environment

Urban development, deforestation and agriculture among other human activities are considered to be the factors that have substantially altered earth's land scape. They negatively affect ecosystem services and processes that are of great importance not only to

humanities but also other life forms. As such wide range long-term aftermaths are realized in various areas where such alterations have been realized. Changes in LU are perhaps the most inescapable socio-economic power driving alterations and ecosystems degradation as was argued by Marland & Paquin (2004). Marland and Paquin contended that local, regional and global atmospheric carbon concentration may be affected by disturbances such as vegetation loss leading to climate change.

According to Czech *et al.* (2000) farm-lands play a critical role in providing habitats for various micro and macro-organisms (wildlife). Altering the use of farmlands into settlements leads to loss of natural habitats which might in turn lead to extinction of some species of organisms. In this regard, conservation of agricultural/farm land is not only for food production reasons but also for the conservation of biodiversity and genetic resources. Therefore conservation of farmlands should be a prerequisite for sustainable development. Contrarily, human activities have been claiming the farmlands transforming and modifying them into built up environment. The extensive agricultural practices for the purposes of food production have also resulted into severe ecosystem repercussions. Uchendu *et al.* (2016) also contended that the alteration of LUs and subjecting land to intensive farming may at times impact negatively on water resources by causing contamination or pollution. For instance the agro-chemicals used in the farms have potential to contaminate or pollute the environment. Further, they posited that conservation of wetlands for irrigation water diversions purposes has threatened wildlife species with extinction. In their view, decline in biodiversity decline and extinction of species is mostly influence by habitat modification, alteration and destruction.

Melaku (2016) postulated that forests play very important roles in purifying the air, controlling the soil erosion, offering habitat to wildlife and contributing to completion of water cycle. They also asserted that some species of plants are herbs and vegetation in general help in interception and storage of water. In this regard their replacement compromises such roles. Further, they noted that sprawling developments around towns and other institutions form the major drivers of which substantially alter LC. Also, they posited that vegetation controls the amount of carbon dioxide in the atmosphere hence anything that disrupts vegetation cover tends to increase accumulation of carbon dioxide in

the atmosphere. Junjie (2008) also emphasized on air pollution associated with LULC changes. He argued that as a result of loss of vegetation cover, more greenhouse gases find their way into the atmosphere. In his view, loss of vegetation cover also reduces the amount of atmospheric moisture. Also, he noted that many vehicles in urban areas and institutions of higher learning are contributors to exhaust fumes emitted into the atmosphere whose accumulation may lead to global warming.

## 2.8. Theoretical Framework

### *LULC Change Detection Theory*

According to Briassoulis (2006) LU change theories can be classified into three. These include; nature-society (human-nature), sociological (political economy) and the urban and regional economics theories. The three categories are concerns of human role in instigating global changes in environment. Further, Minal & Patil (2017) argued that LU change is the outcome of complex interconnections between bio-physical and socioeconomic powers between space and time. He emphasized that it is impossible to tackle the complexity for practical reasons like making policy and management of land to realize sustainable LU unless simplification of the relationships in the complexities are achieved, manageable and made in an understandable dimensions. Considering the above constraint, it is imperative to define a LU change model which expresses operationally the relationships between the main factors of interest as Turner II (1995) postulated.

As was articulated by Lambin (2004), models along theories can be conceived simultaneously and can be applied in place of each other to signify theoretical and working statements based on real situations as expressed by von Thunen's and Alonso's theories and models. Briassoulis (2006) deputed this argument asserting that there is a lack of a clear theory in several models. Singh (1996) established that theories of change detection attempts to identify differences in the state of an object or phenomenon by observing and quantifying it at different times. This was further affirmed by Lu *et al*. (2004). Detection of change in LULC is crucial for monitoring earth's surface features changes in order to understand connections and interactions between the environment and human activities for better management and use of natural resources (Lu *et al*. 2004). As Chiwa (2012) puts it

change detection comprises the application of multi-temporal datasets which are mostly remotely sensed to quantitatively analyze the temporal effects of the phenomenon.

Principal component analysis, image differencing and post-classification comparison are the methods commonly used in detecting LULC changes (Cheruto *et al.,* 2016). Some scholars have highlighted that LU changes of the multi-temporal images are usually complex and non-linear. Non-linear change detection theories and techniques have great importance in resolving change detection. Jianya *et al*. (2008) stated that there are two groups in which a general overview approaches in change detection approaches can be characterized. These include; the bi-temporal change detection (direct comparison, post-analysis comparison and uniform modeling) and temporal trajectory time series analysis. According to Minal & Patil (2017) the bi-temporal change detection evaluates changes on the basis of a simple 'two-epoch' timescale comparison. Temporal trajectory examines the changes on the basis of a 'continuous' timescale, with major focus on both alterations between dates and the evolvement of the change within a specified period of time.

Tumebo (2017) stated that provision of spatial distribution of changed types, area change and change rate, change trajectories of land-cover types, accuracy assessment of change detection results are some of the features of a good change detection research. He added that cross-tabulation and cross-classification using two geo-referenced images of the same area, taken at different dates and classified to the same set of *N* classes is the straightforward method to detect changes in terms of thematic classes. Eastman (2006) established that LU Change Modeler (LCM) algorithm which is based on processing problems associated with accelerated land alteration and a particular analytical requirement of biodiversity conservation is one of the important tools to analyze LULC changes. He argued that the fact that LCM is structured around a set of five major task areas that includes: forecasting the course of change into the future, assessing its consequence to biodiversity, analyzing earlier LC change, evaluating planning intercession for maintaining ecological sustainability and modeling the prospective land alterations makes it suitable. The study adopted a temporal trajectory time series analysis as one of the Non-linear change detection theories. This theory allows for change examination on the basis of a

'continuous' timescale, with major focus on both alterations between dates and the evolvement of the change within a specified period of time.

### 2.9. Gap in Literature

A number of research studies have been done on LULC changes including the factors contributing to these changes and even use of remote sensing and GIS to monitor these changes. The existing scholarly works which have been documented have inadequately addressed establishment of higher learning institutions such as universities as drivers of LULC changes. The University Act Cap 210B of 2011 which was adopted in Kenya in the year 2012 also did not take into consideration the developments and their associated externalities such as rise of informal settlements around the universities. Also, Urban areas and Cities Act No. 3 of 2011 has not provided for the control of these sprawling developments and measures to be adopted to control them. Similarly, Kenya's LU policy (2017) acknowledges that the existing LU data is outdated and inadequate considering the fact that data was developed during the colonial times. According to this policy, this data had not been updated to match the changing circumstances. The policy also noted that access to LU data is limited to a few institutions which generate them with little dissemination to the public. The policy also acknowledged a haphazard approach to managing the different LU practices and policy responses due to absence of a clearly defined LU policy in Kenya after years of independence. In this regard, LU continues to be addressed through many uncoordinated legal and policy frameworks which have done little to unravel the many issues that affect LU management. Thus this study sought to address the existing gap as a basis and foundation for generating new knowledge and information critical for sustainable development and environment.

### 2.10. Conceptual Framework

This study was premised on mapping out the actions required and understanding linkages between university establishment and LULC changes. The study relates university establishment with LULC changes. Rise in number of settlements in most places where universities are established is always evident. The university itself requires learning and accommodation facilities to support its functions. During establishment of the aforementioned facilities, vegetation (LC) is lost. When LC is lost it exposes the soil to the agents of erosion. In the process, the ecological role played by the vegetation which is cleared to pave way for

settlements is compromised. In some instances, development within and around the university may claim a parcel of land which was initially covered with trees/forest or farmland. Consequently, LU change is realized. In order to realize sustainable university education, development policies must be embraced. Universities are stakeholders in policy development and implementation. The policies must be adopted and properly implemented. Having appropriate policies, political good will, willingness of public participation in policy adoption and implementation enables delivery of environmentally sustainable university education. Failure to embrace policies or when poorly implemented can result into haphazard development which not only impact human health but is also detrimental to the environment. Policy failure and inadequate planning to deliver education services can be counterproductive. It may lead to rise of university slums, increased accumulation of carbon dioxide due to loss of vegetation, land fragmentation and loss of biodiversity and genetic resources. Figure 2.1 presents a conceptual model which represents the synthesis of existing relationships based on available information and knowledge from the study's perspectives.

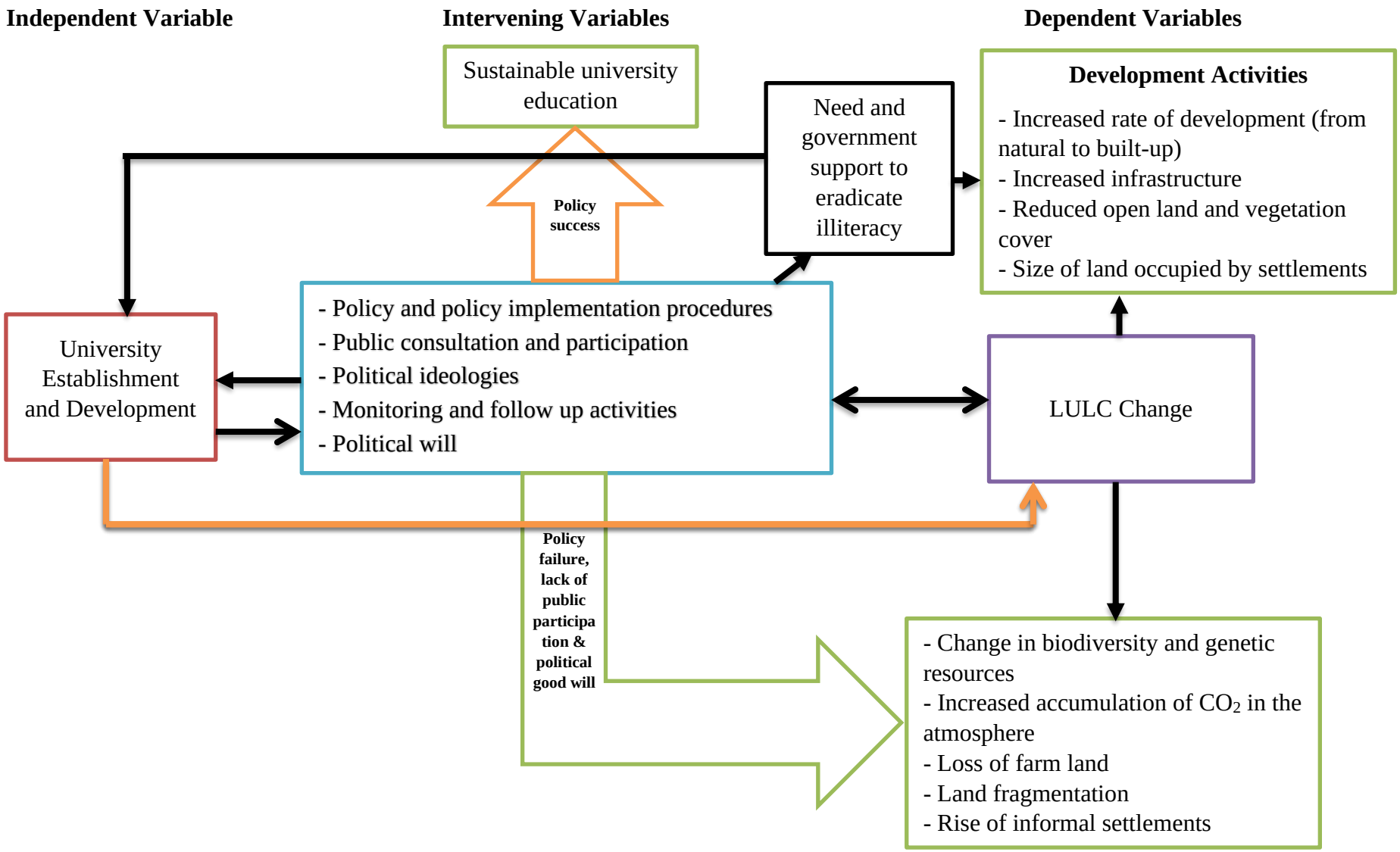


**Figure 2.1: Conceptual Model for University Establishment and LU LC Change**
*Source: Author, 2021.*

# CHAPTER THREE: RESEARCH METHODOLOGY

## 3.1. Study Area

The study was confined to RU and its local environment within Rongo Municipality. The areas it covered included North Kanyajuok, Kanyawanga, West Kanyamamba and Koderobara with a total of 50.7sq km. The university is situated on a high land of Kitere Hills in the South Western part of Kenya in South Kamagambo Ward, North Kanyajuok, Rongo Sub-County, Migori County. It is 2.5 kilometres to the left off Rongo-Migori highway and 11 Km from Rongo town. The university started after collaboration that lasted for five years between Moi University and Moi Institute of Technology. It was started as Moi University's Constituent College. Its establishment was through RU College Order of 2011 (Legal Notice No. 70, of 17th June, 2011). RU was under the University College Council after it was instated in 2012 by the then Ministry of Higher Education, Science and Technology. It was chartered in October, 2016. Figure 3.1 presents the location of study area in a national (Kanya) context. The study area is marked red within the map of Kenya. The area shown in red is Rongo sub-county where the area of focus in the study is situated. The figure also presents the location of the study area within the context of a sub-county, Rongo. It appears as a blown circle on the right side of the figure. The larger green image between the two circles is the map for Rongo sub-county.

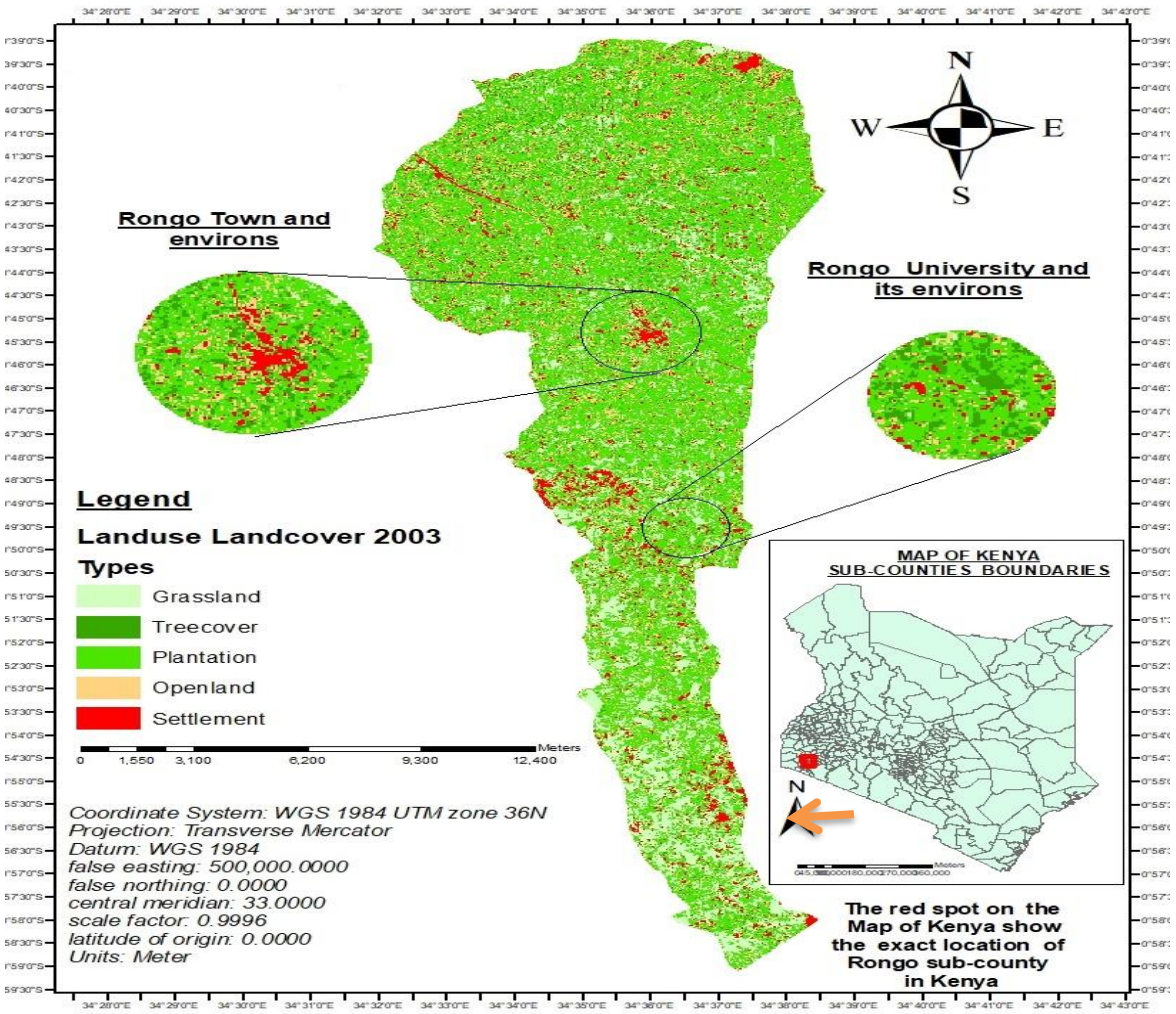


**Figure 3.1: Study Area in a sub-county context**
*Source: Author, 2021*

Rongo sub-county has four assembly wards which include North Kamangambo, Central Kamagambo, East Kamagambo and South Kamagambo. Their location and geographical extent is as depicted in figure 3.2. As mentioned at the beginning of this chapter, the major area of focus in this study was South Kamagambo where RU main campus is situated even though other administrative units such as Central Kamagambo which covers Rongo town were also considered in that establishment of the university affect their development. The consideration of these administrative units was based on their accommodation of various university facilities such as information offices in Central Kamagambo ward. In the same context, North Kamagambo and East Kamagambo wards form part of the regions whose potential for development has been seen by many people as a result of the establishment of RU. They were perceived to be attracting individuals from various corners of Kenya for

business and development reasons since they border the ward hosting RU, South Kamagambo ward hence source of land and other materials for development. Figure 3.2 shows the four wards and their sub-locations.

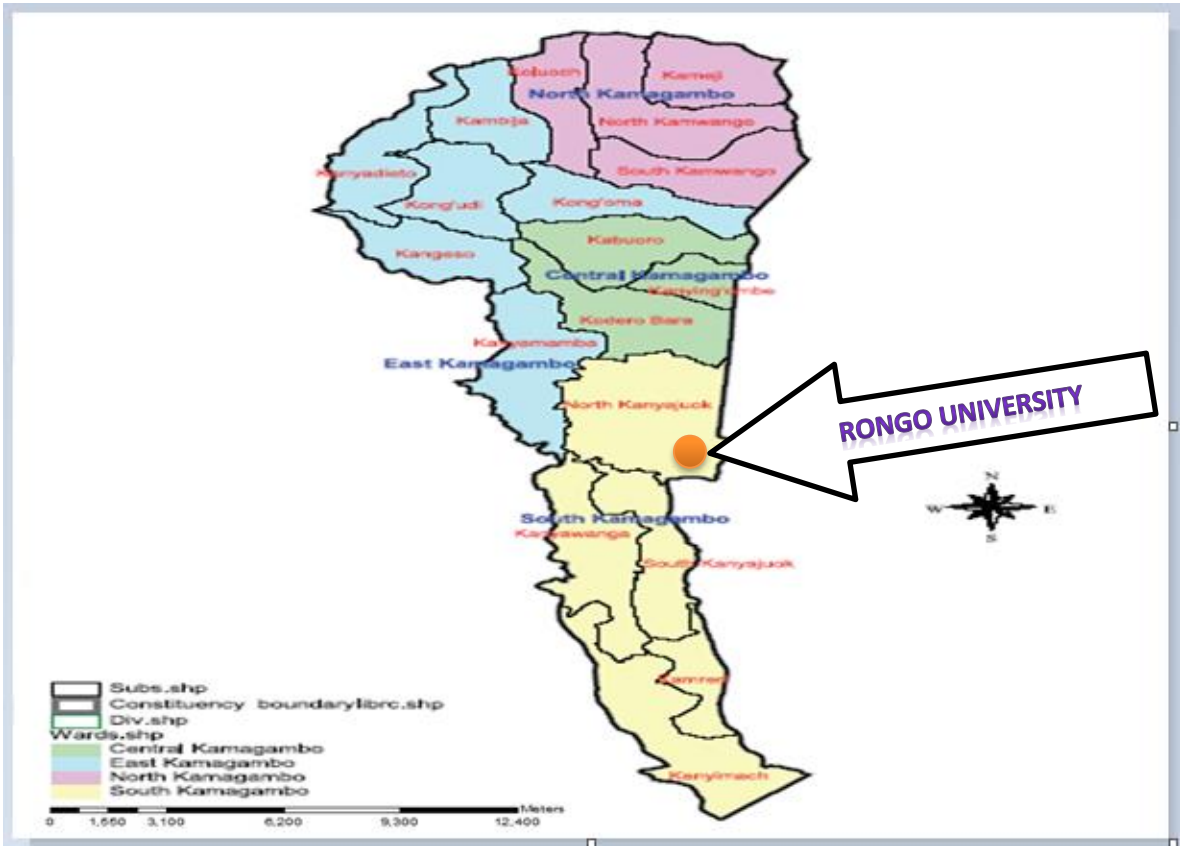


**Figure 3.2: Rongo Sub-County and its sub-locations**
*Source: Adapted from Migori County Integrated Development Plan, 2013*

### 3.1.1. Topographic Features

The altitude of Rongo Sub-County varies between 1140m to 1700 metres above the sea level with several undulating hills and plains. The main drainage system is river Kuja, the only permanent river in the area and its seasonal tributaries. There are also other water bodies including several perennial rivers, streams and springs in the region. Kuja River has the potential for generating hydro- electric power for both industrial and domestic use in the region but not for water transport due to its undulating nature and several water falls along its channel. According to [Migori County Integrated Development Plan (MCIDP), 2013], the river can also support irrigation schemes at its lower basin.

### 3.1.2. Vegetation Cover

Rongo sub-county region has mainly deciduous vegetation and planted forests on individual lands. Other parts of the region are covered by savannah grassland. Some parts of the sub-county's vegetation cover comprise of indigenous forests, trees which were established through seedlings generated from the nurseries. Similarly, some parts of the region are also characterized by shrubs, trees and bush lands. Other parts are also covered by farm lands where crops such as sugar cane, maize and other crops are evident. The major challenge facing vegetation cover in the region has been overexploitation of the limited forest resources [Migori County Integrated Development Plan (MCIDP), 2018]. People cut down trees for charcoal burning and in some cases parts of the land are cleared to create room for settlement or to support agricultural activities. According to the MCIDP (2018), there have been notable effects of forests loss which include soil erosion, siltation of dams, loss of biodiversity, flooding and accumulation of carbon dioxide in the atmosphere as a result of loss of carbon sinks.

### 3.1.3. Climatic Features

The mean annual rainfall in Rongo sub-county ranges from 700 mm to 1800 mm. Rainfall occurs in two seasons annually. The short rains occurring between March and May, while the long rains fall during the October-December period. The average annual temperature of Rongo Sub-County is 20.6 °C. The prevailing climatic condition in the region has been favourable for agricultural development since there is no total dry month without rain. The rainfall pattern in the region has been very reliable enabling farmers to practice agricultural activities such as growing of staple food crops and other cash crops like sugar cane (MCIDP, 2013). As a result of reliability in rainfall in the region, vegetation in the area tends to be evergreen. Even though there are seasonal streams in the region, water is always available in various streams within the Rongo sub-county.

### 3.1.4. Socio-Economic Activities

According to MCIDP (2018), Rongo Sub-County has 113 primary schools (68 public and 45 privately owned). It also has 32 secondary schools (27 public and 5 private). The sub-county is characterized by multi-ethnicity with a mean population density of 376 persons per $Km^2$. The ethnic groups living in the Sub-County include; Luo, Kisii, Luhyas, Maasai,

Kuria and Kikuyus. Agriculture, livestock keeping, mining, trade and commerce, transport and communication form the main economic activities in the Sub-County. Agriculture, although done in small holder farms (2-4ha) generates the highest household income (69%) and is therefore the major employment provider to the rural population. The main crops grown in the area are maize, beans, sorghum, green grams, sweet potatoes, finger millet, cassava and cowpeas. Many farmers cultivate horticultural crops especially tomatoes, onions and kales. Variety of fruit trees species among other numerous tree species are planted in the area. Sugarcane is the most important cash crop in the region. There is also artisanal gold mining practiced in some areas and is a source of income for some communities. The fast growing Rongo town and its increasing population offers market for goods and services hence promoting trade in the area (MCIDP, 2018).

### 3.1.5. Rongo Sub-County's Demography

According to the 2019 housing and population census as provided by the Kenya National Bureau of statistics (KNBS), Rongo sub – county has a total population of 124,586. The number of males in the sub- county are 59, 257 while female are 65, 329. The sub – county has a population density of 584 persons per square kilometer. Based on this census, the study area has a population of 27, 666. Rongo sub-county is characterized by both urban and rural settlements. Nevertheless, rural settlement is the predominant settlement pattern in the region as 90% of Rongo sub-county population lives in rural areas (MCIDP, 2018). Administratively, Rongo town is the headquarter of Rongo sub-county. The 2019 Population and Housing census indicated that only 10% of the population of Rongo sub-county is settled within the major urban and peri-urban centres. According to Migori County Integrated Development Plan of 2018, availability of business and employment opportunities, better living standards together with better amenities are some of the factors which have contributed to rapid urban migration and settlement in Migori County. As a result of these factors mentioned, dense and nucleated urban settlement continues to be experienced in the urban centres of Migori as a County. This is inclusive of Rongo town in Rongo sub-county. The MCIDP (2018) noted that urban migration and settlement has resulted into mushrooming of slums, pressure on social amenities alongside competition for jobs. This has in turn led to socio economic and environmental effects such as prostitution,

crime, poor management of waste, land fragmentation and degradation, rapid changes in LULC among others.

## 3.2. Methodology

### 3.2.1. Research Design

In order to achieve its objectives, the study applied mixed methods research design to establish the relationships between the growth and development of RU since its establishment and LULC changes. According to Creswell (2012), a mixed methods research design is a procedure for collecting, analyzing, and mixing both quantitative and qualitative research and methods in a single study to understand a research problem. It is an approach to inquiry that combines both qualitative and quantitative forms in answering research questions. The study adopted an embedded approach where quantitative and qualitative data was collected and analyzed together. The Landsat images collected and analyzed gave quantitative data in terms of changes in LULC. The changes noted were recorded in terms of increases and decrease in area coverage by LU or LC. Similarly, the views of the respondents were also quantified like number of individuals who were of the opinion that the state of the environment has changed and whether it has changed from good to bad or vice versa.

The use of key informant interview together with focus group discussion constituted qualitative data. The qualitative data collected included people's opinion on what causes LULC changes in the study area, their opinion on how the government is monitoring development in the study area and strategies which could be adopted to realize sustainable development in the study area. In this regard, the study involved describing and correlating data gathered from the respondents and the ones from the Land Sat images. Thereafter, a predictive approach was employed to project the future's state of LULC in RU and its local environment.

The secondary data was collected from relevant existing literature and reports including journals, books, maps, and articles. According to embedded design, secondary data can be collected before or when primary data is collected. This approach allowed for correlation, explanation and prediction of the LULC changes which have occurred over a period of

time. That is from 2003 to 2018. The study correlated LULC which existed in 2003 and what existed in 2018. An explanation in terms of loss in quantity was given based on Landsat images captured at various years and the opinion of the respondents which also formed part of the qualitative data. The predictive approach was thereafter adopted to help project how the study area will be based on the trend in change in LULC over the past years. The secondary data collected before field survey was used to get information for developing study background and exploration of literature which had been documented on LULC changes. This helped to ascertain the gap in literature and also compare what had been documented with the study findings. The literature reviewed included the LULC change theories and models, existing policies guiding the establishment of universities, the causes, LU planning and effects of LULC changes. Also, the literature reviewed examined methodologies which had been used in studying LULC change. Similarly, the study examined the strategies which can be adopted in order to realize sustainable development which integrates environmental concerns at every level.

Primary data was collected through conducting household interviews (HHI), KII and FGDs using appropriate structured questionnaires and guides. The study conducted field survey to gather information from various respondents seeking to establish their opinion on state of the environment during their birth or arrival at the study area. The respondents were also engaged to compare state of the environment in relation to LC and LU at the time of data collection with the state during their arrival at the study area. GIS and remote sensing techniques were used to identify the changes following the establishment Rongo University in 2011.

### 3.2.2. Methods and Instruments for Data Collection

#### (i) Household (Individual) Interviews

Household interview is a method which is based on a face-to-face interview using pre-established questions. The study employed this method to solicit the community's opinions, knowledge and ideas on how establishment of RU has influenced LULC changes. Their views on drivers of LULC changes were also solicited. The study used structured questionnaire with both closed and open ended questions. This was to help gather both quantitative and qualitative data. In order to achieve this, the study stratified the area into

smaller administrative units. North Kanyajuok where the main campus is situated was selected together with West Kanyamamba, Koderobara and Kanyawanga.

**c) Sample Size**

The total population for the study area was 27, 666. The sample size was obtained using the Taro Yamane's formula (1973). Considering the fact that the total population for the study area had been established from the 2019 housing and population census, this formula was appropriate since it is used with a finite/known population. This formula allows for sample size to be calculated with regards to the population which is under study so that conclusions and inferences arrived at after the survey can be generalized to the whole/entire population from which the same sample was gotten. The sample size was therefore calculated as follows:

$$n = \frac{N}{1 + N(e)^2}$$

Where n= Sample size

N= Population size

e= Level of precision or Sampling of Error which is ± 5%

1= Statistical constant

The total population purposively sampled for the study from the four administrative areas was 27,666. The sample size was then calculated as follows

$n = 27666/1+27666(0.05)^2$

$n = 27666/1+27666(0.0025)$

$n = 27666/1+69.165$

$n = 27666/70.165$

$n = 394$

The study noted that some of the areas where the interview was to be conducted were purely rural while other areas were urban especially areas such as Koderobara in Central Kamagambo. Both urban and rural population was targeted. For rural areas where transects could not be easily identified, simple random sampling was applied. The research assistants enumerated households first in order to ascertain the number of households. Thereafter random numbers were used to arrive at the households interviewed. Out of the four

administrative units sampled 99 questionnaires were administered in each. In areas like Koderobara, Kitere and Kanga, transects were identified and major access roads separating various areas were used. Where houses were linear along the road, the first house was identified by simple random sampling while the subsequent one was arrived at by systematic sampling. Questionnaires (appendix 1) were administered to the household heads. The method involved engaging individuals on a one-on-one conversation trying to help them understand what the question requires.

***Snowball sampling***: This is also known as chain sampling, chain-referral sampling or referral sampling. It is a non-probability sampling technique where existing study subjects recruit future subjects from among their acquaintances (Kothari, 2009). This technique relies on referrals from initially sampled respondents to other individuals believed to have the feature of interest. Thus the sample group appears to grow like a rolling snowball. As the sample builds up, enough data is gathered to be useful for research. This sampling method is normally used in veiled populations posing difficulty in accessing. Kothari further noted that snowball samples may lead to numerous biases since there is non-selection of sample members from sampling frame. For example, people who have many friends are more likely to be recruited into the sample. To avoid biasness, the researcher deeply interrogated individual respondents who were referring him to other people for assistance as required by this technique. Deeper interrogation was to ensure that the researcher was directed to the right people with knowledge on the subject under question but not just relatives or friends to the respondents.

This method was used in identifying other resourceful persons who the community believed had knowledge and experience about the history of Kitere region where RU main campus is established. Similarly, in some cases, the researcher was referred to other respondent who the community believed had experience and was informed on environmental management issues. For instance, during household interview, some respondents could not understand how the government monitors development in their regions. Also some did not understand what the National Constructions Authority together with the National Environment Management Authority do. In this regard, individual respondents referred the researcher to the member of the community they felt understood

such subjects. Similarly, other key informant also referred the researcher during data collection to some officers within the county whom they believed could respond to particular questions which were being investigated. For example, there were some officers who were new in their places of work at the county and the question about the state of LULC before establishment of RU was not easy for them to answer. They therefore referred the researcher to individual officers they felt had appropriate answers and could describe the state of environment.

**(ii) Key Informants interviews**

Key informant interviews are one-on-one assessments to gain insight about specific community problems from stakeholders and key leaders of the community. It involves conducting interview to persons who are likely to provide ideas, information, and insights needed on a particular subject. The study reached its key informants through use of purposive and snow ball sampling techniques. According to Saunders *et al.* (2012), purposive sampling which is also known as selective, judgmental, or subjective sampling is a form of non-probability sampling in which researcher relies on his or her own judgment when choosing members of the population to participate in their study. It is an intentional selection of informants based on their ability to elucidate a specific concept, theme, or phenomenon. They further noted that a purposive sample is a non-probability sample that is selected based on characteristics of a population and the objective of the study.

Since the researcher had knowledge about his subject, the study properly chose and approached eligible participants such as the Migori County director of environment, NEMA officer, land department (Housing and physical planning) and Rongo Sub – county environmental officer. These informants were selected with a view that they are informed on environmental and development matters. As the name suggests, the researcher went to the community on purpose because he felt that these individuals fit the profile of the people he needed to reach. This method was also applied in identification of the various other interest groups, for instance relevant institutions and resource persons like county director of education with useful information for the study. To gather information from these individual key informants, an interview schedule (appendix 3) was used. The questions in the interview schedule were open ended. This gave the key informants opportunity to

express their views on the general environmental management together with the changes which have been realized over the years as a result of establishment of RU. Based on their answer on particular questions, the researcher could also probe in order to seek further clarification on particular issues. Most of the data collected through this method were qualitative.

**(iii) Focus Group Discussion**

According to Barbour (2005) an FGD can be defined as a qualitative research method and data collection technique in which a selected group of people discusses a particular topic or issue comprehensively or in-depth. The study applied this technique to help solicit participants' attitudes on LUs and direction of change in state of the environment at the time of data collection. Similarly, participant's perceptions on LC changes were also solicited during the application of this method. Also, the knowledge of participants on policies guiding development and environmental management was sought. In addition the participants' experiences on loss of biodiversity and LC in their localities together with adequacy in implementation of policy guidelines were also solicited. Moreover, the method was applied to determine the participants' shared environmental management practices in their localities.

The rationale of application of this technique was based on the fact that it serves to solicit participants' attitudes and perceptions, knowledge and experiences, and practices, shared in the course of interaction with different people (Flick, 2013). Wong (2008) asserted that focus group discussion relies on the assumption that the group processes activated during application of this technique help to establish and elucidate shared knowledge among communities and groups, which would otherwise be difficult to obtain with a series of individual interviews. The method was adopted since an FDG always allow the researcher to solicit the participants' shared opinions, worldviews, and narrative alongside their differences in terms of experiences during such open discussion rounds.

Bromley and Helene (2003) noted that FDG is particularly suitable in communities with a low level of literacy and/or a strong oral tradition since it utilizes human ability to tell stories. They further contended that an FDG offers better access to individuals who are not outspoken together with those who would normally fear taking part in an individual

interview. This study needed history about the state of the environment before the establishment of RU hence adoption and application of an FDG was necessitated. The techniques helped the study in gathering information through engaging stakeholders including community members from different wards of the sub-county into a discussion seeking their views on how establishment of RU has influenced LULC and other changes on the environment.

In order to realize this, the study applied stratified random sampling technique. Stratified sampling is a sampling design in which the finite population is partitioned or subdivided into several subpopulations known as strata. In this case, sample draws are made independently across each stratum. Bromley and Helene further noted that the strata are formed on the basis of particular common features in the population data. After dividing the population into strata, the sample is proportionally selected. For the purpose of this study, Rongo sub – county was stratified in terms of administrative units, i.e. wards. The wards were also sub-stratified into smaller administrative units (sub-locations). The study then purposively selected four research assistants who were identified in different parts of the study area to help in mobilizing members of the community to voluntarily take part in FDGs. The identified research assistants within various wards such as South Kamagambo, North Kamagambo, East Kamagambo and Central Kamagambo helped to notify and mobilize members in the study area making them accessible for discussion.

In mobilizing the members, the research assistants were able to identify the natives who are informed and had lived in Rongo sub – county for a longer period to witness the establishment of RU and even witnessed the environmental changes that may be linked to it. People of various categories involving farmers, teachers and other members of the community were engaged. Gender was given equal opportunity. Old men and women in the study area were also given opportunity to participate as the moderator who was the researcher in this study could understand their language. Equal opportunity was given to all gender to take part in the discussion. The study adopted a sufficient diversity within groups approach with the hope that bringing together people with differing experiences, various roles, and diverse backgrounds might yield varying, broad-ranging, unexpected, yet robust and meaningful results.

The research assistants helped to convene meetings that were used in the focused group discussion where the views of the members were sought on how establishment of RU has influenced LULC changes. In this regard, Koderobara in Central Kamagambo ward, Kanyamamba in East Kamagambo ward, South Kamwango in North Kamagambo ward and North Kanyajuok in South Kamagambo wards were purposively selected and used for the focused group discussions. These administrative units are adjacent and border the area where RU main campus is situated. The controlled number of participants based on Flick's (2013) assertion that the typical size of a focus group discussion is 6 to 12 participants. Flick preferred smaller groups to large ones and termed them fine and informative as they give all participants opportunity and enough time to share their views. In this regard, individuals who picked the intended numbers from the random numbers were allowed to take part in the discussion. This implies that in all the focus group discussions held, the study only allowed up to a maximum of 12 participants for each. This was to help keep the number of participants into a manageable size and give ample time to every participant. According to Carlsen and Claire (2011), the more knowledge and experience a participant have on a particular subject, the smaller the group should be. They termed this the general rule of the thumb.

The key questions asked during focused group discussion included the state of environment during arrival of the members of the group in the study area. Members were also tasked to describe the state of LULC during data collection period. Similarly, members of the group were asked if they witness changes in LULC and if in any case a change has been witnessed, what they attribute to such changes. Equally, their opinion on direction of change in state of the environment was also sought. That is does the state of environment change from bad to good or vice versa. This was meant to establish the level of community sensitization required in terms of environmental management.

Also, members were asked if they were aware of the policies guiding development in Kenya and whether they were aware of how and the level at which the government monitor development in their areas. Further, in a focussed group discussion members were asked impacts of not monitoring development in the area. Lastly they were asked the strategies which can be adopted to realize sustainable environmental management in their areas. The

study relied on the interview schedule and part of questionnaire to guide the discussion during application of this technique. This was because they contained the same questions whose answers were being sought by the study. The study managed to conduct four different focused group discussions in the four wards of Rongo sub-county that is North, Central, East and South Kamagambo wards. High level of interaction was registered during group discussions.

**(iv) Field Observation and Photography**

According to Kawulich (2005) scientific observation is a systematic account of behaviours, events, and artifacts in a social setting which has been chosen for a study. He further noted that observation is an account of perceptions from the five senses of sight, touch, hearing, smell and taste to provide a written photograph of a situation. Observation delivers a real time information on unfolding behavior and ongoing process, event or situation. According to Kawulich, intuition introspection, or extrasensory observation by the sixth sense results into expression of predictions, describable extrasensory perception and prophecies. The study employed both descriptive and analytic observations as both of them were meant to answer what the study was investigating. Descriptive observation were intended to answer the question of where, why, when, who, what, how many and how much of phenomena which was under investigation. For instance, the study observed development in the study area and the researcher was concerned about where these development are taking place, how they take place and who were responsible.

Similarly, the study employed analytic observation to provide explanations, causal relationships and associations of various activities within the study area. In observing LULC changes in the field, the study could observe cause of LC losses for instance, part of RU forest cleared for the development of a library. In other areas, parts of farmlands were observed secured for settlement development. This method was applied to help identify the various developments taking place in the study area including economic activities and even new structures coming up. It also helped in verification of information gathered using the questionnaires. It was adopted since it serves to increase the range of relevance and reliability of data considering various parameters, issues, activities and resources under investigation. Field note book was used to note the information observed. The physical

characteristics of the study areas were captured during a preliminary reconnaissance. For identification of the LU types and surface features, visual observations was made through transect walks along designated routes. For verification and ground truth of mapped features, fieldwork was conducted. This method was used to collect both quantitative and qualitative data in the natural settings.

The study also employed photography in data collection. Photography is an art, practice and application of creating durable images through recording light or other electromagnetic radiation either by electronic means through image sensor or chemically by means of a light-sensitive substance such as photographic film. The study used photography to capture data using digital cameras as an instrument. The photographs taken acted as evidence of actual conditions on the ground during the time the study was undertaken. Digital camera was used to capture spatial data. Through photography, real situation on the ground was transferred and super-imposed on paper for easier understanding. Construction developments in the area were captured. Other informal settlement developments were also captured.

## 3.3. Remotely Sensed Data Acquisition

### 3.3.1. Landsat Image Acquisition and Processing

According to Maina *et al.* (2020) Remote Sensing (RS) and Geographic Information System (GIS) are considered powerful tools in deriving timely and accurate information on spatial distribution of changes in LULC over large areas. Also, they noted that GIS provides a platform for digital data collection, storage, analysis and display which is necessary for detecting changes. Remote sensing imagery is considered a crucial data resource for Geographic Information System. Satellite images are critical and are used in recognizing synoptic data of the surface of the earth over time. Landsat Multispectral Scanner (MSS), Enhanced Thematic Mapper Plus (ETM+) and Thematic Mapper (TM) data have been employed in determining and studying LULCs since 1972. Their rich spectral resolution of satellite images and archive make them most important to be used.

In view of Maina *et al.* (2020), the purpose of digital change detection process is to identify LULC on features of interest falling between two or more dates. Employing remote sensing and GIS involves satellite image acquisition, acquisition of ancillary data, image

classification preprocessing, ground truthing, accuracy assessment and output derivation. Similarly, application of remote sensing and GIS follows procedures which involve adoption of classification techniques such as supervised classification. This technique is used during processing of Landsat images and classifying attributes based on the interest of the researcher. Image Classification of particular number of reflective bands of Landsat images is then conducted by using maximum likelihood method. This may be done with the aid of ground truth data which is obtained from aerial images which are dated according to the years of interest. Like for the case of this study intended years for study were 2003 to 2018. The second portion of the study focuses on LC and LU changes where change detection comparison is conducted pixel by pixel. The third part of the study involves analyzing LC and LU changes based on the topographic structure using GIS functions.

During this study, GIS/RS data was obtained from calendar years 2003, 2010, 2013, 2014, 2015, 2016, 2017 and 2018 were used and analyzed. Individual bands extracted from the raw image of GIS/RS data were layered or stacked/composited into different bands depending on the interest of color choice or variation, either false or true color composite. For this case, the composite bands 123 were used for true color composite of the Landsat image 2003 and 2010 and for 2013, 2014, 2015, 2016, 2017 and 2018. The bands were made in a composite of the order 543 to obtain false colour composite due to small area of study. The $6^{th}$ band was omitted as it is the thermal band.

After compositing the images were clipped to the Area of Interest (AOI) as necessary following the normal procedure. Clipping was done using the shape file for North Kanyajuok, the area of study and clipped image or subset added onto the viewer once the process was completed. Image clipping is a process whereby a subset of the raster dataset is created for specific use. Clipping normally removes data outside the area of interest thereby reducing the file size and improving the processing time for many operations.

### 3.3.2. Classification of LULC

As the procedure requires, to start classification it is always important to create a shape file or work with the AOI shape file. In this case, the study adopted the use of the AOI shape file but it was renamed. The images were classified for the time stamp interval that was

2010-2013 by drawing some polygons with the help of colour key on the image using interactive supervised classification. The second step for this classification case involved conversion of the classified data into a vector data which involved the use of class names to enable viewing the attribute table. On the attribute table, a field was added as a text and labeled as LULC 2003, 2010, 2013, 2014, 2015, 2016, 2017, 2018. This was then followed by running a field calculator to fill the field. Another field was then added as double and labeled as area in hectares. The field was then filled by calculating geometry and then the data LULC was summarized by areas in hectares. Then data was exported to excel for further analysis.

### 3.3.3. Change Detection

This was achieved by intersecting the vector data of the two years, for instance the years 2010 and 2013 vector data using the product after intersection. This was then followed by opening the attribute table and adding field as a text and labeling it as change detection. A query was then run to fill the change detection field. After that, another field was added as double and labeled as area intersects in hectares. The fields was then filled by calculating geometry and by summarizing the change detection of the area intersect in hectare then exporting data to excel for further analysis to obtain totals in percentages.

### 3.3.4. Change Prediction

Change detection enabled understanding of how human possibly influence environment through altering the use and the cover of the land Minal *et al.* (2017). The change detection was achieved by the use of IDRISI Selva 17.0, computer software that involved running programmes by moving tabs named transition potential. This was followed by a move to a transition sub-model status assigning similar names to the files created. For instance, in this study, it was “anthropogenic disturbance” as a sub model that was evaluated. From there, the transition sub model structure was run and a variable which was static in nature was added. After which, the study ran a transition sub-model while checking on the Multilayer Perceptron (MLP) neutral network. This was because this system is able to work with many transitions. This was followed by setting sample size per class which was to be used. For the purpose of this study, 256 was the sample computed and generated with application of IDRISI Selva 17.0 software. The model was then run and the software allowed to process

data for some time and display the transitional graph and to generate level of accuracy during processing of this data. The final maps were then generated by running a 'create potential transition map tab'. In order to conclude on change prediction, a land change modeler and change demand modeling were run. This was followed by running the Markov chain and assigning the date of prediction. The last step involved running the change allocation and creating a soft prediction by running the model. Percentage in LC change was then calculated as follows:

$$\textbf{Percentage change} = \frac{\textbf{Observed Change X 100}}{\textbf{Sum of Area}}$$

### 3.3.5. Data Analysis

#### a) Data analysis for Field Survey

Data obtained through HHI, KII and FGDs was analyzed using both qualitative and quantitative methods. Qualitative method was employed in analyzing information gathered through KII and FDGs. The study adopted the approaches provided by Canary (2019) study on "How to analyze interview transcripts in qualitative research". Even though Canary posited inductive and deductive as the two main approaches employed in analysis of qualitative data, the study employed thematic content analysis (TCA). This is one of the inductive methods which call for unstructured approach to results. According to Canary (2019), TCA is possibly the most effective and common method compared to other qualitative data analysis methods. It is also considered one of the most reliable in terms of increasing the analysis' traceability and authentication. Its major goal is to find common patterns across the data set. The study undertook the following steps in analysis of its qualitative data**:** the first step involved reading the study notes and transcripts while noting the study's first impressions and identifying common themes such concerns of the informants. By re-reading notes carefully evidence of themes became stronger thus helping the study hone in on significant insights. Biases identified were noted. The second step involved annotation/footnoting or comment. Relevant words or phrases and sentences were labeled (coded) in reference to them being actions, opinion, activities or processes. This was to help identify significant qualitative data sorts and patterns. This is significant in data organization for dissemination. The third step was conceptualizing data. Data was aligned with critical themes the study

considered would be used in publishing. Categories and subcategories were created by grouping the codes created during annotation. This step involved combining some codes. The fourth step was data segmenting which involved positioning and connecting data categories to establish the bulk of data in a cohesive way. Categories were labeled connections between theme described. A work/spreadsheet was created to ease compilation of data. Important variables were structured using the codes as reference tools. Separate tab for the front of the document which contains coding table was created to help identify what the codes refer to. Step five was analysis of the segments which was started by determining possibility of having a hierarchy in data categories in relation to possession of importance than others. Figures were drawn to summarize the results and results written as require in step six of the TCA.

Quantitative techniques was employed through coding the data from the questionnaires based on thematic areas then analysed using Statistical Package for Social Scientists (SPSS). Analytical descriptions using proportions, graphs, percentages and averages were used to draw up conclusions. The frequencies generated by SPSS were transferred to excel for computation of the figures.

**b) LULC Change Analysis**

This analysis was performed by IDRISI Selva 17.0 software where the classified image in Arc map10.3.1 was converted to ASCII for IDRISI to display the image. The IDRISI Selva 17.0 was then launched and converted then images imported. This was then followed by activating Land Change Modeler (LCM) and by running change analysis tab. A new project was created by browsing the earlier and later land cover images in ASCII format hence creating a new ID that is similar to original images in the Arc map. After processing, the software displayed a graph for gains and losses of ID have created. Map and graphs for the changes that occurred in LULC overtime were also generated.

# CHAPTER FOUR: RESULTS

This chapter presents the study findings based on the objectives that it sought to achieve. The information presented here arose from the field. That is data gathered from photography, household interview, key informants, focus group discussion and the Landsat images for years 2003, 2010, 2013, 2014, 2015, 2016, 2017 and 2018. The sample size formula used gave a total of 394 people who were to be engaged in household interview. The study managed to collect information from 391 individuals. The study failed to add three questionnaires in the data. This was because two people failed to return their questionnaires while one questionnaire was incomplete. This accounted for the three household questionnaires missing in the sample size. The study conducted four FDGs involving 8 members in North Kanyajuok, 5 in Kanyawanga, 7 in West Kanyamamba and 5 in Koderobara. This gave a total of 25 members. Member engagement in discussion was voluntary. Also, the study collected information from 11 key informants. These included 3 RU management staff members, 4 Migori County officials, 1 NEMA officer and 3 private developers around RU. Thus the number of people who participated in FDGs and KII were 36. The information gathered from the FGDs and key informants formed the qualitative data. The information was presented graphically and in table forms as follows:

## 4.1. Demographic Characteristics of the Respondents

Data was gathered from both male and female without discrimination. Table 4.1 shows demographic information about the respondents in the household interviews. Male respondents were represented by 52.6% while the female ones were 47.4%. This means that more male than female gender took part in the study.

**Table 4.1: Gender of Respondents**

| Gender | Number | Percentage |
|---|---|---|
| **Male** | 204 | 52.6 |
| **Female** | 187 | 47.4 |
| **Total** | **391** | **100** |

*Source: Author, 2021*

The study sought information from people of varied age brackets. From table 4.2, 18.9% of the respondents were aged below 25 years. Possibly, this represented the students and other youth who took part in the study. 16.9% represented the respondents who were aged between 26-30 years. Similarly, those who were aged between 31-35 years stood at 27.6% while those who were aged between 36 and 40 formed 13.3%. Those who were 41 years and above were 23.3%. This implies that most people who participated in the study were aged between 31-35 years. See table 4.2.

**Table 4.2: Age of Respondents**

| Age Bracket | Number of Respondents | Percentage |
|---|---|---|
| **Below 25** | 74 | 18.9 |
| **26-30** | 66 | 16.9 |
| **31-35** | 107 | 27.6 |
| **36-40** | 52 | 13.3 |
| **41 and above** | 91 | 23.3 |
| **Total** | **391** | **100** |

*Source: Author, 2021*

Among those who were interviewed, most of them had lived in the study for more than 8 years (43.5%). Those who had lived in the study area less than 1 year were only 6.1% as portrayed by table 4.3. This implies that majority of the people interviewed had lived in the study area long enough to witness changes over time.

**Table 4.3: Number of years the respondent has lived in the study area**

| Years | Number of Respondents | Percentage |
|---|---|---|
| **Below 1 year** | 24 | 6.1 |
| **2-3 years** | 48 | 12.3 |
| **4-5 years** | 60 | 15.3 |
| **6-7 years** | 89 | 22.8 |
| **8 years and above** | 170 | 43.5 |
| **Total** | **391** | **100** |

*Source: Author, 2021*

### 4.2. Policies Guiding Establishment of Universities in Kenya

The study established that majority (77%) of the respondents were not conversant with the development policies. This clearly indicates how difficult it could be in implementation of such policies. It becomes apparent that public involvement in implementation of policies guiding development activities in RU's local environment is inadequate. The 23% of the respondents who noted they were aware of the policies guiding university establishment and development activities. It is possible that this percentage comprised the staff and the students interviewed during data collection. The study noted that the number representing those with knowledge of the development policies is small and its influence on proper management of environment might be minimal. As portrayed in figure 4.1, a bigger task remains in sensitizing the 77% without knowledge on development policies as their development activities might impact the environment. See figure 4.1 presents this finding.

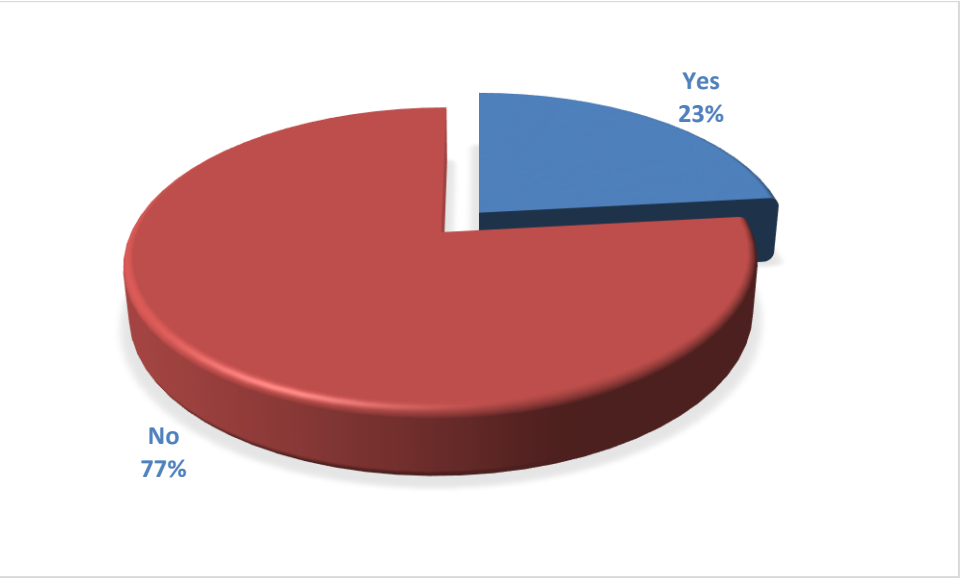


**Figure 4.1: Awareness of Policies and Legal Frameworks Guiding University Establishment and other Development Activities**
*Source: Author, 2021*

In determining whether developments within RU and its local environment are in accordance or compliance with policy and institutional framework provisions, the study noted that 69.3% (majority) agreed. The study found this to be contradicting with the findings in figure 4.1. In figure 4.1, it was noted that many people were not aware of the policies guiding development activities. However, when asked whether these development activities are in accordance with the policy provisions, they agree. This shows a state of unawareness, or not being sure about these important guiding documents (policies). Where they benchmark from is not clear. The 30.7% who dissented that development activities in the RU's local environment are not undertaken in accordance with policy provisions could be the same learned group who noted they are aware of the policies as depicted in figure 4.1. Seemingly, they are familiar with what is spelt out in the policies and hence expect such to be seen or implemented on the ground. Since this is not seen by them on the ground justifies their opinion that development activities in the study area do not follow the policy guidelines. See finding in figure 4.2.

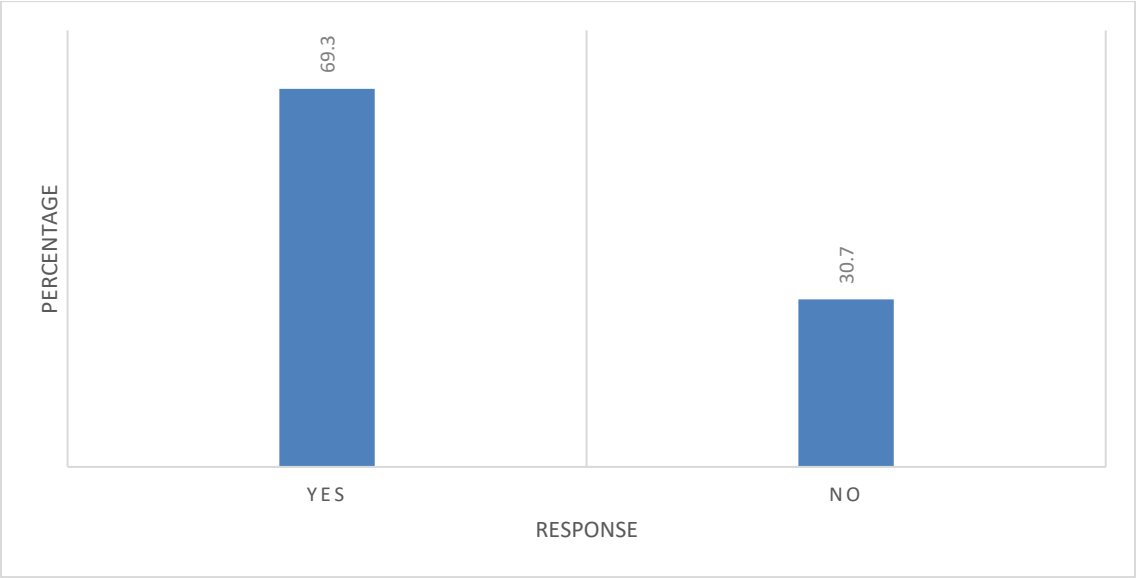


**Figure 4.2: Compliance with policy and institutional guidelines in development within RU and its local environment**
*Source: Author, 2021*

Regarding appropriateness in undertaking development activities without following policy guidelines, study results revealed that many people expressed their displeasure. This was evidenced as 83% of the respondents emphasized that all development activities should be guided by the policies. The study noted that even though the community members might be unaware of the policies guiding development activities, most of them are willing to adopt and implement them. However, a few people represented by 17% did not see the harm in operationalizing development activities out of policy provisions. This group could possibly represent those who do not understand the impacts of unplanned development. Possibly, they do not recognize the harm such developments have on nature or environment. The study noted that though those people were few, their blind actions might negatively impact the environment. Figure 4.3 presents the findings on this matter.

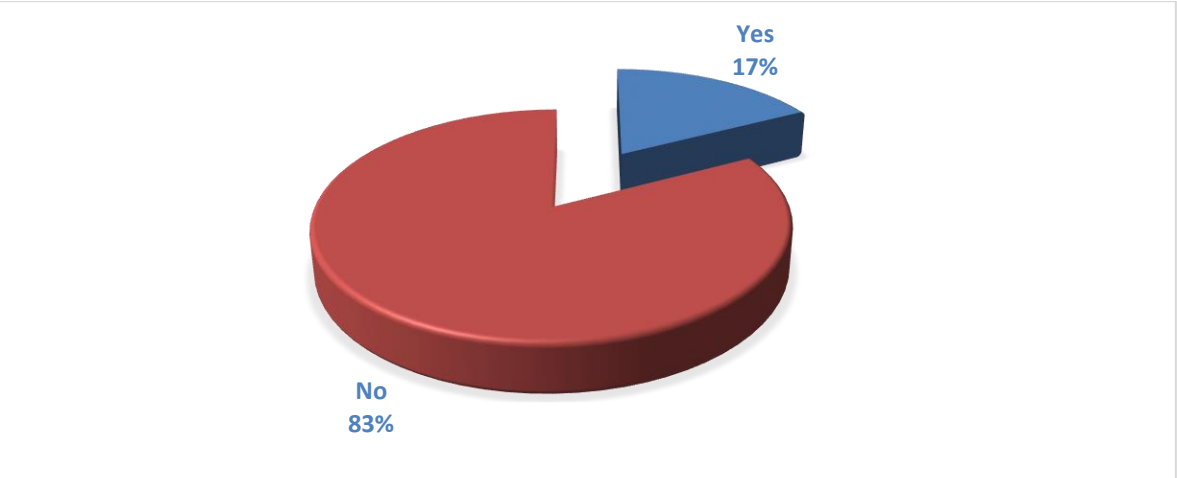


**Figure 4.3: Appropriateness in initiating development activities in RU local environment without following policy guidelines**
*Source: Author, 2021*

The interest of the study in establishing reasons for not following policy guidelines in their development yielded the following results: 78% mentioned lack of knowledge on policy and legislative framework provision. Considering the fact that not everyone has gone to school, many people were totally unaware of the development policies. Similarly, even if some have gone to school, level of education matters. The study noted a possibility of individuals completing their studies without knowing such policy provisions. This finding exposed impossibility or a nightmare in implementation of what one does not know. Besides this, 59.2% contended that many people are basically not willing to implement the policy provisions. Possibly, these people have no idea of the benefits of adhering to the policy provisions. Their perception could be that policies are meant to benefit some specific individuals and not for the safety of humanity and the environment. Also, this group could represent those who take advantage of freedom of choice and laxity in policy implementation procedures. The study noted that such group represents quite a number who urgently need to change their attitude for the safety of the environment.

The study findings also revealed that a number of individuals consider implementation of development policies to be costly. These were represented by 55.8%. The small charges for instance, development of plan and then approval of the plan by the public works office, public health and architect were among the costly challenges mentioned. Some people considered this time consuming and they were not ready to cope with. Initial NEMA 0.01%

charge of the project cost paid by the project proponents was also mentioned to be one of the factors which developers use to avoid thus undertaking development activities without following this policy procedure. On the other hand, 42.5% of the respondents felt that provisions of the policies and other legal frameworks are not easy to understand. Some of these people claimed that a lot is needed to be considered and if all are to be included as per the policy provisions, then little can be achieved by the private developers. Mentioned were things like lot ratio and number of units per specific land size as provided in the Physical Planning Act Cap 286. In this regard, the study noted that some development activities in the RU's local environment are carried out of policy provision not because the owner are not willing to comply but difficulty in adhering to policy procedures hence sideling and oversight of policy implementation. See figure 4.4 for the discussed results.

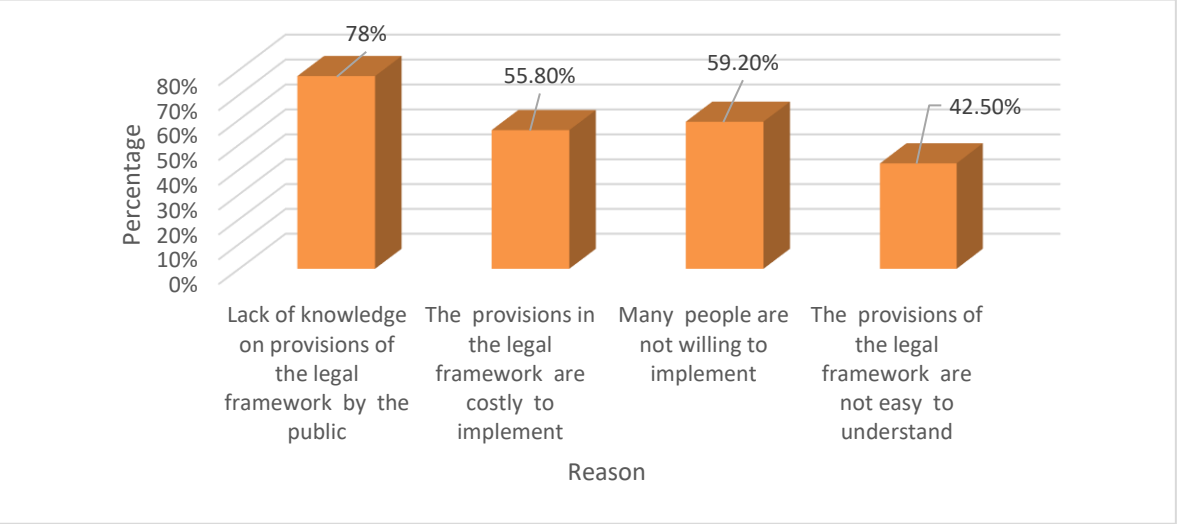


**Figure 4.4: Reasons for not following the policy and legal framework provisions in development within RU local environment**
*Source: Author, 2021*

In an effort to establish government involvement in monitoring development activities within RU and the local environment, the study results recorded an overwhelming agreement (84%) that monitoring was being done by the government. A number of individuals confessed witnessing periodic monitoring activities being conducted by the county government officials. This implies that a significant effort is put by the County government of Migori in order to realize sustainable development of activities within the county. What is left to be answered is the reason why some development activities do not

meet the required standards as stipulated in the policies. The existence of haphazard development evidenced by mixture of new and dilapidating structures, bungalows and storey buildings which lack proper planning despite county government' follow up and monitoring in the Rongo University's local environment portrays a loophole and ineffectiveness in policy implementation procedures. It also shows a possibility of lack of concern by the policy implementers in achieving policy goal. As depicted by figure 4.5, 16% failed to see government commitment and involvement in monitoring development activities in RU's local environment. This group contended that if at all there was monitoring then development in RU's local environment would have taken shape and everybody would be striving to adhere to policy stipulations. In their opinion, little is done by both national and county government in monitoring these developments. The study noted a possibility of lack of deeper understanding of monitoring concept among the community and some of the policy implementers. The 16% representing people who refused they had not seen government commitment and involvement in monitoring activities could be people who deeply examined level of government monitoring. They examined monitoring to see its outcome if at all it was being carried out to achieve policy goal. In their opinion, people should be able to discern between monitoring to check whether the project proponent has acquired plan approved for development and whether monitoring is done to check the whole project's compliance with policy provisions. This group of people perceived monitoring undertaken within RU's local environment as not being compressive as it should be. It is important to note that Rongo University management informed the study that development within the university is guided by the University Act of 2011 whose second schedule stipulates how university' physical facilities should be. In addition, the management added that periodic monitoring is being done to check their compliance with the set standards. See figure 4.5 for graphical representation of these results.

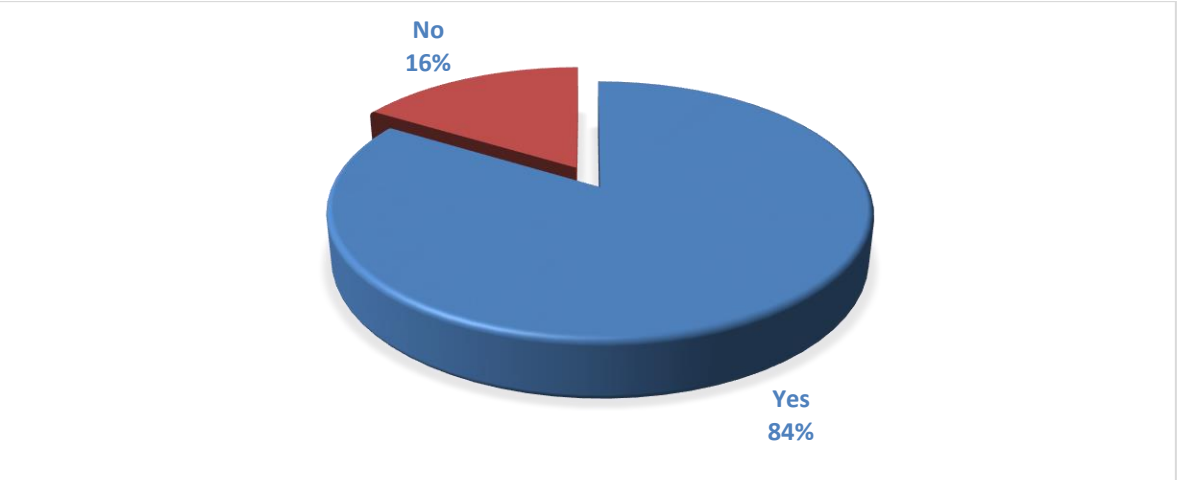


**Figure 4.5: Involvement of government in monitoring development activities in the study area**
*Source: Author, 2021*

Study learnt that, failure to monitor development activities around places where universities are established attracts a number of consequences. These include but not limited to: haphazard development, more destruction of natural environment, unsustainable use of natural resources and rapid degradation of natural resources. The results of the study indicated that many people (71.4%) considered haphazard development as the major problem stemming from lack of monitoring of development activities within universities' local environment. In their view, policies guide what is to be where, when it is supposed to be, who is to initiate it and how it is supposed to be initiated. Thus failure to monitor may lead to sidelining or skipping some critical procedures thereby resulting into haphazard development. A number of individuals (44.4%) noted more destruction of natural environment as another consequence of failure to monitor development activities in the university's local environment. They identified lack of consideration of nature and preference given to new buildings/structures for commercial activities to be the major contributors to the destruction of the environment. In their view, failure to monitor development activities has led and will continue to lead to widespread vegetation clearance to create room for commercial structures. Consequently, negative environmental impacts are encountered due to destruction of vegetation and/or natural environment.

Mentioned earlier as a consequence of failure to monitor development activities is unsustainable use of natural resources. This was represented by 41.3%. Some members of

the public were of the opinion that government monitoring of development activities in RU's local environment controls natural resource use. For instance government's involvement in determining what is to be established where and at what time, how and by who normally controls LUs. Land fragmentation, loss of agricultural land and transformation of natural environment into built environment are some of the issues raised. Proper implementation of development policies together with monitoring and conducting other follow up activities like environmental audits could help control natural resource use. 34.9% of the respondents viewed rapid degradation of natural resources and the environment as one of negative impacts of failure to monitor development activities around universities. According to these people (34.9%), being that university neighbourhoods are potential for development and the fact that a large number of people is drawn into these neighbourhoods, development activities in such areas catalyze degradation of natural resources and the environment. This pull factors influence development rate which results into loss LC and changes in LUs thereby degrading the natural resources such as vegetation and land. Figure 4.6 portrays the results of this discussion.

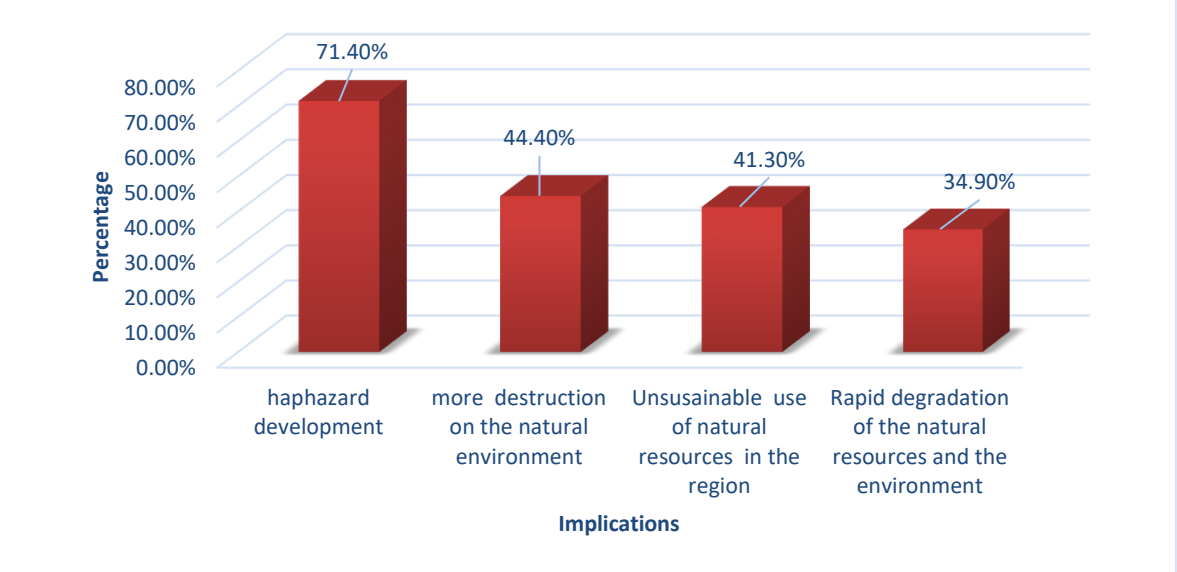


**Figure 4.6: Implications of not monitoring developments activities in the study area**
*Source: Author, 2021*

Through field survey, the study noted particular structure in Kitere shopping centre which collapsed while construction was underway (plate 4.1). It is possible, this unfortunate incident could have been associated with urban rush and quick fix of structures to meet the

increasing demands in Rongo University neighbourhood. The collapse of this structure could be attributed to failure to comply with the required provisions in construction regulations and environmental standards. Efforts to get the owner (private developer) for interview proved futile because of the suspicion and anxiety caused by the collapse of the building.

The result of the study also revealed that in an attempt to quickly fix housing to meet the rising demand in RU's local environment, other structures which are already in place can be affected. The same plate (4.1) shows a hostel which was destroyed by this building which was under construction. The study noted that the proponent lost monthly income he used to collect from hostel. Also, reconstruction and repair of the damaged property were among the cost to be incurred. The hostel used to accommodate students who preferred living in privately owned hostel which are not managed by RU. Unfortunately, it could no longer render the same services after the mentioned incidence. This still calls for proper implementation of development policies and conducting monitoring and follow up activities.

**Plate 4.1: Damage Caused by Collapsed Building under Construction in Kitere, Rongo Sub-county**
*Source: Author, 2021*

An evidence of rise of haphazard development and/or university informal settlement within the neighbourhoods is presented in plate 4.2. The plate is demonstrates what is portrayed in figure 4.6 which indicated that failure to monitor development activities lead to haphazard development. The houses seen in this plate are all occupied. There is also mixture of different forms of structures. Some of these structures are dilapidating while others are coming up as new storey buildings. This is a clear indication of lack of planning and inadequate monitoring of development activities in the area. The study noted that if such developments continue unabated, provision of urban services such as water supply, sewerage systems among other will be difficult since provisions for way leaves are not put into consideration in development. Management of waste will also not be easy since access avenues are not considered. Similarly, other environmental concerns such as sparing some places for trees and other vegetation to control accumulation of carbon in the area are out of priority.

**Plate 4.2: Mixed Structures in a Developing Slum, Kitere in Rongo Sub-county**
*Source: Author, 2021*

Also, the study noted bushy areas within Kitere shopping centre which is now developing as slum. For example, the bushy area shown in plate 4.3 is behind a residential area whose roof can be seen in the plate. It is evident that the residents of this neighbourhood are taking advantage of this park which is gradually being transformed into undesignated dumpsite. This poses environmental threat in terms of how solid waste should be managed.

This indiscriminate waste dumping may be disastrous in that it is difficult to tell whether some of the waste dumped here could be having chemicals contents like pesticides, herbicides or insecticides which are poisonous and others may be broken bottles which are hazardous. This finding, shows how fast we should move to ensure proper planning of this developing urban centre in order to curtail adverse environmental impacts it may cause. See plate 4.3 where solid waste is dumped near the dark iron sheet which is used as fence. Bushy areas attract rodents and snakes which are harmful to human.

**Plate 4.3: Bushy Area in Kitere, Rongo Sub-county being turned into dumpsite**
*Source: Author, 2021*

An additional evidence of poor waste management in Kitere shopping centre was shown in plate 4.4. This plate shows small business temporary structures/premises poorly disposing of their solid waste. The study noted that people take advantage of small open spaces and bushy areas to act as their dumping sites. This is purely unhealthy as far as environmental planning and management is concerned. It remains difficult to understand whether such actions are intentional or people just take advantage of lack of adequate commitment to monitoring activities by the county government to ensure proper environmental management. The study noted the need for an urgent action which should be taken to help curb poor waste management in the developing slum. Plate 4.4 presented the details explained here. Another evidence of poor waste management is as shown in plate 4.5 where a residential area in Kitere takes advantage of its bushy surrounding and uses it to

dispose of its waste. This also shows how environment is made to be vulnerable with regards to waste management in the developing university slum. The study noted that the major focus for the people is having new development activities. There is very little evidence of integrating environmental concerns in these development activities. With faster growth being realized in the area, more land and other environmental resources will continue to be degraded.

**Plate 4.4: Solid Waste in Open Space**

**Plate 4.5: Solid waste in Bushy Area**

*Source: Author, 2021*

### 4.3. Nature and Extent of LULC Changes in RU and the Local Environment

In its effort to meet objective two, the study explored how the environment used to be at respondent's arrival in the study area. The results of the study indicated that over 50% of the people described the environment to be occupied with crops or plantation (52.7%). Initially, people in the study area used to grow sugar cane as their cash crop. This means the use under which the land was put was agriculture. The study noted that during the time sugar cane is in the field before harvesting, it supports various forms of organisms through provision of habitat. It also controls soil erosion as it makes the land to be covered. On the other hand, 18.9% described their environment to be open. They meant that the area was not built. Other people (17.1%) perceived their environment to be covered with trees. The study noted that this does not necessarily mean that everywhere was covered with trees but larger parts of the areas they settled in were covered with trees. Some of these trees were

planted while others were indigenous trees existing in their natural environment. The study justified this description based on the fact of initially, fewer people occupied the study area before the establishment of RU. Thus some areas were left uncultivated hence favouring growth of trees. This description also concurred with the 5.4% who perceived the study area to be forested during their arrival. The study noted there was no government gazetted forest in the study area. Therefore, describing the study area to be forested was based on the respondent's understanding which could mean few planted trees within the study area. This could also be possible with the RU students who must have seen the small forest being developed by the university. A few individuals (5.9%) described the environment to be built everywhere. Possibly, these are some of the RU students and staff who have not taken long and they came when development in the area had started to be influenced by the university. Probably, they found when most areas have been developed. Figure 4.7 presents graphical representation of the explained results.

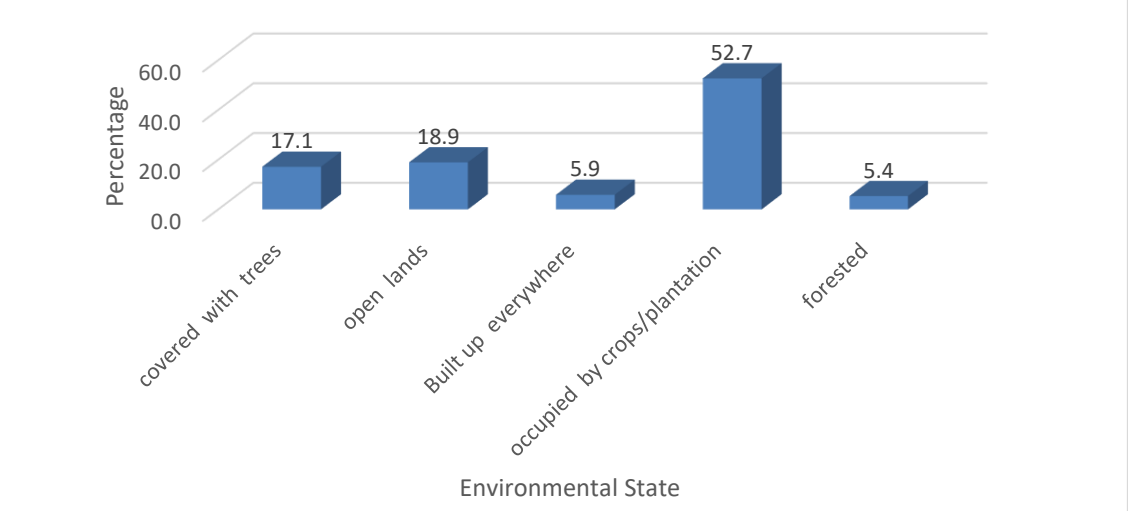


**Figure 4.7: State of the environment at respondent's arrival in RU and the local environment**
*Source: Author, 2021*

In consideration of the current state of the environment the study noted an overwhelming confirmation of 89% that the environment has been transformed into buildings. This implies that we are at the verge of losing natural environment to built environment. Potentiality of the study area for development has triggered and influenced immigration into the area. Possible sudden population explosion has increased demand for goods and other services such as housing. The increased demand has prompted faster development of

housing leading to loss of natural environment due to clearance of vegetation. As portrayed in figure 4.8, the 5.9% of the people who described the current state of the environment to be cleared, concurred with those who contended that the environment has been transformed into buildings in one hand since land can be cleared for construction or agricultural activities majorly. This is because development of structures starts with clearance of vegetation. The study also noted that description of the environment as 'cleared' could mean cleared for other human activities like agriculture. Contrarily, some people (5.1%) perceived the environment to have retained its original state as they found it at arrival. The study noted that this category of people could be students and some new staff members who might have joined Rongo University recently and have not witnessed remarkable changes in the environment. Figure 4.8 shows the results elucidated.

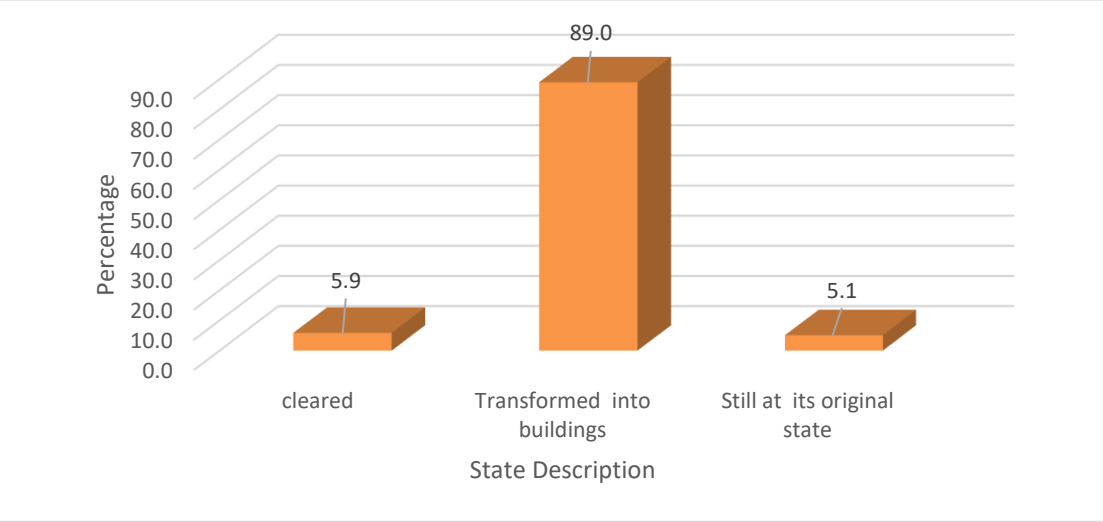


**Figure 4.8: Current state of the environment in RU and the local environment**
*Source: Author, 2021*

In the interest of establishing whether the state of the environment has changed, the study findings revealed that many people (89%) are in concurrence that environment has changed its state. This finding is similar to the results presented in figure 4.8 where majority of the people were of the opinion that the environment has been transformed into buildings. This is a clear indication that the community is witnessing environmental changes and they acknowledge them. What is left to be achieved is their engagement, participation and commitment in ensuring sustainable development. However, some people (11%) did not acknowledge environmental change. In this case, the study noted that possibly, they are the

same group who argued that the environment is still in its original state in figure 4.8. As mentioned earlier, this could be a representation of some students and staff members who had not taken long in the study area but were engaged in the research as equal opportunity of participation was given during data collection. Also, this could represent a group who are not keen to observe environmental changes. It is possible that they lack or have little knowledge on environmental issues. Figure 4.9 presents the results described.

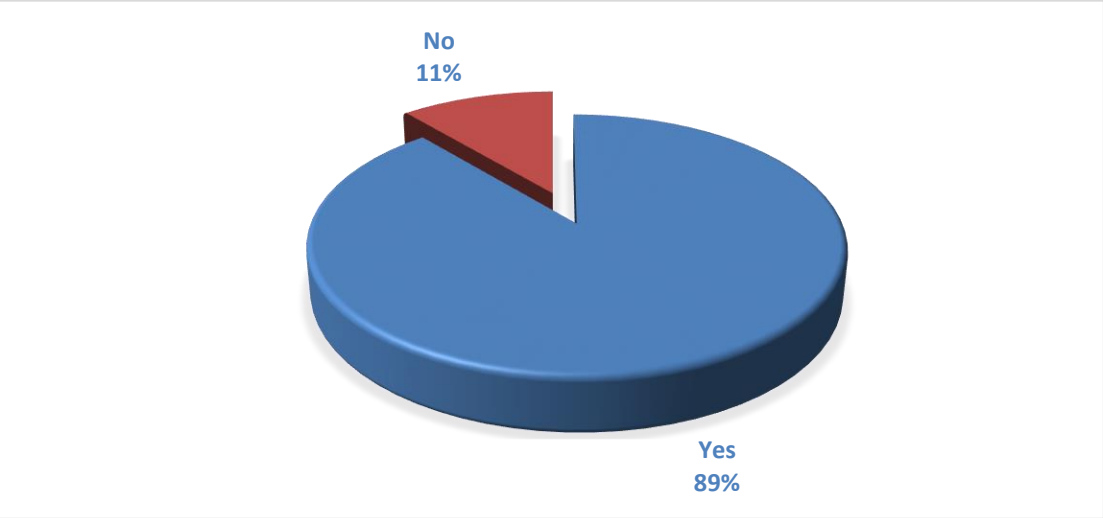


**Figure 4.9: Possibility of environment changing state within RU and its local environment**
*Source: Author, 2021*

The environmental state changes realized by the study were noted to be the contributors to LULC changes that the study sought to establish. For instance, transformation of agricultural land into commercial buildings is a LU change. That is from agriculture to settlement. Loss of vegetation during establishment of buildings and other infrastructure signifies loss of LC. Thus LC change. This notwithstanding, the study noted a change in use of premises. A discussion with one of the private developers revealed that some proponents were forced to change use of some premises in order to meet the student accommodation demands. A good example is shown in plate 4.6. The building used to serve as a shop but was changed to be used as a hostel due to rise in accommodation demand as was argued by one of the respondents during his interview by the researcher. The question is whether the building meets the minimum standards spelt out in the second schedule of the University Act Cap 210B. The Act contains a description of minimum standards in its second schedule on how university physical facilities and any other facility

to be used by a university should be constructed. It therefore follows that any private developer intending to offer accommodation services should comply to theses minimum standards. The study noted a possibility of this being sidelined in consideration for change of use. Such kind of changes might be hidden to the commission for university education which ensures that the University Act Cap 210B of 2012 is implemented accordingly by the universities. Basically such kinds of changes hardly put into consideration the provisions in the Act. See plate 4.6 for change of use.

**Plate 4.6: Premise whose use was changed from shop to hostel in Kitere, Rongo Sub-county**
*Source: Author, 2021*

The study yielded the following results in an effort to establish the direction of environmental change within the study area: 64% of the people were of the opinion that the state of the environment was changing from bad to good. Possibly, their attention was focused on emergence of new infrastructures which are appealing by look. Some could also be imagining of moving from the initial bushy environment which is now being replaced by new buildings. Also, the attention of these individuals could have been captured by increased potential of the area with regards to attraction of development activities. The study noted total lack of integration of environmental concerns in the minds of these many people. This also, portrays urgent need of community capacity building and sensitization on environmental management. This group of people (majority) failed to see impacts created when we lose LC by transforming more natural environment into built

environment. The study noted that if such perception continues among many like the ones identified by the study, then our environment will become more vulnerable and will be degraded faster. It is fortunate that the study did not fail to get those who keenly observed and noted change to be taking wrong direction. This group seemed to understand the pain of losing natural environment. These were represented by 36%. This class could be the environmentally informed people who participated in the research. They were able to foresee danger in replacing natural environment with built up structures. The consequences of compromising ecological roles performed by vegetation and loss of biodiversity could have rung in their minds. The study noted that such people could be used to mobilize the community to adopt best practices in order to realize sustainable development within the study area. See figure 4.10 for the results clarified.

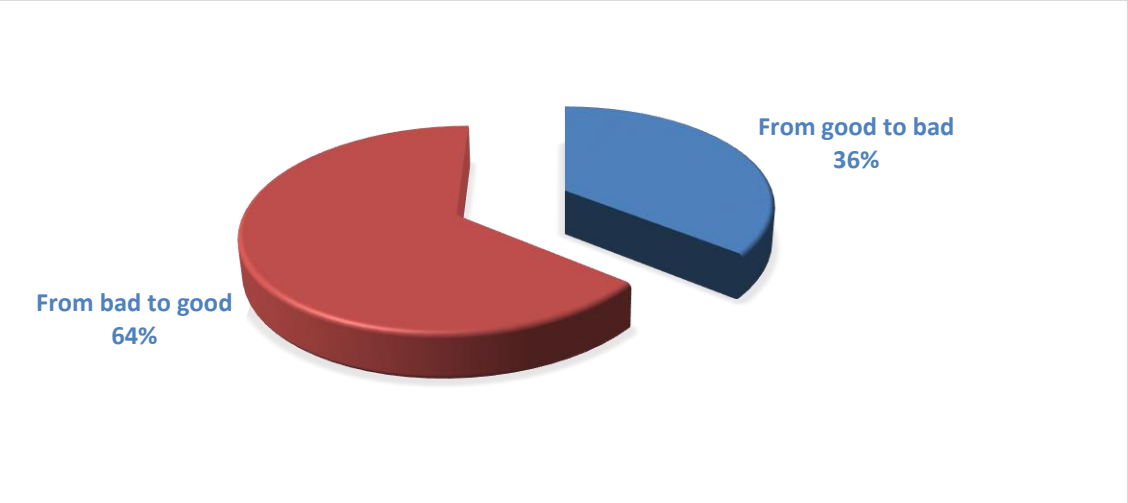


**Figure 4.10: Direction of environmental state change in the study area**
*Source: Author, 2021*

Data gathered through remote sensing was summarized in table 4.4. For purposes of clarity and detailed information on how university influences development in its immediate surroundings, North Kanyajuok where RU is established was clipped and the study focused on it. Various LUs and LC are shown in the table based on the supervised classification used. Their coverage in hectares and percentages from 2003 to 2018 are also portrayed. The results from this table indicated that in 2003, long before RU was established, grassland covered the largest area (1356.84ha). This was represented by 68% of the total land in the sub – location. Area under plantation was 325.74ha (16%) while settlement was

occupying 159.94ha (8%). 88.99ha of land in the area was open with no development activities while 70.45ha was covered with trees. Both tree cover and open land had almost the same percentage (4%). From these results, it was clear that North Kanyajuok had a lot of LC considering the fact that tree cover, grassland, plantation/farmland together with open land with patches of grass all form LC. This gave the area a color green as built up environment was only 8% as presented in table 4.4.

The results in table 4.4 also indicate that agricultural activities in the study area though practiced during this time, was not intense. The study noted that farmland covered only 16% of the total area. This implied minimal interference with the natural environment. Such conditions give opportunity for the various life forms to freely interact and breed in their natural environment. It is also apparent that other ecological roles performed by the environment were still intact and being enjoyed by both human and other wildlife. Little interference with the natural environment during this period was advantageous even to the farmers as LC protects the soil from being eroded. Possibly, much of the environmental resources were also being enjoyed such as herbs and wild fruits such as guava.

In the year 2010, the study noted significant changes in LUs and LC. The changes noted were based on comparative data gathered in the two years, 2003 and 2010. Both of these years, gave information just before the establishment of RU. Study recorded a tremendously change in farmland which increased from 325.74ha (16%) in 2003 to 1065.99ha (53%) in 2010. On the other hand grassland area reduced from 1356.97ha (68%) in 2003 to 386.17ha (19%) in 2010. Also, tree cover reduced from 70.45ha (4%) in 2003 to 13.95ha (1%) in 2010 while settlement increased form 159.94ha (8%) in 2003 to 284.48ha (14%) in 2010. Similarly, open land increased from 88.99ha (4%) in 2003 to 252.53ha (13%) in 2010. In this regard, the study noted the linkage between increase in farmland/plantation areas and other LCs. From the results it was clear that as plantation/farmland increases, grassland and tree cover areas reduced. This may be due to clearance of land for crop cultivation. The areas formally occupied by grass and tree were being transformed into agricultural land for crop production. The increase in settlement during this period could be as a result of normal population growth in the area. As population increases, more housing services are needed hence increased settlement. On the

other hand, increase in open land could be due to the more areas explored for agricultural activities. The study also noted possibility in clearing areas intended for agricultural activities to be contributing to increase of open lands. Other attributes to this could be clearance of areas around homesteads to keep away wild animals.

A rapid development of settlement was noticed by the study between the year 2010 and 2013. The study findings revealed that in the year 2013, settlement was occupying 647.63ha (32%) while in 2010, it only occupied 284.28ha (14%). RU was hardly two years old by the year 2013. Comparing the increase rate witnessed between 2003 and 2010 and what was witnessed between 2010 and 2013, something remains unanswered. Between 2003 and 2010 (7 years), settlement had increased by 124.54ha (6%) while between 2010 and 2013 (3 years), settlement increased by 363.15ha (18% increase). It becomes apparent that for such a rapid increase to be realized, Rongo University must have catalyzed development of settlement in the study area. This is because if seven years elapsed before establishment of Rongo University and only 6% increase was realized while after its establishment 18 percent increase was realized within only three years.

The study also established that in 2013, open land increased from 252.53ha (13%) in 2010 to 500.76ha (25%) in 2013 while grassland retained almost the same coverage in 2013 as it was in 2010. That is 386.17ha (19%) in 2010 and 380.64ha (19%) in 2013. The increase in open land could have been attributed to by harvest of the crops and preparation of some lands for crop cultivation. Retaining the percentage cover by the grassland could be associated with noninterference with such areas by agricultural activities in the subsequent season. Neither were they affected by the new settlement development. Also, the study noted an increase in tree cover with a decrease in plantation/farmland. Tree cover increased from 13.95ha (1%) in 2010 to 171.43ha (9%) in 2013. On the other hand plantation decreased from 1065.99ha (53%) in 2010 to 302.8ha (15%) in 2013. The increase in tree cover could be attributed to by natural growth of various tree species in the different part of the study area. Also it could be as a result of planted trees in the area. On the other hand, decrease in plantation could be attributed to by harvesting of crops.

The results of 2014 indicated that there was tremendous loss in tree cover and open land. In 2013, tree cover occupied 173.43Ha (9%) while in 2014 it was only covering 4.08ha (0.2%). Open land occupied 500.76ha (25%) in 2013 but in 2014 it only coved 18.19ha (0.91%). The linkage between plantation/farmland and other LC was evident in the year 2014. The study noted that other LC together with open lands decrease with increase in farmland/plantation. The significant decrease in tree cover realized in the year 2014 could be attributed to clearance of vegetation during cultivation. Decrease in open land could be as a result of engaging some fallow land to agriculture activities in 2014. The results also revealed that there was no significant change in area covered by grassland since in 2013 it occupied 380.64ha (19%) while in 2014 grassland covered 326.33ha (16.29%). Similarly, settlement only increased by 0.53% as it covered 647.63ha (32%) in 2013 but in 2014 it occupied 651.48ha (32.53%). See table 4.4 for the elucidated results.

**Table 4.4: Summary of LULC Hectares and Percentages from 2003 to 2018**

| LULC | 2003Area in Ha & % | | 2010 Area in Ha & % | | 2013 Area in Ha & % | | 2014 Area in Ha & % | | 2015 Area in Ha & % | | 2016 Area in Ha & % | | 2017 Area in Ha & % | | 2018 Area in Ha & % | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ha | % | Ha | % | Ha | % | Ha | % | Ha | % | Ha | % | Ha | % | Ha | % |
| **Tree cover** | 70.45 | 4% | 13.95 | 1% | 171.43 | 9% | 4.08 | 0.20% | 83.21 | 4% | 4.63 | 0.23% | 43.09 | 2% | 68.73 | 3.43% |
| **Open land** | 88.99 | 4% | 252.53 | 13% | 500.76 | 25% | 18.19 | 0.91% | 339.84 | 17% | 43.23 | 2.16% | 145.37 | 7% | 2.60 | 0.13% |
| **Plantation** | 325.74 | 16% | 1065.99 | 53% | 302.80 | 15% | 1002.88 | 50.07% | 354.24 | 18% | 106.20 | 5.30% | 120.83 | 6% | 82.95 | 4.14% |
| **Settlement** | 159.94 | 8% | 284.48 | 14% | 647.63 | 32% | 651.48 | 32.53% | 849.79 | 42% | 1050.58 | 52.47% | 1165.58 | 58% | 1252.41 | 62.52% |
| **Grassland** | 1356.97 | 68% | 386.17 | 19% | 380.64 | 19% | 326.33 | 16.29% | 375.96 | 19% | 797.79 | 39.84% | 527.93 | 27% | 596.43 | 29.78% |

*Source: Author, 2021*

From the same table (4.4), the study noted that there was significant increase in settlement and open land in the year 2015 as compared to previous years. As was earlier stated, in 2014, settlement occupied 651.48ha (32.53%) while in 2015, it occupied 849.79ha (42%). Open land covered 18.19ha (0.91%) in 2014 while in 2015 it occupied 339.84ha (17%). Equally, tree cover also registered an increase from 4.08ha (0.2%) in 2014 to 83.21ha (4%) in 2015. A significant decrease was registered by plantation as was noted in 2014 that plantation occupied 1002.88ha (50.07%) while in 2015 it dropped to 354.24ha (18%). Increase in settlement could be as a result of increased demand for housing facilities arising from the people pulled by RU. Establishment of the university could have created demand for learning facilities, business enterprises together with accommodation facilities hence rapid increase in settlement. The study attributed alteration in decrease and increase of open land, tree cover, grassland and plantation to change of seasons when the Landsat images were taken. For instance, in 2015 the increase in open land could be due to harvesting season when plantation was seen to have reduced. Tree cover, grassland and open lands are always influenced by increased farmlands/ plantations. The study noted a trend in which decrease in plantation results into increase of LC and open land and vice versa. This applies to the findings in 2015 and the previous years discussed above.

The year 2016 also revealed a significant increase in settlement and grassland. Settlement increased from 849.79ha (42%) in 2015 to 1050.58ha (52.5%) in 2016. This shows a 10% increase in settlement within a span of one year. Similarly, in the year 2015, grassland occupied 375.96ha (19%) while in 2016 its coverage was 797.79ha (40%) showing an increase of 21%. Plantation, open land and tree cover registered a decrease in coverage. Plantation moved from 354.24ha (18%) in 2015 to 106.2ha (5.3%) in 2016. Also, open land decreased from 339.84ha (17%) in 2015 to 43.23ha (2%) in 2016. In addition, tree cover moved from 83.21ha (4%) in 2015 to 4.63ha (0.2%) in 2016. Possibly, there was a lot of pressure in providing housing facilities in the study area. The only question regarding this is whether people adhere to development standards as stipulated in the policies governing development activities especially when working under pressure to make money. Rapid increase in settlement translates to faster rate of transformation of natural environment into built environment. The increase in grassland could have been attributed to by the reduction in plantation. It was worth noting that in 2016, both plantation and tree cover decreased

with open land. This could be as a result of more land taken by settlement while other pieces are also sold to await development hence change of ownership. Probably the ones awaiting development could support growth of grass hence increased grassland.

Increase in settlement was further registered in 2017. This year's result depicted that settlement which occupied a total of 1050.58ha (52.5%) in 2016 rose to cover 1165.58ha (58%) in 2017. This showed an increase of 5.5%. Also, the study noted a little rise in open land as it moved from 43.23ha (2%) in 2016 to 145.37ha (7%) in 2017. Insignificant rise in plantation was also noted as the year 2016 indicated that it occupied 106.2ha (5.3%) while in 2017 its coverage was 120.83ha (6%). Similarly, the year 2017 registered a little increase in tree cover as it occupied 43.09ha (2%) while in 2016 it only covered 4.63ha (0.2%). On the other hand, grassland decreased from 797.79ha (40%) in 2016 to 527.93ha (26%) in 2017. The study attributed settlement's yearly increment in the study area to the establishment of RU which has pulled different activities and catalyzed development in the region. As a pull factor, RU has drawn many individuals from different parts of Kenya hence necessitating development of housing facilities to provide both accommodation and business enterprises and/ or structures. The only challenge is that LC and LU change during such developments.

The finding of 2018 revealed a continued increase in settlement as it showed that the area under settlement was 1252.41ha (62.5%). This indicated a positive deviation of 4.5% since settlement occupied 1165.58ha (58%). A little increase in grassland and tree cover was also recorded as it was covering 527.93ha (26%) in 2017 but in 2018, it occupied 596.43ha (29.8%). Tree cover increased from 43.09ha (2%) in 2017 to 68.73ha (3.43%) in 2018. Plantation dropped from 120.83ha (6%) in 2017 to 82.95ha (4.14%) in 2018. Similarly, open land also dropped from 145.37ha (7%) in 2017 to 2.6ha (0.13%) in 2018. From these results, it was evident that settlement continued to increase every year. The study also noted decline in plantation coverage from 2015. This implied that more agricultural land was being lost as settlement increased. Equally, loss of open land was evident from 2014. This means that the lands which were formally lying fallow were being built up. The above results were summarized in table 4.4 as presented above.

In order to ascertain if there is any difference in rate of development between RU local environment and other places, the study used Rongo town to compare its LULC over the same periods as RU. Table 4.5, presents Rongo town LULC changes which occurred between 2003 and 2018. The study noted that the rate of LULC changes is higher in North Kanyajuok as an administrative unit (a rural setup) than in Rongo town. Under normal circumstances, it is always believed that the rate of development in urban area is higher than in rural areas. The findings of the study have revealed that this is not true in a section of Rongo sub-county as establishment of Rongo University has catalyzed development of Kitere region than Rongo town. See table 4.5 for the described results.

**Table 4.5: Rongo Town LULC Changes**

| LU/ LC | Percentage 2003 | Percentage 2008 | Percentage 2010 | Percentage 2013 | Percentage 2015 | Percentage 2017 | Percentage 2018 |
|---|---|---|---|---|---|---|---|
| **Grassland** | 6.47 | 19.83 | 2.34 | 5.47 | 4.51 | 3.57 | 3.511 |
| **Open land** | 14.83 | 3.04 | 4.31 | 2.86 | 2.35 | 1.10 | 0.72 |
| **Plantation** | 65.29 | 72.06 | 46.48 | 34.26 | 31.49 | 30.18 | 22.77 |
| **Settlement** | 2.48 | 4.87 | 15.81 | 22.77 | 30.37 | 35.68 | 48.51 |
| **Tree cover** | 10.93 | 0.21 | 31.06 | 34.64 | 31.27 | 29.47 | 24.49 |

*Source: Author, 2021*

Table 4.6 presents a comparative data on LULC changes in North Kanyajuok (NK) and Rongo town. It is evident that development of settlements in Kitere, North Kanyajuok is higher than that of Rongo town. This implies that natural environment is transformed into built environment at a higher rate in Kitere than in Rongo town. LC is also lost as a faster rate in Kitere than Rongo town. See table 4.6.

**Table 4.6: Comparative Data of North Kanyajuok and Rongo Town**

| LU/LC | 2003 | 2010 | 2013 | 2015 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| **Settlement** | | | **Percentage** | | | |
| North Kanyajuok | 8 | 14 | 32 | 42 | 58 | 62.5 |
| Rongo Town | 2 | 15 | 22.8 | 30 | 35 | 48.5 |
| **Tree Cover** | | | | | | |
| North Kanyajuok | 4 | 1 | 9 | 4 | 2 | 3 |
| Rongo Town | 10.9 | 31 | 34 | 31 | 29 | 24 |
| **Grassland** | | | | | | |
| North Kanyajuok | 68 | 19 | 19 | 19 | 27 | 29.8 |
| Rongo Town | 6 | 2 | 5 | 4.5 | 3.5 | 3.5 |
| **Open Land** | | | | | | |
| North Kanyajuok | 4 | 13 | 25 | 17 | 7 | 0.1 |
| Rongo Town | 14.8 | 4 | 2.9 | 2 | 1 | 0.7 |
| **Plantation** | | | | | | |
| North Kanyajuok | 16 | 53 | 15 | 18 | 6 | 4 |
| Rongo Town | 65 | 46 | 34 | 31 | 30 | 22.8 |

*Source: Author, 2021*

Table 4.6 reveals that most of the development in the town has been done on the land formally open. Also, grassland which is a LC has been lost. Similarly, farmland (areas formally occupied by plantation) has tremendously reduced from 65% in 2003 to 22.8% in 2018. It is worth noting that in North Kanyajuok where Rongo University main campus is established, settlement increased by 18% between 2010 and 2013. This is one year just before and after the establishment of the university. Comparatively during this period, settlement in Rongo town only increased by 7.8%. This clearly shows the difference in rate of development between North Kanyajuok where Rongo University main campus is situated and Rongo town. Despite the fact that Rongo University has also influenced development of settlement in Rongo town such as establishment of student accommodation facilities, the rate of development in North Kanyajuok is evidently higher.

The study used table 4.7 to present comparative results of the years 2010 and 2018. This was done to determine the extent and nature of changes which have occurred since the establishment of RU in North Kanyajuok. The information provided was in hectares and percentages. The results in this table indicate that built up environment is taking over from the natural environment in the study area. This was justified by the constant rise of settlement depicted in table 4.4. The study noted that in 2010, a year just before the establishment of RU, settlement occupied 284.48ha (15%) of the total area of North Kanyajuok. In 2018, seven years after the establishment of the university, settlement coverage increased to 1252.41ha (62.52%). This is an increase of 48.52% within a span of only seven years. A comparison made with regards to rate of change registered between 2003 and 2010 raises a concern on environmental planning and management issues. In 2003 for instance, settlement only covered 159.94ha (8%) of the total area of North Kanyajuok while in 2010 it occupied 284.48ha (14%). This implied that the change realized within this span of seven years was only 6% while the change realized between 2010 and 2018 was 48.52%. The question left unanswered is the reason why same periods (7 years) that is (2003–2010 and 2010–2018) give different rate of change in LUs and LC. The study noted that there must be a catalyzer which instigates this rapid rate of change. From table 4.7, the study also learned that open land has significantly reduced from 252.53ha (13%) in 2010 to 2.6ha (0.13%) in 2018. This represents a 12.87% decrease. The significant loss of open land could be as a result of increased settlement which might have claimed most part of the lands which were initially not built.

The study also made a summary of changes which had been realized on farmlands/plantations. The results yielded indicated a total decrease of 48.86%. This was based on consideration of total area occupied by plantation in 2010 against 2018. In 2010, plantation covered 1065.99ha (53%) while in 2018, it only occupied 82.95ha (4.14%). This signified massive loss of agricultural land as built up environment increases in acreage. However, the results obtained after comparing grassland and tree cover data of 2010 and 2018 revealed an increase in LC. In 2010 grassland occupied 386.17ha (19%) while in 2018 it covered 596.43ha (29.8%). This is a 10.8% increase. Also, tree cover was occupying 13.95ha (1%) in 2010 while in 2018, its coverage was 68.73ha (3.43%). This shows a 2.43% increase. The reason for increases in both tree cover and grassland was revealed by

table 4.6 which addresses issues of change detection. Table 4.7 shows that between 2013 and 2018 LULC changed. For instance area of 122.85ha (6.14%) which was formally open land transformed to grassland. Similarly, 12.39ha (0.62%) changed from open land to tree cover. The study also noted government campaigns for national increase in tree cover which might have influenced planting of more trees in the study area. However, despite notable increase in grassland and tree cover (LC), it is worth noting that they are threatened by the faster rate of LU changes in the area. Built environment is rapidly increasing due to increased demand for housing. Equally, these increases might not be maintained since they are affected seasonally by agricultural activities. The study noted that increased agricultural activities lead to loss of grassland and tree cover since they are cleared to pave way for cultivation. See table 4.7 for the results explained above.

**Table 4.7: North Kanyajuok LULC Changes between 2010 and 2018**

| LULC | 2010 | | 2018 | | DEVIATIONS | |
|---|---|---|---|---|---|---|
| | Ha | % | Ha | % | Ha | % |
| **Tree cover** | 13.95 | 1% | 68.73 | 3.43% | 54.78 | 2.43 |
| **Open land** | 252.53 | 13% | 2.60 | 0.13% | -249.93 | -12.87 |
| **Plantation** | 1065.99 | 53% | 82.95 | 4.14% | -983.04 | -48.86 |
| **Settlement** | 284.48 | 14% | 1252.41 | 62.52% | 967.66 | 48.52 |
| **Grassland** | 386.17 | 19% | 596.43 | 29.78% | 210.26 | 10.78 |

*Source: Author, 2021*

In order to portray the trend in LULC changes, the study used figure 4.11. The figure shows graphical representation of LUs and LC from 2003, long before establishment of Rongo University to 2018, and even years after Rongo University establishment. These changes had been described year by year as demonstrated in the previous pages.

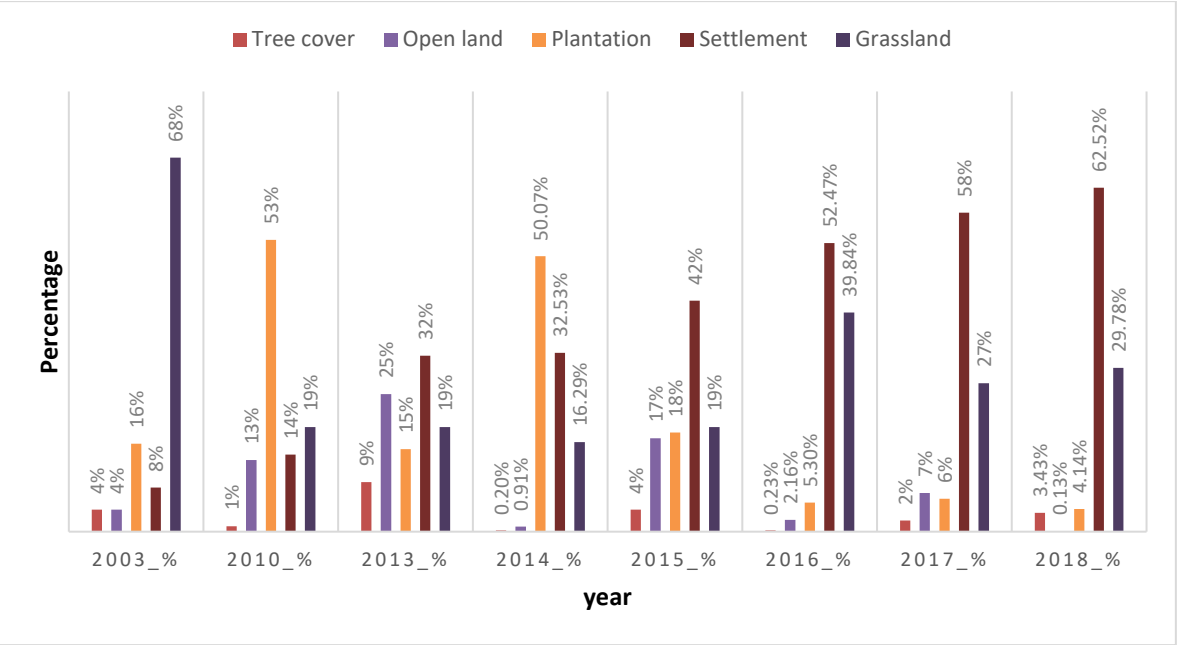


**Figure 4.11: Summary of North Kanyajuok LULC between 2003 and 2018**
*Source: Author, 2021*

Figure 4.12 presents a summary of Rongo town LULC changes which occurred between 2003 and 2018. The figure shows constant increase of settlement from 2003 to 2018. It also shows how areas formerly open have been built up as indicated by constant reduction of its bar heights from 2003 going to 2018. See figure 4.12.

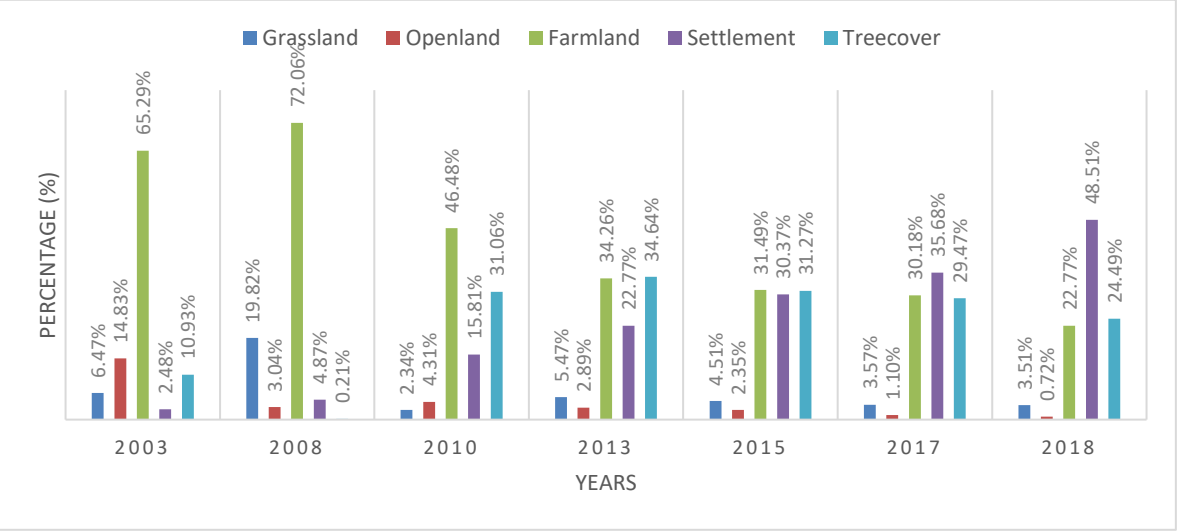


**Figure 4.12: Summary of Rongo Town LULC Changes between 2003 and 2018**
*Source: Author, 2021*

The nature of changes in LULC from the year 2013 to 2018 was summarized in table 4.8. The transformation or modifications were presented to show LU or LC shifts in occupation or coverage. For example, an open land changing to settlement or tree covers and vice versa. The results in this table shows that a total of 181.23ha (9.06%) initially occupied by trees was transformed into settlement. Possibly, this could be as a result of the increased housing demand created by sudden influx of population in the study area. Also, a total of 127.39ha (6.39%) of tree cover was changed to grassland. Apparently, trees were felled to be used for construction and other activities. Clearance of trees may sometimes favour growth of grass in some areas thus increase in grassland. 31.9ha, (1.59%) of the area initially occupied by trees was lost to plantation. This means that areas which were occupied by trees were transformed into farmlands. It is only 39.49ha (1.97%) that was retained. That is, it was initially occupied by trees and continued to be.

Table 4.8 also shows that a large area of open land, that is 356.45ha (17.82%) was transformed into settlement between 2013 and 2018. More demand for housing facilities put pressure on available resources such as land hence open areas provide opportunity for development of settlement. Equally, open land also lost 122.85ha (6.14%) to grassland. This implied that some areas which were formally open supported growth of grass hence changed to grasslands. In addition, 12.39ha (0.62%) of open land was also transformed into tree cover hence increasing LC. When open areas stay fallow for a longer period of time, they favour growth of a variety of vegetation such as trees. The study noted that 8.08ha (0.4%) of land which was initially open was transformed into plantation. This means it was transformed into agricultural land hence change of LU. The study also noted an insignificant retention of open land as almost equal to zero percent was evident. See table 4.8.

**Table 4.8: LULC Changes between 2013 and 2018**

| Change Detection | Sum Area change Detection | Percentage change 2013 to 2018 (%) |
|---|---|---|
| Tree cover to Tree cover | 39.49 | 1.97 |
| Tree cover to open land | 0.12 | 0.01 |
| Tree cover to plantation | 31.90 | 1.59 |
| Tree cover to Settlement | 181.23 | 9.06 |
| Tree cover to Grassland | 127.39 | 6.37 |
| Open land to Tree cover | 12.39 | 0.62 |
| Open land to open land | 0.17 | 0.01 |
| Open land to Plantation | 8.08 | 0.40 |
| Open land to settlement | 356.45 | 17.82 |
| Open land to Grassland | 122.85 | 6.14 |
| Plantation to Tree cover | 4.33 | 0.22 |
| Plantation to Open land | 1.68 | 0.08 |
| Plantation to plantation | 27.06 | 1.35 |
| Plantation to settlement | 114.42 | 5.72 |
| Plantation to Grassland | 154.91 | 7.74 |
| Settlement to Tree cover | 3.13 | 0.16 |
| Settlement to open land | 0.09 | 0.00 |
| Settlement to Plantation | 7.47 | 0.37 |
| Settlement to settlement | 508.55 | 25.42 |
| Settlement to Grassland | 127.53 | 6.38 |
| Grassland to Tree cover | 9.29 | 0.46 |
| Grassland to open land | 0.53 | 0.03 |
| Grassland to plantation | 8.32 | 0.42 |
| Grassland to settlement | 89.64 | 4.48 |
| Grassland to Grassland | 63.33 | 3.17 |

*Source: Author, 2021*

The findings in table 4.8 also showed that 114.42ha (5.72%) of land which was initially occupied by plantation was changed into settlement. This implied that even agricultural land was not spared in provision of space for housing to the growing population in the study area. Also, 154.91ha (7.74%) of area which was formally under plantation changed to grassland. This could have been caused by agricultural practices like shifting cultivation or possibly leaving farms to lie fallow after harvesting hence favouring growth of grass. Similarly, 4.33ha, (0.22%) of plantation area changed to tree cover. This could have been

because of some planted trees such as Eucalyptus or natural growth of indigenous trees when farmlands lie fallow. He study noted that only 1.68ha (0.08%) of the area which was covered by plantation changed into open land. This was attributed to possible seasonal changes and activities such as harvesting of crops. Besides, 27.06ha (1.35%) of the area formally occupied by plantation remained untransformed. This means it retained its use as agricultural land. It was initially farmland in 2013 and it remained as a farmland even in 2018.

Table 4.8 also indicates that in LU and cover change, even built environment changes to natural environment. However, such changes were minimal. The study noted that 127.53ha (6.36%) of the area which was initially under settlement was transformed to grassland. Also, the table shows that 3.13ha (0.16%) of the area which was formally occupied by settlement was transformed to tree cover. Possibly, this could represent some areas with abandoned dilapidated structures which were demolished and left for natural growth of vegetation like grass or tree planted in such areas. Study findings also revealed that 7.47ha (0.37%) of the area formally occupied by settlement was transformed into plantation. Possibly, in some places some buildings were demolished and the area they occupied was changed to agricultural land. The study also established that only 0.09ha of settlement area was changed to open land. This could be as a result of demolition with future plan of development. The land is therefore left open awaiting future development. Study findings also revealed that a total of 508.55ha (25.42%) of the area initially occupied by settlement was retained. That is, it was settlement area in 2013 and still remained settlement area in 2018. Meaning the settlement structures were maintained to provide housing services as they formally were.

Other findings of the study as revealed by table 4.8 indicate that 89.64ha (4.4%) of grassland was lost to settlement. That is, areas which were occupied by grassland were developed or built up to provide housing services. Some areas, 8.32ha (0.42%) of grassland were also transformed into plantation. This implied that grassland was changed into agricultural land for crop production. Part of grassland, 9.29ha (0.46%) was also changed to tree cover. This implied that these parts were planted with trees. The study noted that change of grassland into tree cover does not show change in LC since both tree cover and

grass land are LC. A section, 0.53ha (0.02%) of grass land was also lost to open land. Possibly, it was ploughed awaiting planting season. The study also established that 63.32ha (3.17%) of grassland area was reserved. That is, it was formally grassland and remained to be grassland hence no change in LC.

From the findings in table 4.8, it becomes apparent that other LUs and LC contributed immensely to settlement. In detecting changes, the study noted that settlement took a large area, 356.45 hectares of open land. Tree cover which is a LC contributed 181.23 hectares while plantation lost 114.42 hectares to settlement. Grassland on the other hand contributed 89.64 hectares. In total, these other LUs and LCs contributed 741.74ha (37.12%) of the total acreage of North Kanyajuok to settlement. This data shows how these LUs and LC lose to settlement. That is, the rate at which they lose while built up environment gains. This calls for an urgent action of integrating environmental concerns in development activities. Substitution of LC with buildings without taking into consideration environmental concerns implies loss of biodiversity and other genetic resources. This is may in turn threaten the very survival of humans together with other life forms.

### 4.4: Local Environmental Impacts of RU

In the interest of determining local environmental impacts associated with the establishment and development of RU, the study began by identifying reasons why the respondents settled in the study area. This was done with the view that RU could have influenced people's immigration into the study area.

The findings of the study as portrayed in Figure 4.13 revealed that a number of factor have influenced people's settlement in the study area. As is always known, increased human population influence demand for more housing services. A part from the fact that RU has become its own pull factor, other services in the area have contributed to LULC changes. Study results showed that only 25.9 % of the people interviewed were natives of the study area. The rest 74.1% represented people who were pulled into the study area by various factors such as, schooling, employment, business, marriage reasons and consideration of the area to be open for development. As figure 4.13 portrays, 22.8% of the people moved and settled in the study area for business reasons while 10.9% represented those who viewed the area to be potential for development activities. The two categories viewed the

area with a commercial aspect. They perceived the area to be a business hub with increased market for goods and services. On the other hand, 14% represented those who came to seek knowledge and skills (schooling) while 20.5% had the opportunity to secure jobs in the study area, probably RU. The study noted that as many people are drawn into the area, demand for housing and other infrastructure increase. This puts pressure on other resources such as land whose uses are then compelled to change. More vegetation cover is cleared and hence loss of LC. Therefore, study considered the factors discussed here to be subjecting LULC to changes. It was worth noting that even the natives contribute change of LUs. This they do by transforming their own farmlands into commercial buildings in order to fetch monthly income through rent. See figure 4.13 for the elucidated results.

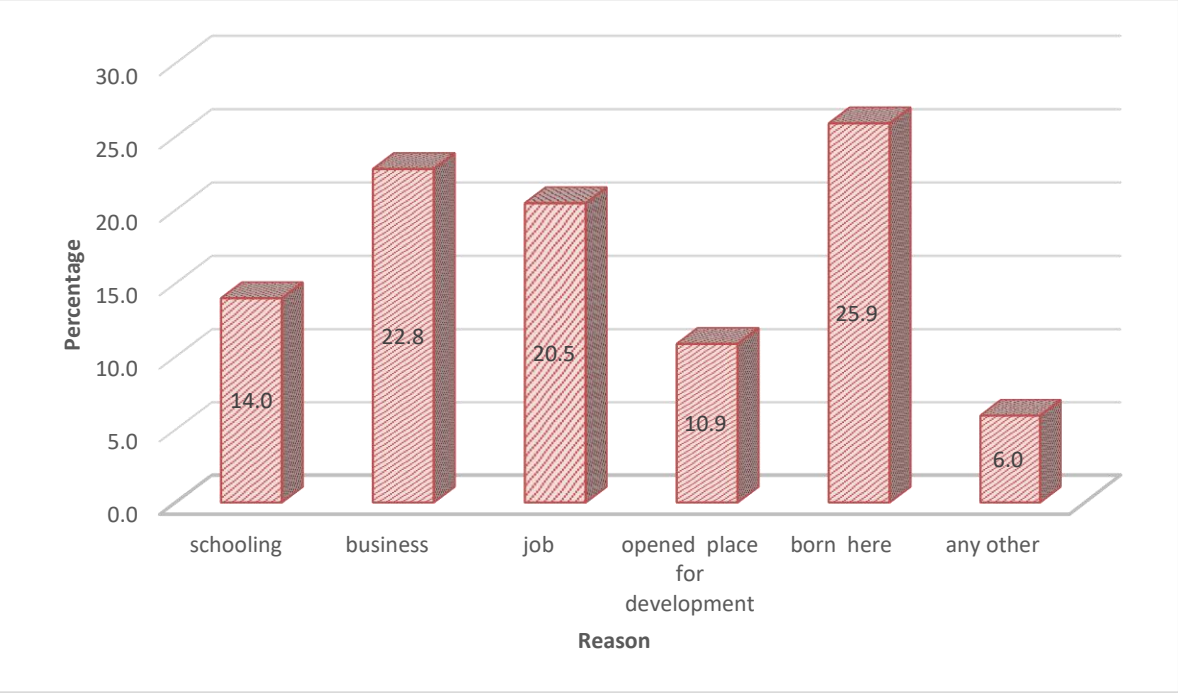


**Figure 4.13: Reasons for settling within RU and its local environment**
*Source: Author, 2021*

### 4.4.1: Drivers of LULC Changes within RU Environs

In its interest to determine drivers of LULC changes, study results indicated that many people (74.1%) were of the opinion that the LULC changes were instigated development activities undertaken by private developers. In their view, private developers have purchased parcels of land from the natives. The parcels purchased have been subjected to modification and transformation to suit commercial needs of the developers. In most cases,

the parcels of land purchased are used for development of housing facilities and not for agricultural reasons. This was justified by the 56.8% of the respondents who affirmed rapid development of housing in the study area. The result portrayed in table 4.8 supports their view as it indicated that large percentage of LC was taken by settlement. The study also noted that a number of people (66.9%) were in agreement that they witness more agricultural, tree cover, grassland and open land being transformed into built up environment as depicted in figure 4.14. Equally, some people (69.8%) considered RU on its own to be a driver of LU and cover changes in the area. In their view, RU has its own development activities such as development of studying, learning and accommodation facilities. They contended that LC is lost while such development activities are being undertaken. This group of people was supported by the 38.1% who noted that changes in LULC were brought about by the university expansion itself. Besides, they argued that RU influences even neighbourhood development as it is viewed as a source of market for various goods and services. The settlements are to cater for the demand for housing by the growing population in the study area. Establishment of the university has made Kitere region to be considered potential for development. In this regard, many people struggle to secure pieces of land and develop hence change of LULC. It therefore becomes apparent that RU is both direct and indirect driver to LULC changes in the study area. Figure 4.14 portrays the results described above.

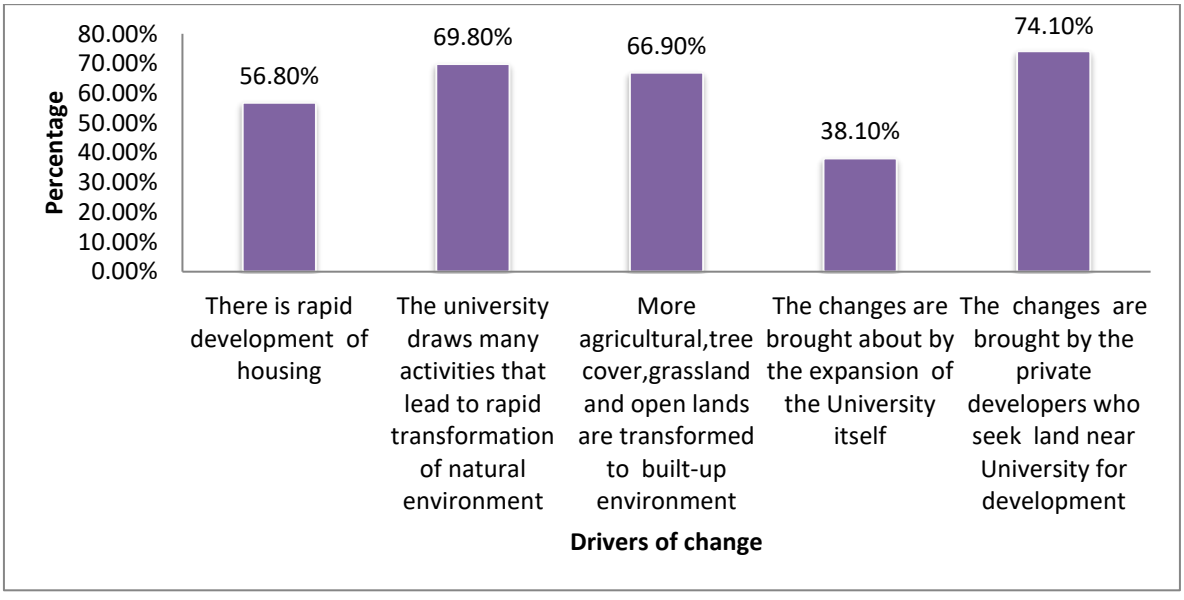


**Figure 4.14: Drivers of LULC changes within RU and its local environment**
*Source: Author, 2021*

The information gathered through observation and photography provides evidence which supports the claim of 38.1% of the respondents in figure 4.14. These people stated that the changes in LULC are caused by the university expansion itself. Plate 4.7 provides a ground truth evidence as it presents a section of the RU's forest which is cleared for the development of the library. This is a clear indication of loss of LC and change of LU. The area used to support forest but is under transformation to support a studying facility. See plate 4.7 for the results elaborated.

**Plate 4.7: Part of RU forest transformed for development of library**

*Source: Author, 2021*

The study managed to get many evidences of development activities within RU local environment undertaken by the private developers. As was claimed by majority (74.1%) in figure 4.14, the study noted a number of parcels near the university being developed by private developers. A good example is presented in plate 4.8. This plate shows hostel under construction by a private developer. This is to supplement on the university accommodation facilities. A number of such buildings were witnessed in the study area and more are still expected to come up. When such are expected, more modification and transformation on LULC are also expected. Considering the fact that the university is just few years old and more development are still expected, the study noted potentiality of the region for development increases. Therefore, if such development continues unabated or uncontrolled, then more LULC will be realized. Plate 4.8 portrays the results described.

***Plate 4.8: Privately owned hostel on a subdivided land***

*Source: Author, 2021*

Other evidence of already purchased and fenced lands awaiting development is as depicted by plate 4.9. This plate shows a parcel of land which has been sub-divided. This parcel has one structure which acts as a strore. Evidence of building material (sand) can also be witnessed. This is a clear indication of development activity which is yet to be undertaken by a private developer. Soon, the vegetation cover seen in the plot will be cleared hence loss of LC. There is also evidence of maize stalk in the plate. This implies that this was farmland. The study noted that there will be a LU change since this farmland will be transformed into settlement.

**Plate 4.9: Sub-divided parcel of land awaiting development**
*Source: Author, 2021*

In presenting the influence of RU establishment on LULC changes, the study also relied on the Landsat images for the selected years. The year 2010 was used as reference year since it portrays the status of the environment before the RU was established. Figures were put side by side for ease of view during comparison of image appearance. Figure 4.15 and 4.16 show how the environment was like before the establishment of RU.

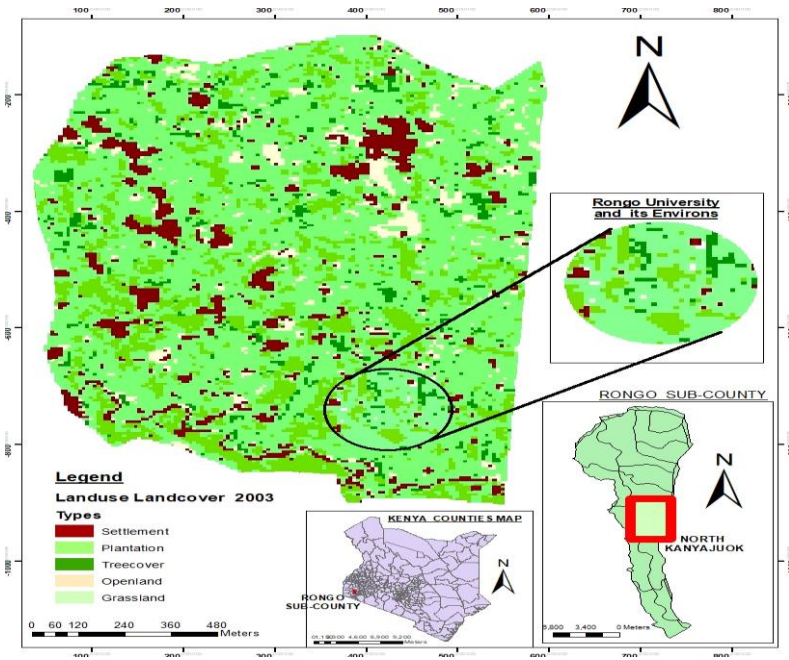


**Figure 4.15: Landsat Image for 2003 LULC**

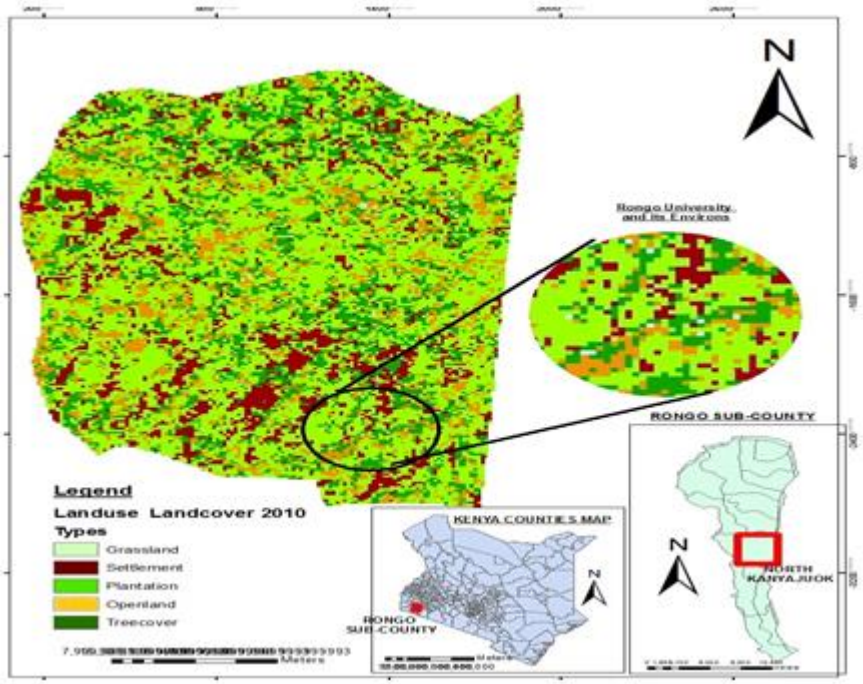


**Figure 4.16: Landsat Image for 2010 LULC**

*Source: Author, 2021*

Figure 4.15 shows the greenness of the area in 2003 long before RU was established. The intensity of red colour representing settlements increased in the year 2010. This signifies increase in settlements even before the university was established. It is also evidenced that the plantation has increased while tree cover reduced in areas occupied by settlement. In the year 2013, when the RU was hardly two years old, LULC changes could be realized as portrayed in figure 4.17 and 4.18

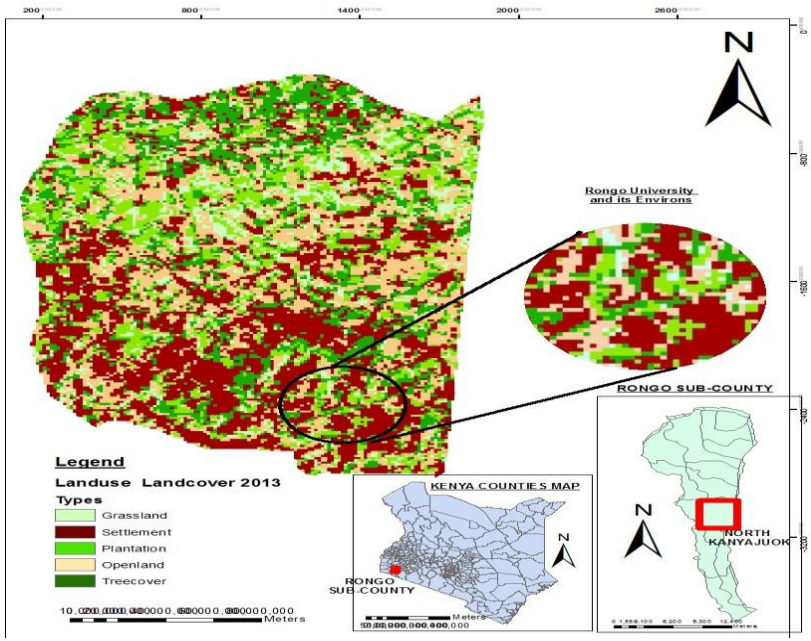


**Figure 4.17: Landsat Image for 2013 LULC**

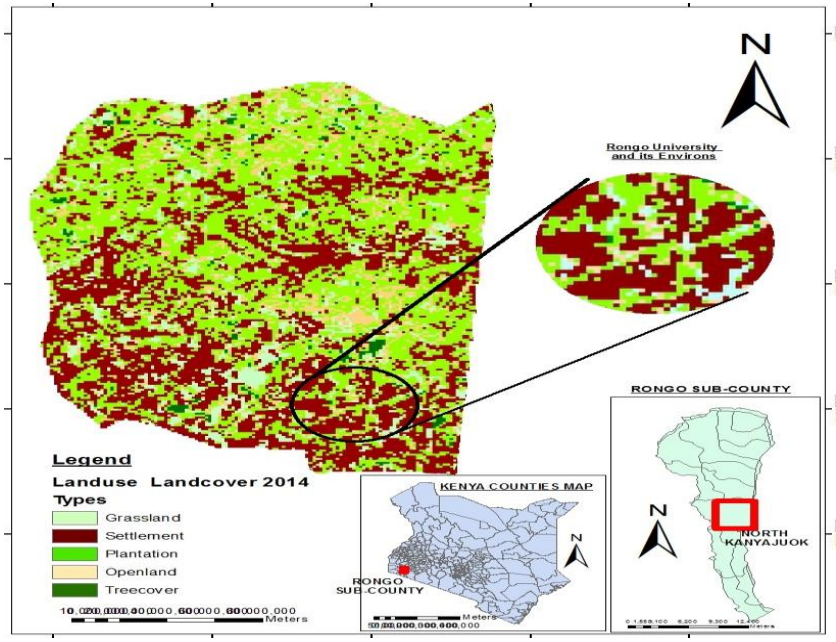


**Figure 4.18: Landsat Image for 2014 LULC**

*Source: Author, 2021*

As presented in figure 4.17, tree cover and open land was almost lost in the year 2014. There was no significant increase in settlement when 2013 and 2014 were compared. On the other hand, plantation increased significantly from the year 2013 while grassland has no significant reduction. In the year 2015 and 2016, more changes were realized as the university was growing and drawing many development activities within its environs. Figure 4.19 and 4.20 demonstrate these changes.

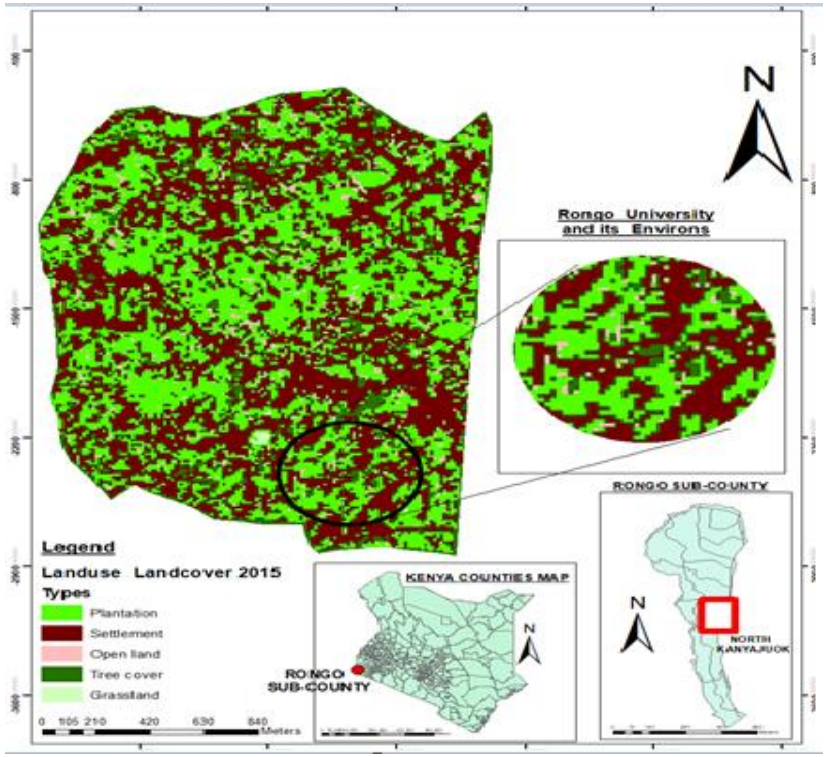


**Figure 4.19: Landsat Image for 2015 LULC**

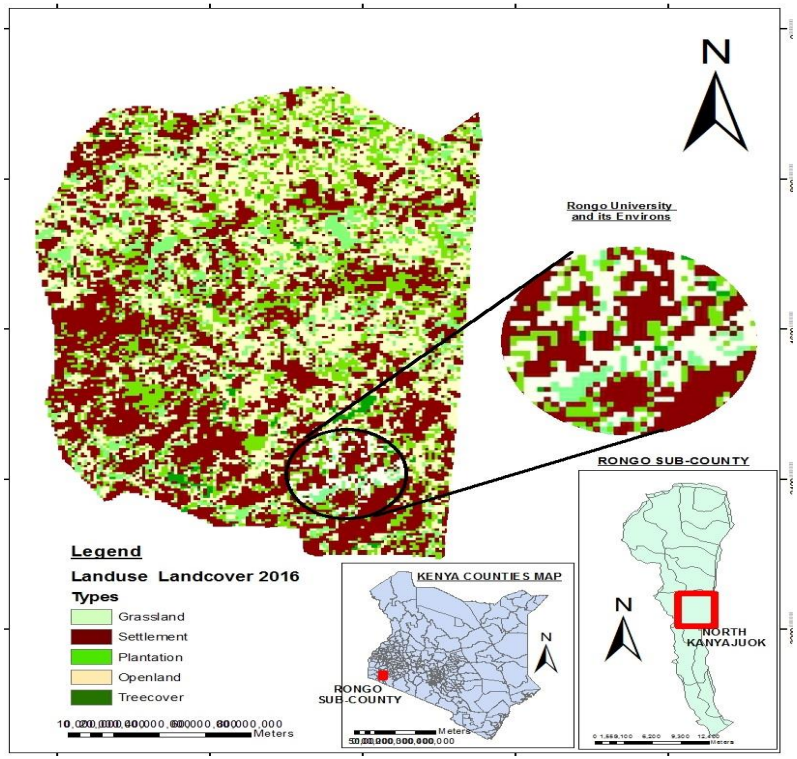


**Figure 4.20: Landsat Image for 2016 LULC**

*Source: Author, 2021*

Figure 4.19 and 4.20 depict how settlement continues to spread and occupy almost all the area around RU. The continuous increase in settlement leads to loss of LC and it also influences LU changes. Plantation has significantly reduced while the grassland has increased. Open land and tree cover have also gone down as you compare the information in 2015 and 2016. Study also used the Landsat images for the years 2017 and 2018. The year 2018 though not last in LULC changes, marked the end of this study. The information for the 2017 and 2018 were as illustrated in figure 4.21 and 4.22

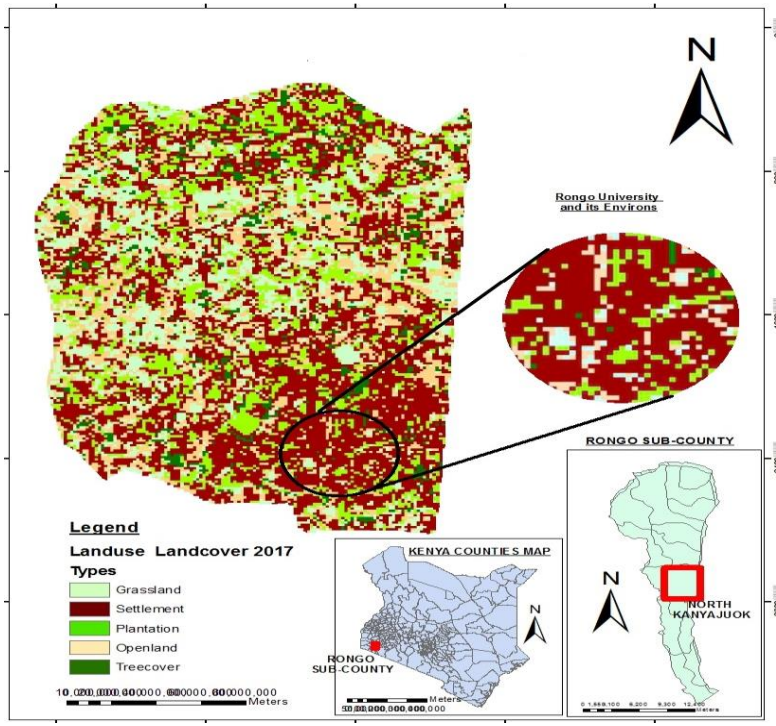


**Figure 4.21: Landsat Image for 2017 LULC**

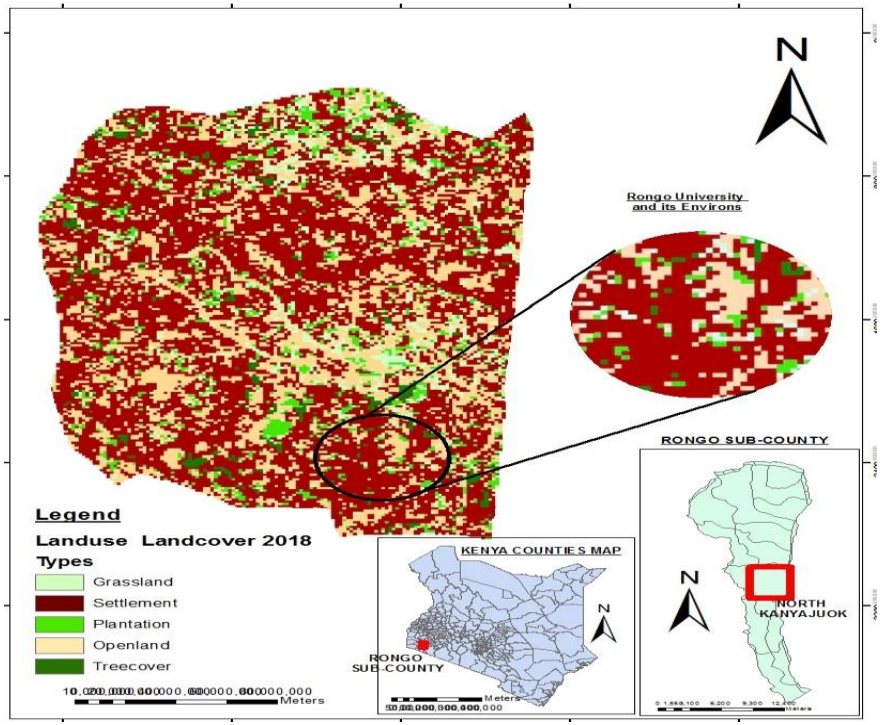


**Figure 4.22: Landsat Image for 2018 LULC**

*Source: Author, 2021*

Increase in settlement is still witnessed in the years 2017 and 2018 with intensity of the red colour increasing in 2018. Open land is almost lost and plantation is also disappearing. On the other side (LC), grassland and tree cover have little increase though are threatened with the increase in settlements. The study made a comparison on how North Kanyajuok used to look like before the establishment of RU and after the university has been operational for some time. The years 2010 and 2018 were used and the findings are as illustrated in figure 4.23 and 4.24.

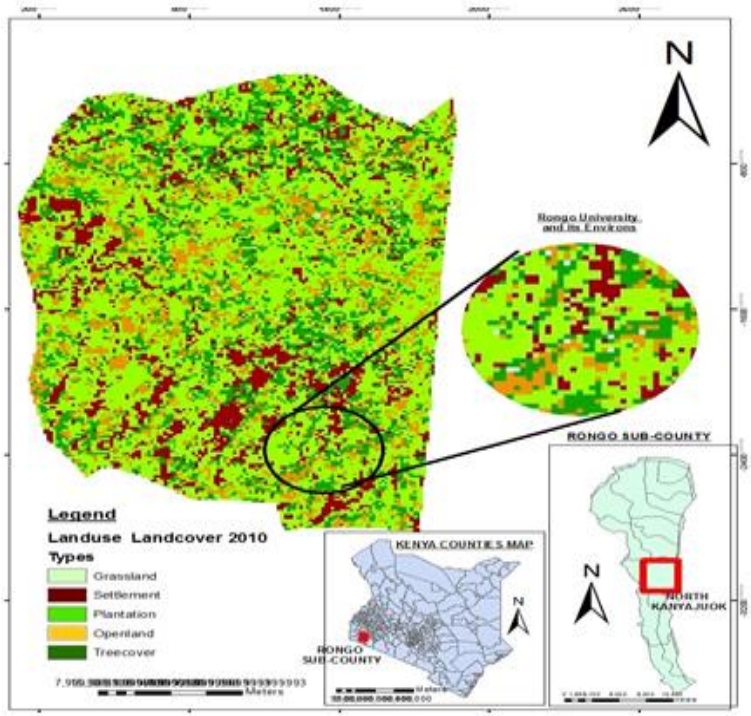


**Figure 4.23: Landsat Image for 2010 LULC**

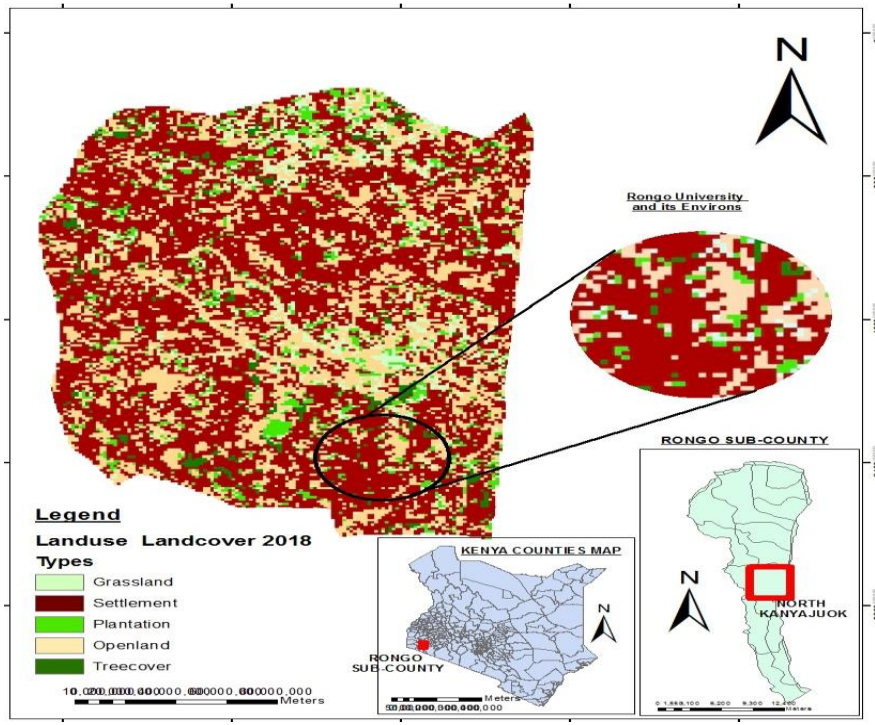


**Figure 4.24: Landsat Image for 2018 LULC**

*Source: Author, 2021*

The information portrayed in these two years speaks volumes in terms of changes in LULC which have been influenced by the establishment of RU. In the year 2010, the area appeared green with patches of settlements. In the year 2018, settlements were all over. The area is red and this signifies the danger we are posing to our environment. Even though there is a normal population growth which requires increased housing facilities, what is witnessed in North Kanyajuok is a catalyzed development brought about by RU.

Having studied the changing trends, LUs and LC changes were summarized and results presented graphically in figure 4.25.

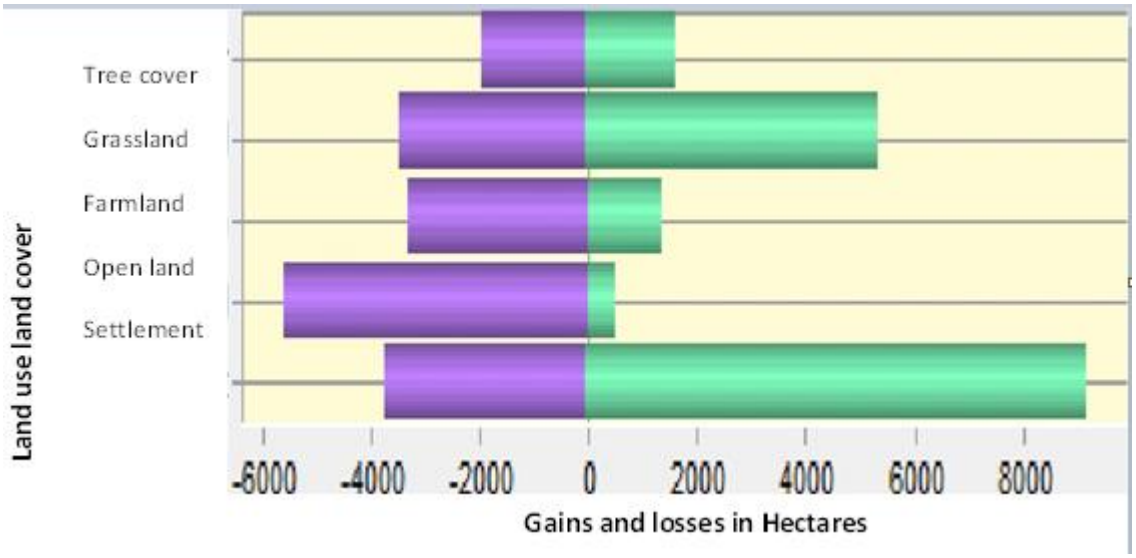


**Figure 4.25: Gains and Losses in LULC between 2013 and 2018**
*Source: Author, 2021*

From this figure (4.25), it is clear that settlement continues to gain. Its increase is consistent while open land on the other hand is extremely losing. The tree cover which is a LC is balancing losses and gains as some people engage in tree planting while at times some areas are cleared to support crop cultivation. The study noted that even though grassland has lost even though a sign of it gaining is also evident. Some farmlands may favour seasonal growth of grass when not under cultivation. Despite this gain, the study fears grassland reduction due to evidence of increasing settlement development. Though, plantation is seen to have gained a little, it is also in danger as more developments are also expected.

The study made a projection on what should be expected if LULC changes are not monitored and managed properly. The reference was made to the year 2030 and the projection was as presented in table 4.9. The results portrayed in table 4.9 indicate that settlement which occupied 1252.41ha (62.52%) in 2018 will cover 1506.72ha (75.27%) of the area in 2030. This implies that in 2030, a greater percentage of North Kanyajuok will be built as only 494.97ha (24.74%) will be left unbuilt. This indicates how the natural environment together with its resources is threatened by human development activities. A

built up environment implies loss of biodiversity and other genetic resources. The study noted that settlement as a LU continues and will continue to gain as has been witnessed in the past while other LCs like tree cover and grassland will continue to lose. The projection also indicates that by 2030, open land will be almost zero. Data on open land by 2018 showed that it occupied 2.6ha (0.13%) while in 2030, it is projected that open land will only be 1.99ha (0.1%). This trend had been witnessed in the previous years presented in table 4.4. A lot of open lands and spaces have been and continues to be built up.

The results of the projection also revealed that there will be reduction in plantations/ farm lands. In 2018, plantation or farmlands covered 82.95ha (4.14%). In 2030, it is projected that plantation, farmland will only occupy 69.51 (3.47%). This signifies continued loss of plantation or agricultural land. It is worth noting that crops such as sugar cane may be treated as LC since they protect the soil from being eroded. Other cover crops also play the same role. Total loss of agricultural land will also threaten food security in the study area. The study also established that there will be insignificant change in tree cover if 2018 is used as the base year in comparison. The year 2018 showed that tree cover stood at 68.73ha (3.43%). On the other hand, projection results indicate that tree cover will occupy 74.42ha (3.72%). This data gives some hope as it portrays that there will be increase in tree cover (LC) by 0.29%.

With continued planting of exotic tree species such as Eucalyptus, tree cover is expected to increase in the study area. The study noted a significant decrease in grassland in the projection. By 2018, grassland occupied 596.43ha (29.78%). This was projected to reduce to 349.05ha (17.44%). This implies that grassland will lose a total of 247.38ha (12.34%). Grass is a LC. Its loss implies loss of LC. When LC is lost, habitat is lost together with various forms of life (biodiversity) and genetic resources. Grass controls infiltration rate since it reduces speed of runoff or water flow. Its loss may affect ground water as infiltration helps to recharge ground waters. Also, grass helps to protect the soil from being eroded. It holds soil particles together and make them to be compact hence reducing their susceptibility in being swept away by the runoff. Loss of grass would mean making land susceptible or prone to agents of soil erosion such as water and wind. The study noted that

one of the factors which will result to such loss of LC is increase in built up area which has been witnessed in the previous years. See table 4.9 for the described results.

**Table 4.9: State of LULC in North Kanyajuok by 2018 and 2030 Projection**

| LULC | 2018 | | 2030 Projection | |
|---|---|---|---|---|
| | Area in Ha | Percentage % | Area in Ha | Percentage % |
| **Tree cover** | 68.73 | 3.43% | 74.42 | 3.72 |
| **Open land** | 2.60 | 0.13% | 1.99 | 0.10 |
| **Plantation** | 82.95 | 4.14% | 69.51 | 3.47 |
| **Settlement** | 1252.41 | 62.52% | 1506.72 | 75.27 |
| **Grassland** | 596.43 | 29.78% | 349.05 | 17.44 |
| **Total** | | | **2001.69** | |

*Source: Author, 2021*

The 2030 projection image of North Kanyajuok appeared as presented in figure 4.26. The area appeared to be overwhelmed by red colour representing settlement. This implies that almost all the region will be built up. From this figure, one can easily tell the danger facing the natural environment. The only question we can ask is where other living organism will be if the whole area turns to be a built up area. The figure shows how threatened they are. They might not wait to face the future. The study established from this figure that it will be difficult for human to co-exist with other living organisms in the region as almost all the area will be built. Figure 4.26 also shows how other living organisms are faced with extinction in the future. This should be a worry to the humanity since natural resources support the lives of human beings. They provide direct food, purify air and at the same time provide aesthetic value to the region.

From the figure 4.26, it is also clear that other LUs like plantation representing agricultural land only appear as patches within the area. From the legend, it is clear identifying open land becomes a nightmare. This is because such areas shall have been consumed by the built environment. Even though tree cover and grassland (LC) can be evident, they all appear as patches. They are threatened by the rapid development activities currently undertaken in the study area. Their loss will be detriment to the environment. The area will lose ecological resilience. Since LC especially vegetation act as carbon sink, their loss will

imply a lot of carbon dioxide accumulating in the atmosphere. As such the region will be a major contributor to global warming in the region. See figure 4.26.

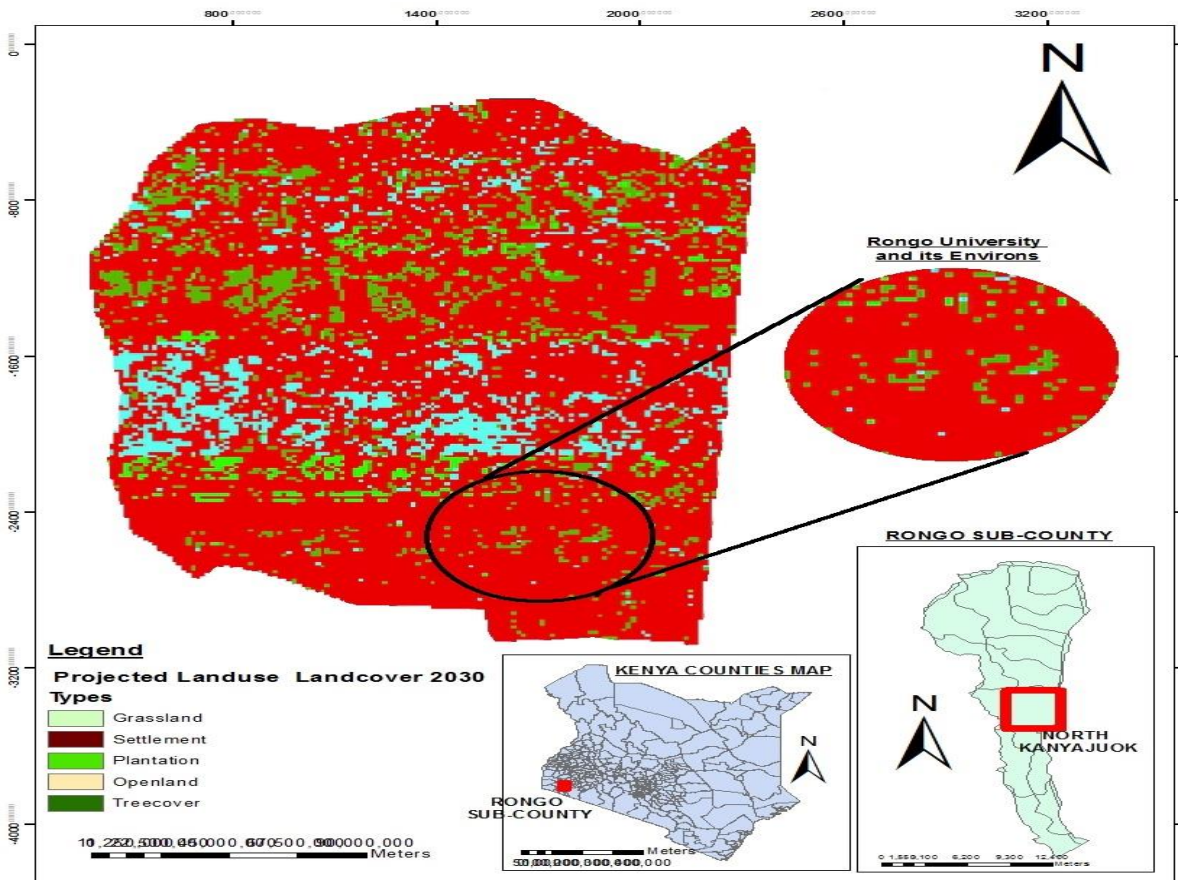


**Figure 4.26: 2030 projected LULC for RU and its local environment**
*Source: Author, 2021*

### 4.4.2: Effects of LULC Changes on the Environment and its Resources

Considering the fact that natural environment offers habitat for many living organisms, Figure 4.27 presents results where many people (68.1%) were also of the opinion that changes in LULC is a direct loss of habitat to wildlife. The study noted that habitat loss implies loss of other genetic resources. This is because some organisms might not be able to adapt to the new conditions after the loss of habitat. Thus such organisms might be subjected to extinction. Also, in places where vegetation has been replaced by buildings, getting the same indigenous species which used to exist there becomes a challenge after their destruction. The study also noted concern of loss of aesthetic value due to LULC changes. This was emphasized by 54.7% of the people. As other scholars had mentioned in

the previous studies that nature is beauty, it therefore follows that loss of nature implies loss of beauty. In this regard, loss of LC translates to loss of natural beauty of the area. Another environmental effect mentioned was air pollution. Even though identified by 19.9% of the people, the study noted that it is an indirect effect of LULC change on the environment. Their argument could have been based on the fact that green plants act as carbon sinks. Thus their loss would mean accumulation of more carbon dioxide in the atmosphere hence air pollution. Another environmental effect revealed during study was interference with atmospheric moisture recharge which was reported by 13.2% of the people. The study also considered this as an indirect impact of change in LULC. Considering the fact that vegetation contributes to completion of water or hydrological cycle, their elimination or clearance would lead to interference with evapotranspiration system. This in turn negatively impact atmospheric moisture recharge. With the view of the kind of development around RU, some people (30.3%) considered rise of slum to be having environmental impact in the area. Rise of unorganized structures and poor waste management were considered to negative effect of slums. Some people were of the opinion that massive loss of tree cover is being realized due to overdependence on wood and charcoal by the low income class. According to some respondents, this class is also found in Kitere shopping centre and they influence rapid development of poor structures. They are always ready to offer cheap labour in the area. In this regard, they have to find cheap houses for their accommodation and sustainability. Contrarily, the study noted that a good number of people (13.2%) were not able to link any environmental effect to LULC changes. Possibly, they did not see or are not informed on environmental matters. See figure 4.27 for the explicated results.

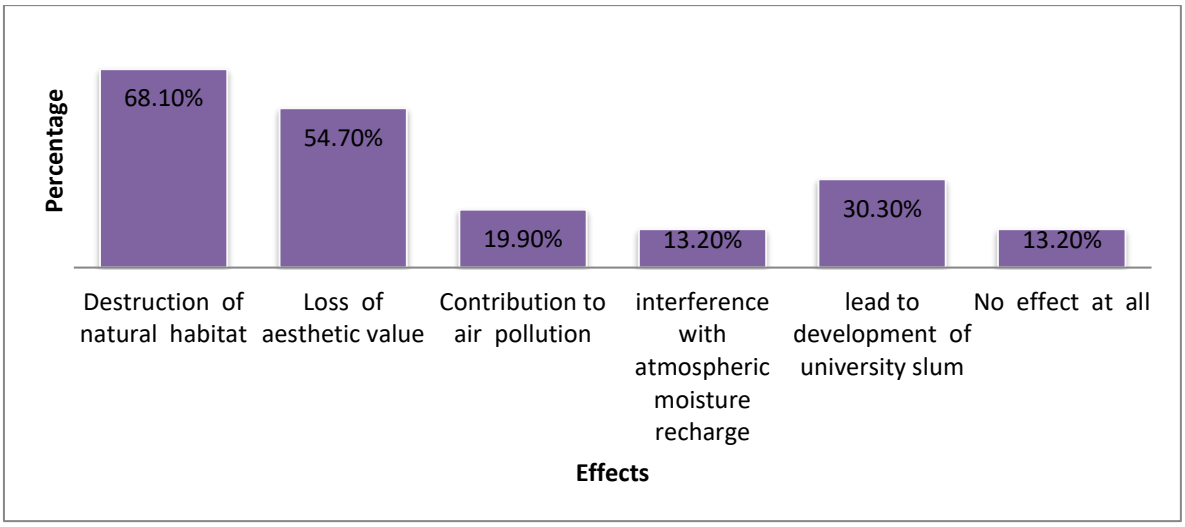


**Figure 4.27: Effects of LULC changes on the environment and its resources within RU and its local environment**
*Source: Author, 2021*

Considering the fact that environment hosts and is influenced by socio-economic activities, the study examined the implications of RU and its associated LULC changes on these activities and the results were presented in figure 4.28. From this figure, loss of agricultural land was one of the implications as was reported by 78.8% of the respondents. The built up environment is taking over the land that used to be agricultural land. The environmental implication attached to this is that crops are also considered LC. Cover crops for example can be used in soil conservation. Crops like sugar cane also offer a seasonal habitat for birds and other wildlife. Hence loss of agricultural land affects LC. Further, majority of the respondents (78.2%) were of the view that changes in LULC within RU's local environment could lead to land fragmentation. This is not only detrimental to the environment as it may lead to soil erosion and excess use of water resources but also has economic impact as it leads to reduced agricultural productivity.

In addition, the study noted there exists potential family conflict in relation to LULC changes to the extent that it was reported that 34.5% of the respondents expressed cases of family disagreements on LU. Sale of land to private developers without the consent of other family members results into conflicts. This not only affect family harmony but also impact conservation of the environment. Furthermore, the study established (30.3% of the respondents) that such changes in LU bring fear to the community noting that they have to live with non-family mebers such as tenants and students among others. This is not only a

threat to the natural environment because of increase in built up area but also to the indigenous members of the community since they welcome strangers whose characters they don't know in their areas. However, a number of individuals (3.9%) failed to see any socio economic implication associated with establishment of RU in the study area. In their view, LULC changes within RU environs have no socio-economic implications at all. Probably, this category did not give an in-depth thought what loss agricultural land means to the community or family members. Figure 4.28 portrays the responses as were reported during data collection.

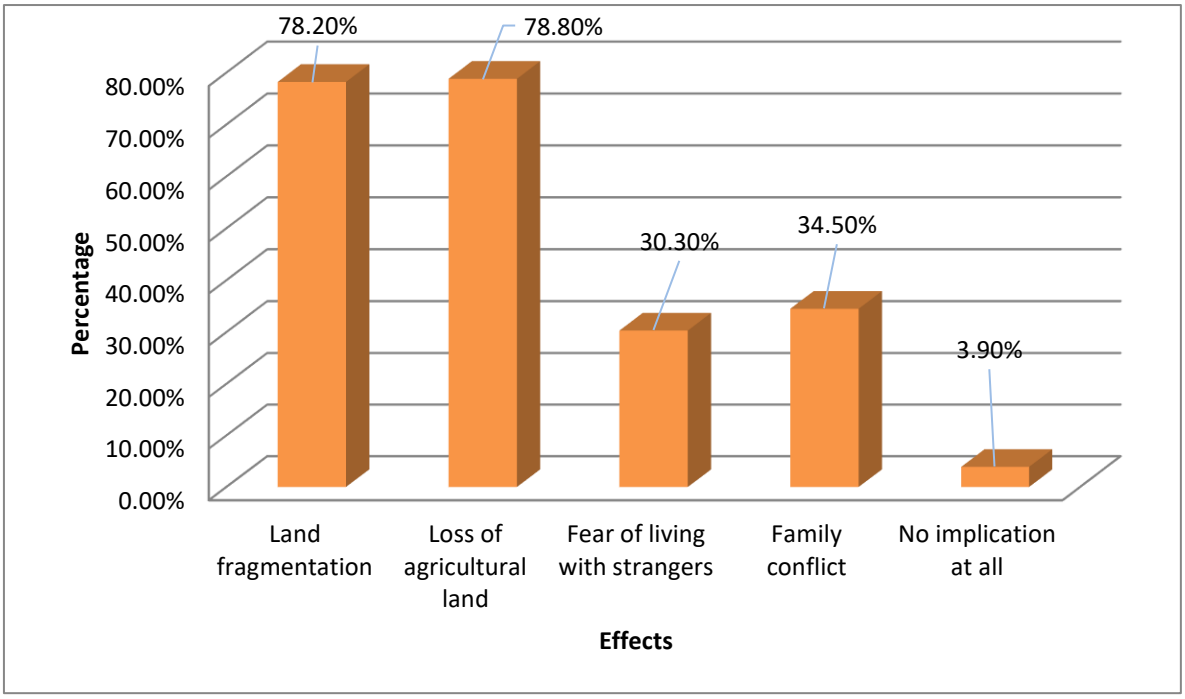


**Figure 4.28: Socio-economic implications of RU establishment and its associated LULC changes in the local environment**
*Source: Author, 2021*

Evidence of socio-economic implication of RU establishment can be seen in plate 4.10. This plate shows a tall building serving as hostel for the RU students. The building belongs to a private developer and is located close to someone's homestead. For the private developer, the building serves to meet his commercial obligations. Contrarily, the same building may be seen as a security threat to the neighbouring homestead. For the purposes of compliance and conformity with the neighbourhood, the building may be considered out of character as provided in the EMCA (1999). The study noted a number of such buildings

in the area. The aspect of fear living with strangers expressed by some natives can be justified. One can imagine the number of peoples whose movement is not restricted and they are from different places occupying such places.

**Plate 4.10: Tall Hostel and the Neighborhood**
*Source: Author, 2021*

Further evidence can be seen in plate 4.11 which indicates rise of informal settlement within RU's local environment. The study noted a fast growth of informal settlements leading to slum development around the university. These have severe social and environmental implications as they continue to increase around the university. As mentioned earlier, management of waste becomes a challenge in such set ups since people use the bushy areas of the informal settlement and dispose of waste indiscriminately. Vegetated areas are constantly being turned into a dump site which hosts a wide range of waste such as broken bottles (hazardous) among others. Similarly, the study noted that as informal settlement continues to develop, access routes/avenues which are meant to link either sides of the shopping centre/developing urban centre become narrower with time. The developers do not give priority to such considerations. See plate 4.11 for the elucidated findings.

**Plate 4.11: New & Dilapidating Houses in Kitere Shoping Centre**
*Source: Author, 2021*

The study noted that because of lack of integration of environmental planning concerns in development, every developer conducts his/her development activity the way they deem fit. Planning issues like access avenues are not given adequate consideration as spelt out in the planning acts. This was evident in Kitere shopping centre which is currently under rapid development as a university slum. See plate 4.12 where people struggle to find their way out in either end of the shopping centre. People are forced to use a bushy meandering footpath to access either side of Kitere shopping centre.

**Plate 4.12: Unplanned access route in Kitere, Rongo Sub-county**
*Source: Author, 2021*

***Proposed Way Forward***

In an effort to find way forward with regards to achieving sustainable university development, monitoring LUs and development projects was highly recommended. 96.1% of the people were of the opinion that monitoring LUs and development projects will be helpful in identifying the likelihood of occurrence of environmental impact hence providing early warning to mitigate the impact on time. That is when it is still at manageable state. Further, planning for development activities was suggested by 92.5% of the people. In their view, planning development activities provides a schedule of what to be done, where and at what time is it supposed to be done and how should it be done. It also provides who is supposed to undertake given activities at a particular time. This helps in providing clear control and monitoring measures through holding the victims of environmental damage accountable for their actions be made to undertake restoration measures. Planning also helps to create a regional balance and equal distribution of resources. This in turn helps to reduce conflict which may result into overexploitation of natural resources hence unsustainable development. The study noted that a holistic framework to achieve sustainable development can only be achieved through embracing environmental planning

and management. Also, recommended was creation of public awareness on environmental planning and management issues. 95.3% of the people noted that this would help in enlightening and make the community to embrace environmental management best practices which aim to ensure sustainable resource utilization. This was supported by the 20% of the people who suggested promotion of public participation and consultation in development projects. In their view, consulting and engaging the public to participate in development project will help to provide a clear insight and the feelings of the public about the projects to be initiated. Their ideas might also be useful as they will become part of the projects hence embrace the policies governing them. This will also help to preserve some natural resources holding the public interest hence ensuring environmental protection.

In addition, 79.8% of the people suggested proper implementation and monitoring of the policy and the legal framework guiding development activities. In their view, these should be observed during construction works and monitored all the time to ensure compliance with environmental planning and development requirements. This will help to place various development projects in their appropriate location thereby controlling environmental interferences. By observing development policy provisions haphazard development which contribute to environmental degradation will be minimized. It is also expected that environmental concerns will be integrated in every phase of the development project cycle. That is construction, operation and decommissioning phases as provided by the Environmental Management and Coordination Act of 1999, reviewed 2015. Also, zoning will be embraced to avoid mixture of settlement structures which cause nuisance and discomfort in residential areas. See figure 4.29 for the explained results.

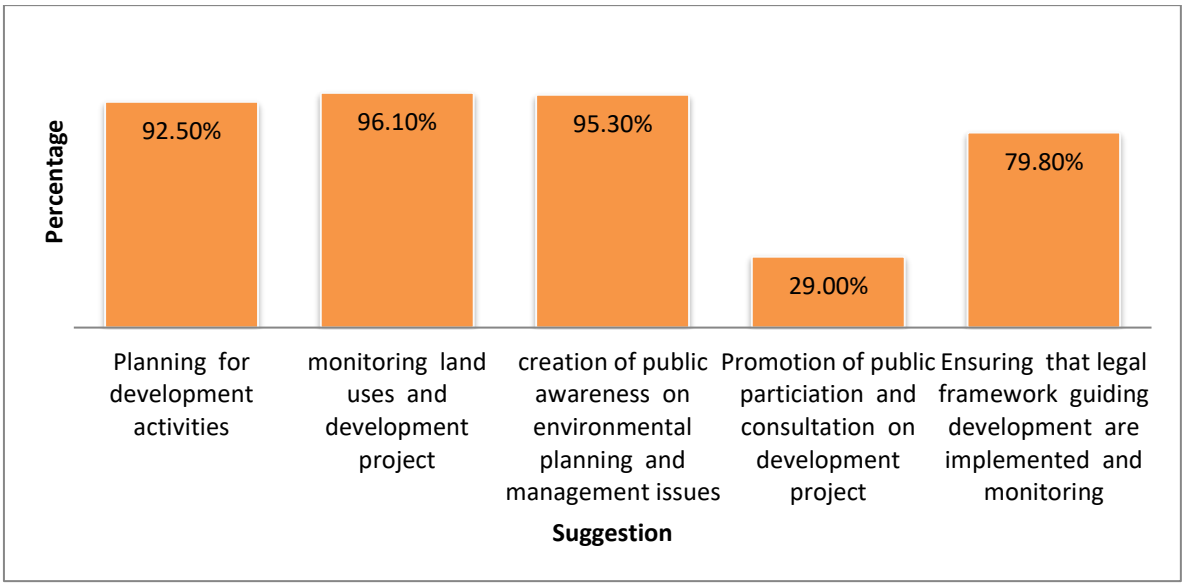


**Figure 4.29: Suggested measures to be adopted to realize sustainable development within RU and its local environment**
*Source: Author, 2021*

### 4.5 Proposed Spatial and Environmental Management Plans

Apart from suggestions on way forward presented in figure 4.29, the study developed a spatial plan and environmental management plan. It was in the view of the researcher that if these plans can be adopted and used accordingly, improvement in environmental management will be realized. Figure 4.30 shows a spatial plan proposed. The plan was made based on the environmental planning issues identified. The issues identified included: Haphazard development, poor waste management, lack of consideration of access routes/avenues, mixing of various types of buildings and rapid LU change.

In the plan, the study proposed planned residential structures in RU's immediate surroundings. The study felt that having well developed residential buildings will help to provide accommodation services to students who might not be willing to settle in the university hostels. The residential building proposed must be constructed in accordance with second schedule of the University Act Cap 210 of 2012. Also, the developers must consider the provisions of section 36 of the Physical Planning Act Cap 286 (revised 2012). This section provides for submission of the environmental impact assessment report before the development plan is approved. Further, the developers must take into consideration provisions of section 115 of the Public health Act cap 242. What the study proposes in this

case is having well planned residential structures in RU's immediate outer ring. Having planned residential area will help solve the problem of mixing structures such storey buildings and bungalows. This will also help limit questions of some structures being out of character as zoning of such structures will be achieved. Further, the feeling of some people that they are being deprived of their privacy will be out of question. In addition to the residential structures, the study proposes installation of shopping points/areas within the residential areas. These may be in form of snack shops where students can easily access some goods they use on a daily basis.

The study noted that parcels of land around RU are privately owned. This poses a challenge in planning since every person uses his/her land the way they may deem fit. Despite such fact, the study proposes that the community around the university should embrace agroforestry practices. This will help balance between crop production and conservation of the environment. The green areas in the plan (figure 4.30) are farmlands but the study recommends integration/mixing of particular type of trees with the crops grown. Also, the study acknowledges the challenges this proposal will face in that the community within the study area are becoming commercial. Individual developers have started adopting ideas of developing commercial buildings rather than practicing agriculture. This they do in consideration of the fact that the area attracts development activities. Also, they perceive commercial buildings to greater importance as monthly income can be yielded from them.

The study also proposes that the upcoming slum (Kitere shopping centre) should be planned. Its faster growth cannot be overemphasized. It contains buildings which are not well organized. It is also characterized with all sorts of structures. Some are already dilapidating while others are being developed. Some are permanent while others are semi-permanent. Other structures in the centre are purely temporary but occupied. The centre is also bushy in some parts. The study noted that if such trend of development continues unabated then more negative environmental impacts should be expected. Planning this young developing urban centre will help solve issues of haphazard development which render delivery of urban services difficult. Issues of poor waste management in the centre will also be solved. The bushy areas which some people take advantage of in terms of waste management will be no more. Planning will also ensure well designed avenues which

enhance movement within the urban centre. In summary, the study was of the view that if environment planning is embraced in RU's local environment, sustainable development will be realized. It was worth noting that RU has its master plan. Though not yet completely refined, is being used to guide development activities being undertaken within the university. The university also has environmental policy whose provisions are being integrated in development activities. Mobilizing the local community and private developers to embrace planned development still remains a challenge. See figure 4.30 for the proposed plan.

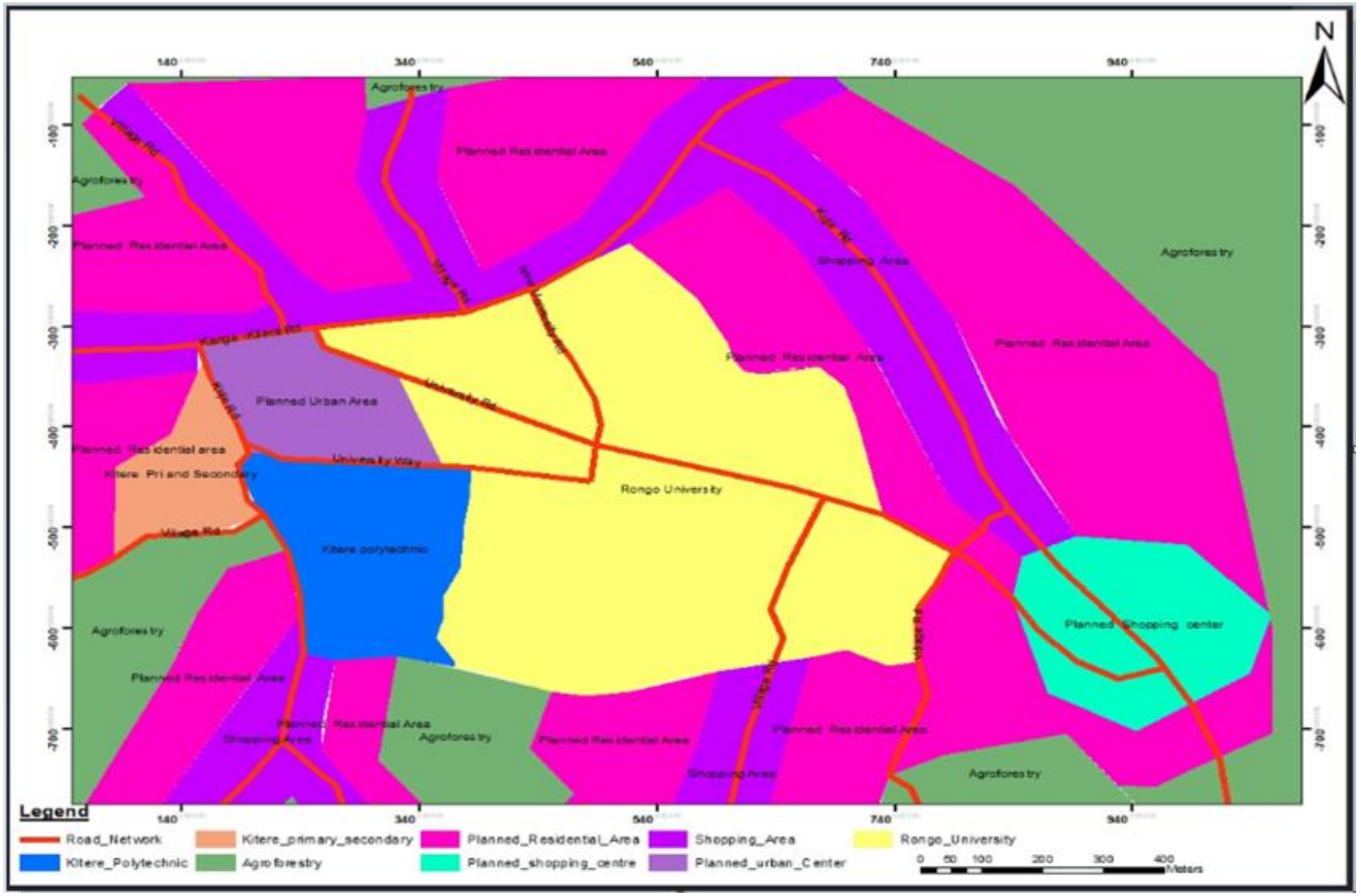


**Figure 4.30: Proposed Spatial Plan for RU and its Local Environment**
*Source: Author, 2021*

***Environmental Management Plan***

In consideration of the environmental management issues identified during the study, an environmental management plan was proposed. This section presents the issues, strategies, proposed activities, time frame and the actors. To begin with, the study noted poor coordination during policy implementation as challenge in realizing sustainable environmental management. There should be clarity on who, where and when policy implementation activities are to be undertaken. Failure to specify this leads to work being left to no one with an assumption that someone will do it. This generally leads to policy failure. Suggested strategies included designing a national and county level framework defining roles of various stakeholders at given level of policy implementation. This strategy involves activities such as conducting campaign for adoption of a formal coordination structure that is transparent. Secondly, engaging stakeholders in policy implementation can help in identification of where loopholes exist. Thirdly, there should be clear definition of roles of various agencies involved in policy implementation. Lastly, conducting workshops aimed at building capacity and enlightening policy implementers on policy implementation best approaches. The study considered these activities to take a short term with engagement of the County government of Migori (CGoM), community, National Environment Management Authority (NEMA), Non-governmental organization (NGOs), Rongo University Management Board (RUMB), Rongo Municipality Board (RMB) and community based organization (CBOs).

The second issue identified by the study was failure of the development policies to integrate university influenced sprawling development and externalities. The study noted that existing policies are silent about university surrounding sprawling development and their externalities. The study suggested review of the university policy to accommodate university neighbourhood sprawling development associated with their establishment. Activities associated with this include monitoring policy performance, carrying out the policy (strength, weaknesses, opportunities and threats) analysis and engaging stake holders in adjusting where the weaknesses exist. Undertaking such activities can be medium term. It will involve CGoM, RUMB, RMB, CBOs, NGOs, and NEMA.

Another planning issue identified by the study is improper follow up activities in policy implementation. During policy implementation, there should be follow up activities such as audit and monitoring. These help to reveal strength and weaknesses of policies being implemented. The study noted that inadequate follow up could be overcome by promotion of policy enforcement activities and ensuring proper understanding of follow up procedures. The activities in realizing this involves training personnel involved in conducting follow up activities and conducting regular stakeholders meetings to identify the areas of weakness. This can be undertaken by the county government, NEMA, RUMB, RMB, NGOs and the CBOs in both short and medium term basis.

Further, the study noticed low level of awareness of development policy provision among some members of the public. This affects natural resource use such as land. Obviously, it become impossible for someone to put into practice what he/she does not know or understand. Some development policy provisions are technical and might not be easily understood by the common man. Failure to understand means no implementation hence initiating development activities which might be detrimental to the environment. The study proposes development of a platform for public awareness creation and capacity building on environmental management policies as a strategy in solving this problem. Other strategies proposed include ensuring involvement of public representatives in the policy formulation process and establishment of tailored training institutes for Environmental Management in the counties. Activities proposed here include providing training and conducting workshops and seminar aimed at enlightening the people on environmental policies. This is considered a short term activity. The second activity involves undertaking adult education with the aim of creating community awareness on environmental matters. This is a medium term activity. The third activity comprises evolving county based policies and packages of incentives to support specific Environmental Management training institutes at county level based on its production output. This is a long term activity. The actors of these activities include NEMA, CGoM, RUMB, RMB, CBOs and NGOs.

The study also identified wrong attitude from the public on existing policies. The small charges such as the one on approval of development plans have made members of the community to have wrong impression on the existing development policies. They view

implementation of such policies to be costly and therefore not willing to hear about them. This attitude makes them sideline policy implementation and thereby secretly carry out development activities which might be detrimental to the environment. The study suggestes proper involvement and integration of public concerns during policy formulation and implementation as a strategy to influence change of their attitude. The study felt that by engaging the public and integrating their concerns, they become part of the whole system and own the solution. This makes them to embrace policy decision which is crucial in environmental management. Activities to realize this involves carrying out campaigns on environmental conservation and organizing seminars and demonstrations to show the public the benefits of environmental conservation. This should be done by the county government, CBOs, NGOs and NEMA, RUMB and RMB. The study noted that the activities can be both short and medium term.

In addition to the above issues, the study noted inadequacy in public involvement in policy implementation. Willingness of people in participation and adoption of policies should be influenced. The members of the public should not be always surprised by the policies but should be influenced, made to understand and encouraged to participate in policy implementation system. In most cases, people are taken by surprises when they see officers working round and conducting inspections on what the public do not understand. Low level of public involvement always signalizes failure of what is yet to be implemented. In this regard, the study saw the need to understand who to involve and the level at which he/she should be involved as a strategy in managing this challenge. Some of the activities to achieve this involve conducting stakeholder analysis and consultative meetings to understand their concerns and interest of various parties and representatives. Secondly, the study also proposed establishing an inclusive Private-Public dialogue as an activity aimed at improving public involvement in policy implementation.

The study also noted a challenge of unclear definition of roles between the county the national government in implementation of some development policies. For instance, when do the NEMA, public health and the National Constructions Authority officials conduct inspection for compliance? This also applies to the sub-county environmental officers. Failure to clearly define the roles of these officers brings confusion and friction in service

delivery. This may result into a weakness where policy may not be properly implemented thus resulting into development which is injurious to the environment. The study proposes clear definition of the roles of the National Constructions Authority, NEMA and other line ministries at county level in order to curb this. This may involve activities such as engaging all stakeholders in various fora and conducting training to various stakeholders on their roles at various levels. The activities are both short and medium term. They are to be carried out by CGoM, RUMB, RMB, CBOs, NGOs, NEMA and other line ministries.

Another planning issue realized was overlap among the line ministries i.e. Agriculture and Environment. This affects use of resources like land. Environmental management and conservation may provide for reservation of some areas to save particular biodiversity and genetic resources. On the other hand the same area proposed may be of interest for agricultural production. Who controls what may remain a challenge. Weighing between land conservation and agricultural production remains a debate. In most cases, more land is transformed to agriculture which to some extent negatively affects the environment. The study suggests adoption of optimized central coordinating institution. This involves activities like conducting an explicit and open policy development processes and engaging stakeholders in a formal coordination structure that is transparent. The activities can be achieved in both medium and short term respectively. The actors are CGoM, RUMB, RMB, CBOs, NGOs, NEMA and other line ministries.

On the issues of LULC changes, the study noted a higher rate of transformation of natural environment into built environment. Since Rongo University attracts many development activities, the natural environment is lost rapidly. In order to curtail this, the study proposes promotion of sustainable use of environmental resources which can be achieved by conducting campaigns on adoption of best practices such as agroforestry. There should also be training and capacity building on sustainable natural resource utilization. Further, there should be awareness creation on the dangers of unsustainable LULC changes. The study also proposes undertaking checking and monitoring development activities to ensure their compliance with policy provisions. These activities should be carried out by the NCA, CGoM, RUMB, RMB, CBOs, and NGOs in both short and medium term basis.

Rapid increase of population in the study area is another challenge identified. Rise in settlements in the study area implies population increase. The rising population continues to put pressure on the available resources such as land. This in turn leads to transformation and modification on LULC. In order to deal with this, the study suggested adoption of population control measures. This may include control of sale of land in the area. Alternatively, the government may deploy strict adherence with the provisions of development policies. This will ensure that only the people whose developments meet the minimum standards in the policies are left. Thus limiting the number of development activities. Controlled settlement will imply controlled population. This may take a short term and medium term. It is the responsibility of the CGoM, RUMB, RMB, CBOs, and NGOs.

Another issue realized is land fragmentation. The study noted small divisions of land in the study area. The natives have been selling their lands to private developers who have been transforming the initial agricultural land into settlement. Other natural environments are also being lost and transformed or modified to suit the existing demand in the study area. This has severe implication on biodiversity and other ecosystems. In order to manage this challenge, the study proposes government involvement in control of LUs in the study area. This will help determine what is to be placed where, when and by whom. This strategy involves activities such as awareness creation on land acquisition procedures and control of land rights. The activities are supposed to be undertaken by CGoM, CBOs, RMB, RUMB and NGOs in both short and medium term basis.

Transformation of farm lands into settlement was also an issue identified by the study. This implies future threat in food security. It also means increased built up environment. The study proposes enforcement of the provisions of development related policies (LU policy, Physical Planning Act and EMCA). This will ensure that developments which substitute agricultural land are in compliance with environmental management provisions. This can be achieved through capacity building on environmental management and conservation and subjecting the development projects to EIA and EA. The community has to be empowered on environmental management so that they become good steward of nature. This is the responsibility of NEMA, CGoM, CBOs, RMB, RUMB and NGOs.

The study identified loss of LC and transformation of open lands into built environment as other challenges in the study area. This is because of the sudden influx of population in the area. This calls for enforcement of environmental regulations and government involvement in development control. Activities such as restoring of the degraded environment, backfilling of the degraded lands, tree planting, awareness creation and campaigns for environmental conservation can be adopted to mitigate these challenges. Also, public campaigns on protection of natural resources and open spaces can be conducted. Other activities involve capacity building on the provisions of the environmental policies institutional frameworks. It is the responsibility of NEMA, KFS, CGoM, CBOs, RUMB, RMB and NGOs to initiate this in both short and medium term.

Other challenges established during study are loss of biodiversity and genetic resources and emergence of informal settlement. Change of LU has been the major contributor to loss of biodiversity and genetic resources. For instance an area which has been under tree cover could be serving as a habitat for many organisms. When trees are cut down and the area changed into settlement, several biodiversity are negatively impacted. Some of them may be extinct thus loss of genetic resources. The same applies to transforming grassland areas into settlement. In order to mitigate this, the study proposes promotion of environmental conservation programmes. This may involve conducting campaigns on tree planting, creating awareness and capacity building on environmental conservation. It also calls for carrying out restoration programmes on the degraded areas. These activities are responsibility of NEMA, CGoM, RUMB, RMB, CBOs and NGOs which should be undertaken in short and medium term basis.

In order to mitigate the impacts of the emerging informal settlement in the study area, the study considers enforcement of development control measures as one of the strategies which can be adopted. In addition, it proposes development and strict implementation of county specific development plan. This plan should provide ways of dealing with sprawling development associated with institutions of higher learning. Activities for such strategies involve training and workshops on plan development and implementation procedures. Other activities include enforcement undertaking constant monitoring of development in the area to ensure compliance with development policy stipulations. The activities

mentioned require involvement and commitment of the NCA, CGoM, CBOs, RUMB, RMB, NGOs and NEMA. The study proposes this to be done in a short term basis. See table 4.10 presents the proposed environmental management plan.

**Table 4.10: Proposed Environmental Management Plan**

| Objectives | Planning Issues | Strategies | Activities | Timeframe | | | Actors |
|---|---|---|---|---|---|---|---|
| | | | | Short | Medium | Long | |
| **1.** To assess how the national and university policies and regulations have guided university establishment process and as applicable to development of RU. | Poor coordination during policy implementation | Designing a national and county level framework defining roles of various stakeholders at given level of policy implementation | • Campaign for adoption of a formal coordination structure that is transparent<br>• Engaging stakeholders in fora<br>• Clear definition of roles of various agencies involved in policy implementation<br>• Conducting workshops on policy implementation procedures | ✓ | | | CGoM, CBOs, NGOs, RUMB, RMB, Community , NEMA |
| | Policies not considering externalities in development | Policy review and amendment of various sections to take into account sprawling development and externalities | • Monitoring policy performance<br>• Carrying out the policy SWOT analysis<br>• Engage stake holders in adjusting where the weaknesses exist | | ✓ | | CGoM, CBOs, NGOs, RUMB, RMB, NEMA |
| | Improper follow up activities in policy implementation | • Promotion of policy enforcement activities<br>• Ensuring proper understanding of follow up | • Training personnel involved in conducting follow up activities<br>• Conducting regular stakeholders meetings to identify the areas of weakness | ✓ | ✓ | | NEMA, CGoM, RUMB, RMB, CBOs, NGOs |

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| | | procedures | | | | | |
| | Low level of policy provision awareness by the public | • Develop a platform for public awareness creation of environmental policies<br>• Ensure public involvement in the policy formulation process<br>• Establishment of tailored training Institutes for Environmental Management in the Counties | • Provide training and conducting workshops and seminar aimed at enlightening the people of environmental policies<br>• Undertake adult education with aim of creating community awareness on environmental matters<br>• Evolving county based policies and packages of incentives to support specific Environmental Management training institutes at county level based on its production output | ✓ | ✓ | ✓ | NEMA, CGoM, RUMB, RMB, CBOs, NGOs |
| | Wrong attitude from the public on existing policies | Proper involvement and integration of public concerns during policy formulation and implementation | • Carrying out campaigns on environmental conservation<br>• Organizing seminars and demonstrations to show the public the benefits of environmental conservation | ✓ | ✓ | | NEMA, CGoM, RUMB, RMB, CBOs, NGOs |
| | Poor public involvement in policy implementation | Understanding who to involve and the level of involvement | • Conducting stakeholders consultative meetings to understand their concerns and interest of various parties and representatives<br>• Establishing an inclusive | ✓ | | | CGoM, NGOs, RUMB, RMB, NEMA |

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| | | | Private-Public dialogue | | | | CBOs, |
| | Unclear definition of roles between the county the national government | Clear definition of the roles of the National Constructions Authority, NEMA and other line ministries at county level | • Engaging all stakeholder in various fora<br>• Training and educating various stakeholders on their roles at various levels | ✓ | ✓ | | CGoM, CBOs, RUMB, RMB, NGOs, NEMA |
| | Overlap/lack of clear understanding among the line ministries i.e. Agriculture and Environment | Adoption of optimize central coordinating institution | • Conducting an explicit and open policy development processes<br>• Engaging stakeholders in a formal coordination structure that is transparent | ✓ | ✓ | | CGoM, NEMA CBOs, RUMB, RMB, NGOs, line ministries |
| **2.** To examine the nature and extent of LULC changes in the local environments associated with the establishment and development of RU. | High rate of transformation of natural environment into built environment | Promotion of sustainable use of environmental resources | • Conducting campaigns on sustainable use of environmental resources<br>• Training and capacity building on sustainable natural resource utilization<br>• Creation of awareness on the dangers of unsustainable LULC changes<br>• checking and monitoring development activities to ensure their compliance with policy provisions. | ✓<br>✓ | ✓<br>✓ | | NCA CGoM, RUMB, RMB, CBOs, NGOs |
| | Rapid increase in population in the area | Adoption of population control measures | • Monitoring the land acquisition in the area | ✓ | ✓ | | CGoM, RU, RMB, CBOs, |

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| | | | | | | | NGOs |
| | Land fragmentation | Government control of LU | • Awareness creation on land acquisition procedures<br>• Controlling land rights | ✓ | ✓ | | CGoM, RUMB, RMB, CBOs, NGOs |
| | Farmland transformed into settlement | Enforcement of the provisions of development related policies (Physical Planning Act and EMCA) | • Capacity building in environmental management and conservation<br>• Subjecting the development projects to EIA and EA | ✓ | ✓ | | NEMA, CGoM, RU, RMB, CBOs, NGOs |
| | Loss of LC | Enforce environmental regulation programmes | • Restoring the degraded environment<br>• Backfilling of the degraded lands<br>• Tree planting<br>• Awareness creation and campaigns for environmental conservation | ✓ | ✓ | ✓ | NEMA, CGoM, RUMB, RMB, KFS |
| | Transformation of open land into built environment | Enforcement of Development control programmes | • Public campaigns on protection of natural resources and open spaces<br>• Capacity building on the provisions of the environmental policies institutional frameworks | ✓<br>✓ | | | CGoM, RU, RMB, CBOs, NGOs, NEMA |

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| **3.** To assess the local environmental impacts associated with establishment and development of RU. | Loss of biodiversity and genetic resources and animal habitat | Promotion of environmental conservation programmes | • Carry out tree planting campaigns<br>• Awareness creation on environmental conservation<br>• Restoration of the degraded environment | ✓ | ✓ | | NEMA, CGoM, RUMB, RMB, CBOs, NGOs |
| | Emergence of informal settlement | • Enforce development control<br>• Development and strict use of county specific development plan | • Training and workshops on plan development and implementation procedures<br>• Monitoring development activities in the area | | ✓<br>✓ | | NCA NEMA, CGoM, RUMB, RMB, CBOs, NGOs |

*Source: Author, 2021*

# CHAPTER FIVE: DISCUSSIONS

This chapter presents discussions of study findings and provides elaborations of the results based on the respondents' explanation. These findings are further compared with others in the previous researches. The comparison helps identify new things the study has established apart from the ones previous studies had revealed on LULC changes. In this regard, the study used institutional and non-institutional based LULC change information.

## 5.1 Demographic Characteristics of the Respondents

The information used in this study was gathered from key informants, focus groups, households and remote sensing. These formed both primary and secondary data. The total number of people engaged in household interview and used for this study was 391 out of the targeted 394. This implies that household survey was almost perfect because 391 gives a 99% response. Those who participated in focused group discussion, key informants interviews totaled to 36. More men than women took part in the study with 52.6 and 47.5 as their percentage respectively. Equal opportunity was given to male and female gender. During data collection, household heads were targeted. This must have contributed to more male than female participating in the interview thus their higher percentage. Also, in some cases women were referring the researcher to their men/husbands who had lived in the study area since birth. This implied that men had the history of the study area in mind. They had also witnessed changes if at all there was. Therefore the native men were more resourceful for this research.

Majority of the people engaged in household survey were above 30 years as they formed 64% of the people interviewed. Those who participated in the study and were below 25 years represented students and other youth in the study area. Out of these people, most of them had lived in the study area for a period of more than 8 years. This was significant to the study since these people were able to observe, account for and explain the environmental and socio-economic as well as cultural changes which occurred over time. This category of residents added more confidence to the results as they had a longer experience with the changes considering the university only started 9 years before the study. They were able to provide comparative information before and after the establishment of the university. Other members of the community who had lived in the

study area for a period of 6 or seven year must have also witnessed the situation when the university was starting. They were also able to comment and account for the changes they had witnessed over time.

### 5.2. Kenyan University Establishment and Development Policy Analysis

In order to sustain a benefiting development activity or project, there must be guiding principles or policies attached. These principles must be properly implemented and strictly followed for good results to be realized. Universality establishment being a development activity and benefits many including the government are bound by some policies and principles. Their importance cannot be overstated. In his study on "*Institutions of higher learning as drivers of urban development*", Okong'o (2014) contended that most Kenyan communities overwhelmingly support establishment of Universities in their areas or regions. This is based on presumed benefits that accrue from their establishment and development. The residents around Rongo University were not exception. However, only in rare cases do people cite negative environmental impacts associated with establishment or development of universities. The study finds that the residents from far and wide associate such establishments with many social-cultural and economic benefits. Many people tend to be shy to mention negative impacts associated with the university establishment. Neither do they mention the attendant unplanned structures which always come up following developments from university.

In the case of Rongo University, results from this study indicate that its establishment has opened up the area leading to rapid development of various infrastructures. It has also led to increased access to education facilities as acknowledged by Nyangau (2014) that higher education institutions increase access to education and influence economic growth in their localities. A discussion held by some RU management staff yielded that the university has a core mandate of offering training services to people. As such, many people have acquired knowledge and skills which they have used to benefit themselves and the community at large. RU management also feels that education services have been brought closer to the people by establishing the university where it is. In their view, this has open opportunity for not only the local community but the general nation and globe to get skills which can be used to develop our nations. Study deliberations with RU management also confirmed that

existence of RU has given people a living by offering them jobs. This, in their view has helped to improve people's livelihoods. Also, the university has increased market for various products and services. This benefits not only the local community but also staff from various places. Further, other respondents reported that the presence of the university has improved people's living standards and led to rapid transformation of the former Kitere rural market to a fast growing urban centre. In their view, there is increased corporate social responsibility shared between RU and the community around it. One of the frequently mentioned benefits is the development of a tarmac road from Kanga Shopping centre to Kitere where the University has been established which has saved the community from the muddy road that used to exist. These results concur with the finding of Nyangau (2014) in his study on "*Higher education as an instrument of economic growth*". In his findings, Nyangau asserted that as learners benefit from education acquired, the institution also benefits the whole community in various ways. Some of these ways are the ones established by this study which include both socio-cultural and economic. His findings echoed what Akpan established in 2006 in his study on "*The impacts of urbanization and institutions of higher education on Houston Texas' Third Ward community*". Akpan noted that the benefits of institutions of higher education on community cannot be overstated. However, some development associated with them impacts negatively on the local community health. His argument was similar to Dindi (2013). Dindi in her study on "*The impact of the rapid expansion of universities on their neighbourhood development*" noted that despite socio-economic benefits realized from university, its development is characterized by rise of informal settlement with poor waste management. It also results into sudden LU changes in the neighbourhood. In addition to this, Florian and Norman (2019) in their study on "*Impacts of higher education institutions on sustainable development*" also applauded universities in their contribution in influencing socio-economic development in their localities.

With regards to policy issues, the study established that initially, university establishment in Kenya was guided by an Act of Parliament until the year 2012 when Kenyan government came up with a clear University Act Cap 210B. This Act was to guide the establishment and development of the universities. Despite the aforementioned benefits of university establishment, there are various challenges in meeting the minimum standards set for

compliance with legal requirements. The study examined the Kenyan 2010 Constitution, University Act of 2012 Cap 210B, County Government Act No.17 of 2012, Physical Planning Act Cap 286 of 1996 (reviewed 2012), the Local Government Act Cap 265 with reference to Development Control, Environmental Management and Coordination Act of 1999, The Public Health Act Cap 242, Urban Areas and Cities Act No. 3 of 2011, Land Control Act Cap 302 and Sessional paper No.1 of 2017, LU policy.

The Kenyan Constitution 2010 entitles every citizen to a clean and healthy environment in its Article 42. In clause 176 (2), it provides for decentralization of functions by the county government which is also mandated to provide services in an efficient and practicable manner. Article 69 of the Kenyan Constitution 2010, provides obligations in respect to the environment. Section (b) of this article advocates for working to achieve and maintain mandatory rate of tree cover. Under this article, section c advocates for protection and enhancement of intellectual property and indigenous knowledge while section e provides for protection of the community biodiversity and genetic resources. Section f provides for establishing Environmental Impact Assessment systems and subjecting development project to the same. On the other hand, section g advocates for elimination of processes and activities that have the potential to endanger the environment respectively.

Similarly, Clause 184 of the Constitution 2010 addresses the issues of urban areas and cities. Under the clause, the national legislation is mandated with the responsibility of providing governance and management of the urban areas and cities. The relevance of these clauses is that university establishment is associated with the development of urban areas. Equally, the vision 2030 also advocates for nationwide planning and development of urban centres. Section 36 of the Physical Planning Act Cap 286 stipulates clearly that an Environmental Impact Assessment report should be submitted before the approval of the development plan. This is to ensure those development projects are not injurious to the environment. The second Schedule of this Act section 24 (2) advocates for conservation of the natural beauty.

The provisions of the Physical Planning Act Cap 286 are very clear in terms of specification for various developments of which university establishment falls. However, there have been challenges in the implementation and follow up of these provisions in

infrastructure development associated with University establishment. The physical and land use planning Act no. 13 (2019) takes cognizance of the dire need of proper planning of land uses for sustainability. Implementation of the provisions of these policy documents has not been given adequate attention. Consequently, unplanned development characterized with environmental degradation become eminent. Also, Public Health Act Cap 242 under section 115 prohibits nuisance causing or anything injurious or may cause harm to human in the environment. Similarly, Urban Areas and Cities Act of 2011 advocates for development which are characterized by better services and social infrastructure in rural and urban areas. It also stipulates improved opportunities and increased survival choices.

According to Okong'o (2014), the current proliferation of universities does not comply with what is provided under these Acts. The existing legislative frameworks have failed to provide for appropriate plans for the establishment of universities such as RU. This has resulted in haphazard development. This in turn poses challenge in the realization of the provisions of the United Nations Development Programmes (2011) which aims at meeting sustainable management of urban areas in terms of urban safety, proper social infrastructure and risk management. The study findings concur with Okongo's as it noted that these policies are silent about sprawling developments in the university neighbourhoods. As always known, development activities are attached to some externalities. Therefore, while planning them, there should be concern about them and ways to mitigate them should be provided.

In its section 58, Environmental Management and Coordination Act Cap 387 of 1999 (Reviewed 2015) provides for subjecting development projects to Environmental Impact Assessment. Equally, it provides for periodic auditing for the on-going project in its section 68. This helps to protect the environment from injurious development projects. The findings of the study revealed that the provisions of this Act have not been adequately followed in the development of some project in the RUs local environment. This was affirmed by one of the developer who acknowledged his lack of awareness of this provision. According this developer, he carried out his development activity without involvement of any NEMA official. The study noted possibility of having a number of such development projects in the study area. Evidences of a haphazard development within the

area could justify this. Worse still, some structures are out of character in the areas they are established. For example, the mix up of bungalows with storey buildings which in most cases deprive other people of their privacy and at the same time interferes with free air circulation and light penetration among others undesirables. The implications of haphazard development associated with failure to apply the legal development procedures are evident in RU neighbouring satellite slums such as Kitere. This finding concurs with what Dindi established in 2013. Her finding in Juja, Jomo Kenyatta University of Agriculture and Technology (JKUAT) neighbourhood asserted existence of haphazard developments which hardly, conform with policy regulations. In her view, the university, JKUAT has drawn people and influenced competitive development in her neighbourhood. Some individuals in the neighbourhoods struggle to secure space and develop hastily without consideration of legal regulatory frameworks.

Besides non-compliance with legal provisions, there is poor waste management in general and inadequate provision of proper avenues (access routes) that link various sections of the developing urban area. This finding corresponds with Florian and Norma (2019) who posited that higher leaning education institutions pull development in their neighbourhood. These neighbourhoods are associated with environmental challenges such as waste management and inadequate planning of infrastructure. In addition, there is also mix up of dilapidating structures and modern ones posing health risks. In this regard, the study engaged the public seeking to establish whether they were aware of the policies guiding development activities. The findings of the study revealed that majority the public (77%) were not aware.

The situation about local community's little or lack of knowledge on development policies was emphasized by one of RU management staff who noted that "I don't think people know even the policy procedures regarding making a well". Being knowledgeable, he expressed his concern that even sinking a well requires permit which he doubted whether the community and developers are acquiring. His concern is an indication of fear of mismanagement of environmental resources. The other technical part he expressed doubt on, is whether the private developers know is the fact that in any piece of land one acquires, developed part should not exceed 49% as provided by the physical planning policy..

Bondinuba *et al.,* (2013) asserted that difficulties exist in complying with policy provisions. This attributed to total lack of knowledge of the policies or lack of understanding. Study deliberations with RU management revealed that there should be consideration on a number of issues during development. Some of them include the mentioned above (percentage of the built up area which should not exceed 49%), water, materials, sanitation among others. RU management expressed fear that some of these crucial concerns are not integrated in the university neighbourhood development. Some of the evidences witnessed in Kitere are non-compliance with the percentage of land built up in plots. Many people seemed to have built over 90% of their lot areas. The study findings revealed that only 23% of the people were familiar with development policies as illustrated in figure 4.1. The study noted that if policies remain the only thing to go by in environment management and protection, then it becomes apparent that RU's local environment will be more vulnerable. This is based on consideration of the fact that people cannot implement what they are not familiar with hence will continue to skip policy procedures and initiate their development activities. These developments might be detrimental to the environment. This concurs with Oanda and Jowi (2012) assertion that effectiveness policy implementation is achieved when the public is able to understand and embrace such policies.

The study also examined the National Urban Development Policy document which provides for planning and development of physical infrastructure and other services such as public open spaces, health facilities, recreational facilities and parks. These are considered major priority areas in the National Development Policy for sustainable urbanization. Nevertheless, development within RU's local environment seems not to have integrated the provisions of this policy. The study acknowledged the fact that RU neighboring lands are privately owned. Despite this fact, environmental management requires some provision of open spaces and parks which act to support recreational activities and regulate amount of carbon in the atmosphere respectively. It is only within RU where such facilities are provided for. The university immediate surrounding has not provided for this possibly because of inadequate knowledge on environmental management. The infrastructural development is also haphazard in the RU's neighbourhood. This finding corresponds with what Dindi established in Juja around JKUAT in 2013. Okong'o (2014) also had similar result in his study of the University of East Africa Baraton. The study noted that

development around these universities tend to sideline the guidelines provided by the policies. Consequently, the structures and facilities yielded do not conform with policy specifications for urban development. As a result, the rise of informal settlements popularly referred to as “University Slum” underscores the fact that even though the existing policies advocate for affordable and quality housing provision, there is very little evidence for compliance.

Initially, in the local government reform programmes, there were provisions for adoption of development control by the various local authorities to help guide development activities. Development control aimed at achieving optimal LU and orderly development that conforms to the provisions of the physical development plans. It advocated for strict adherence with the provisions of the Physical Planning Act Cap 286. The study established that many developers do understand the provisions of these legal procedures. Some of the developers perceive that the legal development procedures are expensive and quite involving thus delay development processes hence they are overlooked by developers. It is unfortunate that the current development trend around RU seemingly does not follow strictly the provisions of the Physical Planning Act Cap 286 and also does not take into consideration what is stipulated in development control. What manifests as a result of this is a development which poses multiple threats to the environment owing to non-compliance with the environmental standards and legal provisions.

The study established that most of the policies relating to the establishment of university including the University Act Cap 210B of 2012, lack considerations for the sprawling development and their externalities associated with university establishment. For instance, approved plans of the sites where the Universities are to be established have not been provided in the policies. Existing policies are silent about these externalities like rise of university catalyzed slums as well as the consequences on LULC changes. The policies have also not stipulated clearly for university development monitoring procedures which may help to realize their sustainable development. In its second schedule, the University Act has only provided specification on standards for physical facilities within the university. It has not mentioned immediate surroundings. The same applies to the County Government Act No. 17 of 2012. Even though the county government has been given

mandate by EMCA to make environment action plans and monitor compliance, little has being realized based on the witnessed haphazard development around the university.

The Kenyan Constitution 2010 and the EMCA 1999 are too general on environmental management. Currently, there is no policy in Kenya that specifically deals with externalities that arise from university establishment. What is envisaged in the existing policies and other legal frameworks have failed to specify the control measures that can be adopted to regulate sustainable development in order to avoid proliferation of slums in university neighbourhoods. This study is a notable case of environmental degradation around the university is threatened with rapid transformation from natural to built-up environment. The biodiversity around the university have been affected. Some of the genetic biodiversity is lost and habitat destroyed leading to loss and even extinction of various species.

Interestingly, having acknowledged they are unfamiliar with the development policies, many people (69.3%) contended that developments within and around RU are undertaken within policy guidelines. They contended that housing development in the area is normally approved by the National Constructions Authority (NCA). In their view, that is a legal procedure. Others provided in the Physical Planning Act Cap 286 and EMCA 1999 could be formalities. The study established that these respondents perceive other policy provisions to be quite involving and are normally attract extra expenses such as fee paid for approval of plans before the project implementation. This indicated low level of awareness on policies and inadequate information. The question one would ask is how someone ascertained compliance with the policy if he/she is not familiar with its provisions. However, the few who were familiar with the policies showed their consistency in figure 4.2. They disregarded the fact that development in RU's local environment comply with policy provisions. This was based on what they witness in the university neighbourhood. In their view, provisions of the legal institutional frameworks are not followed. According to these respondents, many development activities are being undertaken in the areas with no idea at all of what the development policies stipulate.

In addition, some respondents claimed that some developers do understand the policy provisions while others do not bother about the provisions. One of the respondents stated

that “the developers might be aware of the legal provisions but they don’t implement them because there is little follow up by the implementers of the law and policies.” This clearly demonstrates that there is a weakness in monitoring and evaluation of policy implementation. Results of the focused group discussions affirmed this noting that lack of commitment by the law enforcers and other policy implementers. Bossel (1999) contended that understanding policy provisions is key to sustainable development. RU management reported that they have been in an attempt to ensure compliance in the university neighbourhood. The management has been inviting and engaging private developers and potential land lords around the university once a year to enlighten them on university policy requirement. This they do to ensure that private hostels and other facilities used by the students outside the university meet the minimum standards stipulated in the university policy. However, the university recorded inadequate support from the regulatory authority to guide institutional framework. Despite this effort, some private developers and land lord owners are still not willing to join hands with the university in realizing sustainable development. They still put up structures which do not meet the minimum standards set. This not only threatens human health but also the environment. This finding is not different from what Bondinuba established in 2013 in his study on “Developing student’s housing quality scale in higher institutions of learning”. Bondinuba (2013) in this study noted that every developer intends to quick fix their commercial structures which offer accommodation services. Nevertheless, little attention is paid on standards required. The only focus is how fast they can start making income from their projects.

The study also established that there is overlap in performing various responsibilities by both NEMA and the NCA. The respondents claimed existence of a gap in harmonization in how the two authorities operate and which authority is to come first. One of the respondents stated that “there has been confusion in the role performed by NEMA and the NCA in terms of which authority is mandated to approve development projects especially the buildings.” In their view, the NCA normally comes and writes NCA on the walls and from there, no other follow up activities are witnessed. Other respondents claimed they had never seen NEMA officials doing a follow up of development activities in the areas therefore many people do not understand their roles. Consequently, there is a possibility of some developments undertaken without EIA being conducted. A focus group discussion revealed

limited public involvement in development projects taking place in the region. In this regard, the neighborhoods are always getting surprised with various developments in the area in which some do not conform to the character of such neighborhoods.

The study also sought to establish from the pubic whether it is appropriate for development activities to be undertaken without considering policy guidelines. Interestingly, majority (83%) of the people seemingly attach significance to development policies. They overwhelmingly refused as figure 4.3 portrayed. This demonstrated that even the public sees the necessity of implementation of policy guidelines in development activities. In this regard, the study noted that the public could be willing to adopt and implement development policies but weak regulatory authority during policy implementation may be an impediment. This finding echoes Cheruto's finding (2017). In her study on "*Assessment of LULC changes in Makueni County for selected time period*", Cheruto noted that public willingness to adopt and implement certain things like policy is influenced by those involved in the implementation. Their commitment to the goal plays a critical role. However, some few individuals failed to acknowledge the significance attached to the policies. In their view, there is no problem initiating development project without consideration of the policy provisions. They perceived that implementation of policy provisions is costly and time consuming. Therefore they rather go the easiest way. Nabutola (2012) also noted unwillingness and/or hesitance by the people in adoption and implementation of government policies.

Generally, there are many reasons why developers do not follow the required procedures laid down in the development policies. Some of the reasons the study established include lack of knowledge on the provisions of these legal frameworks. As noted earlier, this is a challenge which was mentioned by 78% of the people in the study area. This has impeded implementation of the policies and in turn led to haphazard development characterized by rapid degradation of vegetation cover and poor waste management. This does not stand singly but more concerns about lack of willingness by some community members was also noted by Steinacker (2004). The study established that some members of the community deliberately overlook the requirement of the policies. Their focus is basically on how fast they have their projects in place. This kind of attitude is always detriment to the

environment as priority is given to development without integration of environmental concerns. This category of people view policy implementation to be costly and time consuming and pay little attention to environmental conservation. No matter how technical policy provision may appear as some claimed in figure 4.4, their integration in development activities is crucial for environmental protection. Though involve such charges such as little costs on plan approval, policy implementation should not be disregarded. The study noted that some people in the community would rather avoid costs incurred in policy implementation than have sustainable development.

The results of the study in its effort to ascertain level of government involvement in monitoring development activities left this study with some doubt. The community overwhelmingly recorded 84% involvement of the government in this exercise as portrayed in figure 4.5. The question which remains unanswered still is the reason why many unplanned developments are still coming up in the study area. If it is true that the development is closely being monitored by the government then there would be control and regulation of haphazard development in the area. Contrarily, the area is still being characterized by mixture of dilapidation structures, high-rise buildings, temporary and permanent structures of various forms. Probably these are the similar concerns the 16% who noted lack of government involvement in proper monitoring of development activities in the study area. Anybody who looks at the region critically will pose similar concern. However, the community contended that they normally see some individuals working with the National Constructions Authority (NCA) undertaking inspection activities. Though they noted that in rare occasions do they see offers from NEMA participating in monitoring or auditing exercises. The NEMA officials hardly seen in the area remain to be very crucial with regards to control of projects which might be injurious to the environment. This revealed to the study the weakness in policy implementation in that NEMA should be working to implement what is provided in the EMCA. Similar monitoring concern was raised by Okong'o (2014). The study noted that probably majority of the people in the study area have inadequate or no clear understanding of what monitoring entails. This also portrays the level of community sensitization required.

The study finalized objective one by seeking to establish the implications of not monitoring development activities within RU and its local environment. Highly mentioned implication was haphazard development which recorded 71.4% as indicated in figure 4.6. It appeared obvious to people that lack of monitoring development within the study area will continue to give a leeway to unplanned development which will not only affect human health but harm the environment. The government itself will find difficulty in delivering various services such as water supply and sewerage system once the area shall have developed into a full slum. Also, management of wastes will be a nightmare in such a locality. There should be provisions for such public utilities in an urban set up. The access roads/avenues and way-leaves must also be catered for. The study felt that earlier stage involvement by the government in monitoring and auditing the on-going developments will save the area and the environment from the vulnerability caused by haphazard developments. This finding is in concurrence with Njiru (2016) in his study on "Evaluation of Urban expansion and its implications on LU in Kiambu County". Njiru asserted that the earlier the involvement and engagement of the concerned authorities in controlling development, the better it is for the area and the environment. Commitment of the government in monitoring and controlling development activities should not be overstated in this case. It remains a major requirement.

According to Wu and Irwin (2008), consequences of non-adherence to policy provisions cannot be overstated. These consequences affect the environment and its resources and also extend to humans. The study established unsustainable use of natural resource in the region. This is a fact which was noted particularly on the use of land. Environmental concerns come last as people are giving priority to commercial structures in the study area. More natural environment is losing to built environment. Similarly, agricultural land is losing to built up land. People scramble for spaces to put up commercial buildings since RU has made the region to be more potential for development. This is a clear threat to environmental resources since vegetation cover together with other forms of biodiversity are lost. More genetic resources will eventually be lost in this trend of development. Another implication identified was rapid degradation of natural resources. A discussion held with one of the key informants revealed a rapid loss of natural environment. The information gathered indicated that economic development realized in the study area is

accompanied by environmental degradation. The study noted that an area along Rakwaro-Rongo town road which used to be a wetland has been invaded and transformed to support brick making. These bricks are meant for development of structures in the study area. The aquatic life the wetland used to support is now threatened. Other roles performed by a wetland have been compromised simply because of the attitude that concern for nature comes last.

Natural environment is under destruction with little concern. The analogy of 'Our environment, our future' does not apply to some people in the community. The study noted serious need for change of attitude in order to embrace nature. Lack of monitoring enhances overexploitation of natural resources since everyone feels nobody questions how and why such level of exploitation is undertaken. Every individual will be using resources the way he/she deems fit. This goes against what Cheshire and sheppard (2002) proposed in their study on "*The welfare economics of LU planning*". In their study they recommended a balance between human satisfaction and natural resource conservation. This is based on the fact that there is interdependence between man and nature. Man should therefore see on how he balances meeting his needs and conserving nature. For example oxygen we consume comes from nature. The findings of the study revealed that lack of proper commitment in monitoring in the study area has resulted into urban rush and quick fix of structures. The buildings are coming up hastily and seemingly others do not use the proper materials required as was feared by the RU management. An evidence of this was shown in plate 4.1 which portrayed a building collapsing while under construction. This is a symbol of danger to both human and environment.

### 5.3 Nature and Extent of LULC Changes in the Study Area

In order to ascertain LULC changes which have been realized over time, description of the state of environment during respondent arrival at the study area was critical. From figure 4.7, the study noted that over 50% of the people in the study area recorded that the environment was occupied by crops/plantation during their arrival period. In this regard, the study discovered that the region used to support sugarcane growing. According to the respondents, large pieces of land in the region were occupied by sugarcane plantations. Meyer (1995) in his study on "*Past and Present Land-use and Land-cover in the U.S.A:*

*Consequences*" acknowledged cases in which natural and agricultural lands are lost to built up environment. This consequently affects biodiversity distribution. This study noted lands which were formerly occupied by food crops, fruit trees and other trees but were modified to suit current housing demands. The respondents further indicated that sugarcane was considered as the major cash crop in the area. It used to generate income to the community thus prompting many people to engage in its farming. Other crops like maize and a variety of cereals were mainly food crops which were grown for subsistence. The respondents emphasized that sugarcane as a cash crop was helping the community in issues such as fee payment and boosting their businesses. This justified their description of the area to be occupied by crops/plantation. The study was informed that sugarcane crop has been grown under contract farming arrangement with the nearby South Nyanza Sugar Company factory. It is imperative to note that some particular crops such as sugar cane do support ecosystem services considering their growth and time taken before they mature for harvesting. Sugarcane for instance acts as a habitat for the period it is in the field. During the same period, they serve as LC and to some extent contribute to recharge of atmospheric moisture through evapotranspiration. Therefore, in some ways it saves the environment. The study conducted by Musa and Odero (2015) on "*LULC changes and their effects on agricultural*" acknowledged the environmental roles played by agricultural land. In their view crops such cover crops are vital for soil conservation. Their assertion is married by the thoughts in this study. Some members of the community also described the environment to be covered with trees or forested during their arrival in the study area. This showed existence of LC at their time of arrival. The study considers that the areas which were forested at the time the respondents were settling contributed to the protection of the environment. For instance, the trees conserved the soil, water and biodiversity while at the same time ameliorated the area's micro-climate and acted as carbon sinks, among many benefits.

According to Minal and Patik (2017), there exist progressive changes in LU owing to constant increase in human population in different parts of the world. Development activities instigate these changes. It is only in rare cases and few places where LULC changes are not evident to people. This study noted that only a few people (5.9%) reported that their environment was built everywhere during their time of arrival. The study considered this category as students and new people including staff who arrived in the

study area when it was already built. Possibly this group also represented the earlier settlers who had settled much earlier as residents of Kitere shopping centre, Rongo town and other centres like Kanga and Rakwaro among other centres where data was collected. This group of residents emphasized that the areas they presently occupy were not natural environment but those areas had been transformed into a built environment with many structures for accommodation and businesses. In that case, what these respondents described as built everywhere represents Rongo town and the shopping centres aforementioned. Also some people stated that the landscape was open at the time when they started settling in the study area. This implies that the area had only few structures and crop growing was not intensive. The open lands is interpreted as areas which were not subjected to human settlement and cropping which in real sense was not necessarily open during their arrival in the study area. Such lands could be used by the community as grazing and fallow lands which were not supporting structures and farming during that period.

Globally state of environment is changing as a result of modification to suit the current needs. This change has environmental implications (Mwathi, 2016). Members of the community reported 89% transformation of the area into buildings. This implies that the natural environment, agricultural lands open spaces is lost. People are witnessing development of housing in the area. Environmentally, this means compromising ecological and ecosystem roles played by the natural environment. This description of the current state of the environment indicate that area is being cleared and land transformed or modified to suit the existing demands of housing in the area. This was supported by some of the key informants who stated that "new developments witnessed in Kitere region is not only characterized by loss of LC. Its modification of LUs cannot be whispered. It is something that everyone sees". Further, deliberations in FDGs revealed that the existence of RU has influenced movement of people from various places. This has resulted into increase of population which does not only put pressure on available housing facilities but also on goods and other services. This finding echoes the establishment of Uchendu *et al.* (2016). In their study report on "Tenure responsive LU", they considered sudden population rise as a major factor in LU modification and transformation. In their view, pressure on limited resources such as land will always instigate thoughts of modification to suit the existing demands. Study found Kitere regions as a no exception. People in the region seem to be

over-carried with the thoughts of commercializing the area. The development witnessed in the region, justifies the commercial direction the area is subjected to take thus modification and transformation into built environment. However, a few people held that the area is still in its original state. This possibly could be a representation of the individuals who have not taken enough time in the study area to witness changes it is undergoing.

The study noted that the area is still undergoing further changes considering the fact that most of the areas visited are being sub-divided and fenced awaiting development. Therefore, it is imperative that appropriate plans be drawn to guide proper utilization of our environment. As already highlighted in objective one under policy and institutional framework, most development activities in the area inadequately integrate laid down policy procedures and the provisions of the policies guiding development. While development activities are already taking place it is prudent to super impose appropriate plans where possible to remedy the flaws in developing without guidelines. The starting point is to monitor these development activities to determine their status and ensure that they are undertaken in a sustainable manner. If appropriate interventions are undertaken it would be possible to change or alter the status quo by increasing the tree cover. A focused group discussion revealed that further changes in the status of the environment in the study area should be expected since RU is still a young university with potential for more future developments to take place. According to some of the focused group discussion members, the university still expects more enrolments which will attract increased demand in accommodation facilities as well as for learning facilities. This finding marries Dindi's (2013) establishment who also foresaw further environment challenges in JKUAT's neighbourhoods linked with the future university expansion. Similarly, private developers are also eying the area since it has great potential in terms of new businesses coming up which will result in land acquisition for further developments and attendant changes.

According to Maina *et al.*, (2020), change in environmental state is not something to be whispered as it becomes eminent in almost all places. The study established that the majority (89%) of the respondents overwhelmingly confirmed that the state of environment has changed as further depicted by Figure 4.9. Some of the respondents claimed that what they have seen over the time that they have stayed in the study area is alarming. In their

opinion, there has been rapid transformation of natural environment into a built environment. Vegetation has been cleared to pave way for the development of various infrastructures. They also argue that RU is developing at a faster rate and as a result of this several development activities and services are being drawn. The study has also indicated that land that used to be inhabited by various forms of biodiversity is progressively been lost. This implies loss of genetic resources. The information obtained from the focused group discussion and key informants revealed that there has been change of use even for structures which were initially established to serve as business premises. In the respondents' opinion, some business premises have changed to serve as hostels. Further, the respondents noted that initially there were fewer high-rise buildings but as a result of the establishment of RU, a number of storey buildings have emerged in the area. According to some property owners and residents, there has been significant shortage of accommodation facilities when RU was established. The high demand for hostels contributed to the change of use of various structures to meet the increasing demand for accommodation. This finding is in concurrence with Wu and Irwin (2008). In their study on "*Optimal land development with endogenous environmental amenities*", they acknowledged existence of circumstances where alternative lands might not be sought for but some developments can be modified to suit the demand in question. However, the study finds this to be challenging in that some modifications may not be done to the standards stipulated by the policies. Developers may take advantage while hurrying to start getting income from the facilities. The risk will only be realized by the residents or occupiers of such modified structures. Even though it saves space, some risks are attached to it.

In a related development, the focused group discussion established that sugarcane plantations are fast disappearing. Jones and Clark (1997), listed infrastructural development as one of the factors of LU change. Land is continually fragmented into smaller units and change of use of buildings and lands occasioned by high demand for accommodation and premises for business sets in. The land parcels where such agricultural practices were taking place have been sold to private developers leaving the natives with small pieces which cannot support large scale sugarcane plantations. The study also noted that the issue of selling land to private developers is leaving some of the community members landless thus precipitating family conflicts. Equally, concern was raised over the rapid

transformation of Kitere shopping centre into a new town outfit. The main concern is that the shopping centre is developing into a slum with no planning at all. The characteristics of structures coming up is basically a mixture of different structures and orientations for unclear utilization. Worse still, some structures which are old and dilapidating have not been demolished nor renovated to meet current or changing demands. Also, the on-going developments do not provide for services such as waste management, among others.

However the study noted that a few members were not able to notice any environmental change taking place in the study area. The study attributed their reasoning to inadequate knowledge and lack of capacity to monitor environmental changes or altogether they have no idea of what change exactly means. Alternatively, there could be a possibility that actual change had not taken place at all in their places of residence considering the duration they have lived in the study area. In rare cases, this group could represent individuals who have no concern at all about their immediate environment or surroundings hence it might not matter to them whether there are changes or not.

Many people have not been able to discern the direction in which changes in LU lead them. Some people become overwhelmed with joy having realized benefits after LU modification or transformation. LU change has some opportunities [Food and Agriculture Organization (FAO), 2016]. In determining direction of change, the study learnt that many people (64%) viewed the change to be taking the right direction. That is moving from bad to good. Analysis of this response left the study with no doubt that there is little knowledge on environmental conservation in the study area. The responses of interviewees who perceived the change in the environment to be taking the right direction were merely based on reasons that the area used to be bushy and occupied by sugarcane plantations which could habour dangerous animals but currently these places have been transformed and nice structures can be seen even from far. This position qualifies the existing gap in knowledge and information regarding the environment and the natural resources thereof (i.e., environmental illiteracy). Many people consider transformation of natural environment into built-up environment to be of more value. This finding concurs with the assertion of Zacharia *et al.* (2013). In their study on "*Morphology and spatial dynamics of urban villages in Guangzhou*", they perceived urban villages to be associated with challenges

whose cause may be the surrounding people. In their view, spatial dynamics are influenced by the people. In cases of inadequate knowledge or understanding on environmental issues, worrying and detrimental spatial uses may arise. This may include indiscriminate placement of structures among other poor use of spaces.

The 64% indicates the number of people in our society that we have to educate and empower on the issues of environmental conservation and management. Apparently, they may not totally fail to understand the kind of losses we realize when we substitute the natural resources such as vegetation with structures, rather, they vaguely understand the implications of such changes. It is a fact the ecological roles performed by natural resources such as vegetation on the environment is compromised in such changes. Equally, the aesthetic value of the natural environment is also lost. Their claim that the area has been opened up for development and they could cite some of the benefits like availability of market, job creation by the university, availability of various services created by the university, income from rentals among others is not refuted. The important and fundamental message this study is alluding to is that the nature of development which unfortunately majority of people in our society/ community promotes in many cases is not sustainable considering that it does not adequately integrates environmental issues in our development activities. Such inadequate integration of environmental concerns in development was also reported by Nabutola (2012). However, some people felt that transformation of natural environment into built-up environment has greater consequences. For instance, loss of genetic diversity, interference with atmospheric moisture recharge, displacement of various organisms and even total extinction of some species, among others were cited as negative impacts brought about by the changes taking place.

The study therefore established how critical it is to build capacity and empower our community on environmental matters so as to enable them understand and become part of the custodians of the environment. The journey of achieving sustainable development entails embracing public participation and capacity building. If the people are left behind and not empowered, little can be achieved with regards to sustainable development (Bossel, 1999). The study has also established that a number of development activities undertaken under the banner of development are indeed injurious to our environment owing to lack of

adequate understanding or knowledge by the communities and those tasked with the responsibility to execute them. The significance of this study and in particular the direction of change, show that there is fundamental challenge in value judgment by the majority of the public. This is so because most people in our communities ordinarily value structures and other development activities on land more than the environmental value and its resources (tangible and intangible). The inability to understand how the environment functions and its countless benefits may not be easily comprehended by most people. The gap in understanding of our environment and its role is perhaps one of the major contributors to environmental degradation in our communities.

Maina *et al.,* (2020) acknowledged use of GIS and remote sensing as one of the effective methods studying changes in LU. Landsat images for the year 2003, 2008, 2010, 2013, 2014, 2015, 2016, 2017 and 2018 were acquired. Information for the year 2003 was intended to help establish the environmental status long before the university was established. Analysis of this information revealed that grassland had the largest percentage (68%) in terms of coverage in 2003. During this period there was relatively large sugarcane plantation coverage as indicated in the table 4.4. Tree cover and the open/bare land had almost the same coverage (4%) but with little difference. This implied that there was a lot of LC. Build up environment was only 8%. Information from 2010, a year just before the establishment of RU indicated that tree cover percentage changed from 4% to 1% based on what was there in 2003. Open land increased from 4% to 13 percent. This was associated with the loss of tree cover. There was also increase in plantation or farming activities from 16% to 53 %. This could have also contributed to the loss in tree cover and grass land which also lost from 68% to 19%. The study learnt that it is possible that much of the land that was considered grassland could have been transformed into farm land due to the large change in percentage from 68 to 19%. This implied significant change in LC between 2003 and 2010 because both tree cover and the grass land tremendously reduced in percentage cover.

Also, the study noted that an increase in plantation or farmland affects LC like grass, tree cover and other vegetation. This is because vegetation is always cleared to pave way for cultivation. Increase in settlement also impacts negatively on vegetation cover. This finding

is in concurrence with FAO, 2016) report of "*State of the world forest and agriculture, LU challenges and opportunities*". Similar concerns were reported by Melaku (2016) in his study on "*Effects of LULC changes on forest resources of Ethiopia*". The study noted that settlement almost doubled in 2010 as compared to 2013. It increased from 8% to 14%. Analysis of the information from 2003 to 2010 was used to determine earlier rate of environmental changes before establishment of RU. The findings of 2013 also revealed a significant increase in settlement compared 2010. The study learnt that in 2010 just before the establishment of RU, settlement occupied only 284.48ha (14%) of total area of North Kanyajuok while in 2013 it moved to 647.63ha (32%). This is alarming as it was noted that between 2003 and 2010 (7 years), settlement only increased by 6% while between 2010 and 2013 (3 years), settlement recorded an increase of 18%. The study attributed this to Rongo University whose establishment and development has been seen to catalyze development in the region. It has become a pull factor with a lot of potential for development. It draws various development activities including businesses. Also, this sudden increase in settlement was linked to the increase in student population following new enrollment which had started as well as the sudden population explosion in the area hence need for more housing facilities. Increased development of infrastructure for learning and accommodation facilities was also evident during this period. The local residents and private developers had started noticing the potential of the area in terms of development activities.

According to Minal and Patil (2017), most changes in LU occur due to varied human demands such as housing and infrastructure. The study established that settlement in the study area showed a constant increase. A total change of 48.52% was registered by settlement between the year 2010 and 2018. It moved from 14% in 2010 to 62.52% in 2018. This is period of 7 years. When data for 2003 to 2010 was taken (period before RU was established), it indicated that settlement only increased by 6%. That is from 8% in 2003 to 14% in 2010. This justifies why the study is linking the establishment of RU with changes in LULC of the study area. The question one would ask is why we have totally different rate of change/development in the same period (7 years before and 7years after the establishment) of RU. The study compared this data with information of Rongo town. Between 2003 and 2010 the town recorded 13.3% change in settlement while between 2010 and 2018 it registered 32.7% increase in settlement as portrayed in table 4.5. Even though

there was a higher rate of change in Rongo town between 2003 and 2010, 7 years before RU was established, the study noted that after the establishment of RU, the rate of development surpassed that of Rongo town. Even though other factors such mining are evident in the study area and could attract population in the area, the study singled out Rongo University to be the major contributor in catalyzing development in its immediate surroundings. This is because economic activities like mining existed in the area even before establishment of Rongo University. Despite their existence during those days, such rapid change in settlement had never been witnessed. This can be justified from the Landsat images used in this study. This finding coincides with Steinacker's (2004) report. In her study on "*Economic effects of urban colleges on their surroundings*", she noted that colleges and other institutions of higher learning have influence on development of their neighbourhoods. They provide ready market and open up their surroundings for economic growth. Summary of comparison of LULC of the two areas elucidated here are as indicated in table 4.4. Considering the fact that RU is less than ten years old, someone can imagine how the area will look like in the next ten years. There is constant transformation of the natural environment into a built-up environment. More housing facilities are required in the area to be used as rentals and provide accommodation to the increasing number of students and other people pulled by the university. Other housing will also be needed for business purposes.

### 5.4: Local Environmental Impacts of RU

This section involved establishing reasons for respondent settling in the study area and examining drivers of LULC changes in the study area. After which, the study explored how these changes affect the environment and its resources. From the analysis of the findings, the study noted that many people engaged in household interview were natives as was presented in figure 4.13. Others were driven by a number of factors such as business and job opportunities. Therefore, their reason to settle in the study area was because of the business they were involved in and job they had secured in the study area respectively. On the other hand, some people like students settled in the study area for schooling reasons while others like private developers perceived the area to be potential for development hence settled in the area for development reasons. This finding revealed that apart from

those who were born in the study area and the students, other people were pulled into the place. Oanda and Jowi (2012) posited that university attracts people and various development activities in their localities. For instance improved business opportunities must have influenced business persons into the study area. A market had been created in the region by the students and the staff at RU therefore it became a potential place for business activities. Among them, some were hotel operators, others were hair dressers, while others were running other businesses like printing and photocopying, M-PESAs, shop keeping among others.

One of the respondents contended that "with the view of trend in development in the study area and continued increase in students' population, Kitere region remains the area with the highest potential to attract more developments." In his view, there is a ready market for various commodities and services in the region considering the increasing population in the area. People could get ready market for their goods and services as was reported by one of RU management staff that "The University has created ready market for even vegetable venders and other small goods and services". In this way the university has acted and still acts as a pull factor in the region. Many developers attracted by the fact that Rongo University neighbourhoods exhibit ready market for various services instigate development in the region thereby posing social, economic and environmental impacts as was reported by Dindi (2013). In his study on "*LU changes: Economic, social and environmental impacts*", Junjie (2008) posited that as more population is drawn into the area LU is modified and this has a number of impacts which are not only environmental but also socio-economic.

**5.4.1: Drivers of LULC Changes within RU and its local environments**

The changes brought about by private developers who seek land near RU and modify them to suit their interest was the major driver of LULC the study established. This was reported by majority (74.1%) as portrayed in figure 4.14. This scenario has been discussed on a number of occasions concerning land acquisition and development of private hostels and business enterprises to supplement what RU is able to provide. The construction of these hostels is seen as a strategy to help the students who are not able to cope with the rules governing the university hostels. Other students are also married and would like to enjoy

their free life hence prefer these other hostels which are not managed by the university. Plate 4.8 and 4.10 show examples of privately owned hostels. Another driver of LULC change mentioned is RU itself. Arising from the FDGs was the fact that RU has attracted many development activities which lead to rapid transformation of the natural environment. Further deliberations with the key informants indicated that a lot of development activities are evident within Kitere region where RU main campus is established. This concurs with Njiru (2016) finding that urban development and expansion is influenced by a number of factors including existence of learning institutions in a given area.

As was previously noted, University itself has been expanding through development of its own structures which support leaning and research activities. For example, at the time when the study was being conducted, RU library was under construction on a land that was initially covered by trees (university forest). The area covered by the library is approximately two hectares. The area seemingly has lost the ecological roles which were performed by the forest to some extent. The trees for example act as carbon sink and their presence in area can help regulate amount of carbon dioxide in the area. This finding coincides with establishment of Melaku (2016) who asserted that LU changes does not only interfere with forest resources but also compromise their ecosystem roles. The study does not negate these development activities but advocates for a sustainable development that takes into account the environmental concerns at all levels. Plate 4.7 shows part of forest which was cleared for development of a library within RU. This is a clear indication of changes in LULC within the university. The same thing is happening with developments undertaken by the private developers in RU neighbourhoods. However, the study regained hope when one of the university management staff reported that the RU has started and is in the process of planting trees. He stated that they have covered 5 hectares with tree seedlings which are now developing and the exercise is expected to continue. This is an indication of replacement of the lost LC.

It is common knowledge that establishing a forest takes a lot of time and resources and yet it takes a very short time to destroy it together with its multiple benefits as being done now under the cover of so called ‘development’. Proper management of the environment must be upheld for sustainability to be realized. In their study, Framer-Brower *et al.* (2006) on

"*Drivers of LU changes*: *Matching opportunities to motivation*" acknowledged the significant roles played by vegetation and noted that interference with such resource may have direct impact on various life forms. They noted fact that forest cannot be grown overnight but take years to develop. In this regard, the ecological roles performed by a fully grown tree cannot be played by a seedling. Therefore the policy of cut one plant two is sometimes challenged. It therefore follows that large transformation by clearing vegetation contributes to more accumulation of carbon dioxide which is a greenhouse gas in the atmosphere. University forest for instance acts as a natural laboratory where biodiversity conservation may be taught. It is obvious that many biodiversity life forms that were occupying the area before it was cleared may have lost their lives during excavation. Rudel *et al.,* (2005) contended that many forest benefits exist but people tend to focus on face value benefits rather than ecological ones which are more important. This is one of the things which necessitate proper implementation of Environmental Impact Assessment.

It is in view of the study that development of other learning and accommodation structures together with offices has also contributed to the loss of the LC and even change of LUs. What is evident at the moment around Kitere shopping centre which is now growing as RU neighbouring slum, is the linear development of structures towards Kanga shopping centre. Several small structures are being constructed along Kanga-University highway. A lot more of such structures and others in the category aforementioned should also be expected as the university is still growing and registering more students. This implies that more learning and accommodation facilities will be required in the future. The University will also think of establishing staff quarter together with various facilities such as amphitheater. Such kind of development will still lead to LULC changes. Similarly, more people are also seeing the potential of the region with the growth of RU and this will still lead to more transformation of the natural environment.

Arising from deliberations with key informants is that more farmland, grassland and the areas formerly covered by trees are under transformation. This finding corresponds with the finding of Tumebo (2017) in his study on "*LULC change detection using remote sensing*". In this study, Tumebo established transformation of farmlands into settlements in order to meet demand of the rising population. The neighborhoods and outsiders have perceived

that there are a lot of benefits that accrue from development of rental and other accommodation facilities. They end up selling their lands to private developers so as to acquire money to develop their own structures for income generation. Unfortunately as was observed in the focused group discussions, the household heads in most cases end up consuming what they have acquired from the sale of their land and remain stranded. That is to say, the agricultural land is lost but the beneficiaries become the private developers. What was evident during data collection exercise was the fragmentation of land into small units or plots. This consequently subjects the land to degradation as it may lead to soil erosion. A good example is plate 4.9 showing a plot awaiting development. They are meant to offer housing services to students and other residents. Some of these places were farmlands as maize stalk can be witnessed in plate 4.9. They are now being turned into buildings. Other places were occupied by trees or vegetation and these are being lost gradually. The land is losing its natural nature.

The study findings revealed that the lands which were formerly open/bare have tremendously reduced in sizes. The Kitere region is taking a new look. The only challenge is that the community in the study area perceives this as positive direction of change. Little or no attention has been paid to the harm caused on the environment as was noted earlier that development in the region have not adequately integrated environmental concerns. Signs of avoiding policy guideline are evident in their haphazard development. It is apparent that such trend will most likely continue unabated with resulting degradation of the environment and natural resources thereof. Framer-Browers *et al.,* (2006) considered development of infrastructural development as one of the major drivers of LULC changes. This is also applicable in Rongo University and its local environment. New housing development plays a major role in this. The results discussed above were supported by the Landsat images of different year starting from 2003 to 2018 as portrayed in figure 4.15 to 4.24. From analysis of these images, the study noted a constant development in settlement and continuous loss of LC. Despite the fact that there is natural increase in population, the study noted a unique development in the study area which it associated with the establishment of RU. The rate of change seemed to be slow before the establishment of the university but suddenly increased immediately after the university establishment. This was evident by change in coverage and intensity of red color representing settlement. According

to Minal and Patil (2017), increased settlement influences other LUs. It reduces farmland and vegetation cover. Similar finding was recorded by the study. However the study noted that other LUs like agriculture also affect LC. The study noted that increased farmland reduces open spaces and grassland together with tree cover.

Florian and Norma (2019) contented that institutions of higher education tend to influence development in their neighbourhoods immediately they are established. Rongo University is less than ten years old and the impacts of its establishment can be seen and spoken about even by the dumb. The study summarized the gains and losses in LULC as has been influenced by the establishment of RU and the results were as illustrated in figure 4.20. The study established that settlement has not been losing. Its increase is consistent while open land is losing consistently. Even though little gain was evident in tree cover and grassland, constant rise in settlement remains to be a threat to them. Though, plantation is seen to have gained, it is also in danger as more developments are also expected. With this trend of change and modification of the environment, the study projected what should be expected in the year 2030 being a year of vision. From the projection, the study noted that settlement will occupy 75% of North Kanyajuok with almost total loss of open land as was portrayed in table 4.9. On the other hand, plantation was projected to be at 3% indicating loss of agricultural land. This is a food security threat as was mentioned earlier. The projection revealed that open land will be lost. The study attributed loss in open land projected with many development activities taking place in the area such as development of housing facilities. The study also learnt that the transformation and modification realized contribute to environmental degradation and loss of genetic resources. Also, a number of species of organisms might face extinction. The projected 2030 image of the study area appears red as portrayed in figure 4.26. The red colour seen, occupying almost all the area is an indication that the area will be built everywhere. This raised a lot of concerns with regards to environmental conservation matters considering the fact that LC which purifies the air, provides habitat and also contributes to completion of water cycle will be lost. It also indicates that biodiversity is faced with future extinction. Various genetic resources in the region will likely be lost.

### 5.4.2: How LULC Changes Affect the Environment and its Resources

The major effect of LULC change on the environment as observed by many people (68.1%) in the study area is destruction of natural habitats. Substituting a natural environment with houses leads to total destruction and loss of wildlife habitat. Equally, similar effect is realized when we transform forests and agricultural lands into built up environment. According to Mwathi (2016), vegetation in tree form, grassland and even undisturbed open land are habitats for various organisms. In her study on "*Effects of LULC dynamics on environmental quality of Nairobi city and its environs*", Mwathi posited that environmental alterations as a result of LULC changes have a direct impact on natural habitats. The destruction of forests, rangelands and agricultural lands leads to loss of habitat for various species occupying such habitats. This poses danger to particular organisms such as the crawling ones which might face extinction as a result of habitat loss. Some organisms such as bird species and snakes like forested or areas covered with trees i.e. bushy places. Clearing and transforming these places into built environment pose a great threat to such species of organism. In general loss of habitat may mean loss of genetic resources.

Another environmental effect is loss of aesthetic value associated with the natural environment. As it is always said "Nature is Beauty." Natural plants and vegetation together with particular landscapes add value to the surrounding. Some of them are natural flowers while other landscapes are beautiful sceneries. Modifications of the land that make us lose these natural resources eventually result into loss of the beauty they bring. In some cases, the presence of natural vegetation in an area makes such areas more appealing and attractive to the eye. It therefore implies that even if changes are inevitable, we must always integrate environmental concerns in our development activities so as not compromise the aesthetic value associated with nature. Junjie (2008) acknowledged the fact that life of human being depends on nature in that we get valuable resources from nature. For example, nature may provide our direct food in form of fruits, it can be a source of medicine (herbs), it may attract tourists hence generate revenues and at the same time protect or buffer agricultural land from practices which work against nutrient recycling.

In addition, the study noted that LULC changes contribute to air pollution. This is a fact when we consider the role played by vegetation as carbon sink. Vegetation especially the

green plants which manufacture their food through photosynthesis process, absorb carbon dioxide in the atmosphere during this process and yields oxygen hence lowers the amount of carbon dioxide as a greenhouse gas in the atmosphere. This is why it is always advisable to plant trees in urban areas where a lot of emissions are expected. Clearance of vegetation in the area or any kind of activity that interferes with vegetation cover contributes to more accumulation of carbon dioxide in the atmosphere which may lead to global warming. As was noted earlier, the role of vegetation as a LC cannot be overemphasized because it helps in air purification. Both human beings and other animals breathe fresh air because of the existence of vegetation, specifically the green plants which are also producers in the ecosystem.

Another environmental effect of LULC changes is interference with atmospheric moisture recharge. In his study on "*Effects of LULC changes on hydrology of Weruweru Kiladede sub-catchment*", Chiwa (2012) contended that what is normally given out during evapotranspiration from plants or vegetation in general contribute in recharging the atmospheric moisture. This is very essential in completing the water cycle or hydrological cycle. Water is one of the most important resources that no living organism can do without and anything that disrupts its supply and distribution disrupts the very survival of humanity and other living organisms. It supports plant growth and the lives of various animals on earth. In man for instance, it form 71% of the body fluid. Having fresh natural water in the area, may imply having vegetation cover. This is because vegetation helps to control soil erosion which may lead to siltation of the water bodies and at the same time vegetation may help create a micro-climate where rainfall may be experienced in an area. Study deliberations with one of the RU management staff yielded that increased housing development in the study area has increased roof cover and impermeability in some areas which not only erode and degrade the environment but also interfere with water cycle.

LULC changes in the study area are also caused with development of informal settlements in university neighborhoods. RU establishment is considered to have catalyzed the growth of satellite slum. The study had noted earlier evidence of mixed up of structures and developments which inadequately meet the standards stipulated in the development policy guidelines in Kenya. New storey buildings are evidenced among the old dilapidating

structures. There is also quick fix of housing facilities which becoming detrimental both to human beings and the environment as portrayed in plate 4.1.

According to Cheshire and Sheppard (2002), human development activities impact the welfare economics of LU planning. Considering the fact that socio-economic activities influence environmental management and thus become part of environmental planning considerations, study assessed the implications of LULC changes on socio-economic activities within RU and its environs. The findings presented in figure 4.28 depicted that 78.8% of the people in the study are expressed their fear for loss of agricultural lands. This in turn has environmental impact as some crops such as cover crops protect the soil. Others like sugar cane also provide a seasonal habitat to wildlife hence loss of agricultural land may imply loss of habitat to wildlife. This concurs with assertion of Musa and Odero (2015) who noted that to some extent particular crops help in environmental conservation. The study noted the rise in land value in the area and high rates of sale of the lands pose a lot of socio-economic challenges. The land value has risen because of potentiality of the area for development. The community around are selling their lands without thinking of the risk of being stormed by food insecurity in the future. What they focus on is development of buildings which can be used to provide accommodation hence increase in built up environment.

Land fragmentation becomes another effect noted by the study. Land fragmentation is known to have environmental impacts such as promotion of soil erosion and degradation of the land due to constant engagement in farming practices. The soil nutrient is exhausted. In such cases, soil organisms are also disturbed and may lead to their extinction (FAO, 2016). The study noted that the sale of land and subdividing it to private developers is a major issue of concern. The resources on land are degraded because of subdivisions. All the plots sold are built or await various forms of development of structures. That implies an increase in the built-up environment. Other people mentioned family conflict as a socio-economic effect in the area. Family conflict in this case comes in two dimensions; one is through issue of prostitution where some respondents during focused group discussion argued that the RU establishment has increased prostitution in the area. They claimed that young ladies studying in RU are not keen in their dressing code and a number of young men get lured

and fall in love with them because those ladies want money. Some respondents mentioned that a number of marriages have been broken because of such relationships. Female respondents present during the focused group discussion mentioned neglect of the families by men in the region because of the new catch they get from the university hence resulting in family conflict. Men were also not left behind in this case, they also claimed of the danger their young wives have been exposed to by RU. According to some men, the young men learning in the university look neat and resourceful in terms of finances hence fear that their young wives are always attracted to those young men in the university. This did not go to the male students alone but also to the RU staff who had secured jobs. The young men see them as a threat in their marriages.

The second family conflict was associated with the sale of land where some individuals in the focused group discussion claimed that the household heads sell some portion of land without involving even a single member from his homestead. According to the claimants these household heads disappear having sold the land, go and squander money and later reappears. This is a contributor to conflict in the family as it may result into landlessness. Environmental implication attached to family conflict is overutilization of available environmental resources. Small lands left after sales are put in intense agricultural practices which degrade them. Similarly, the entire land left can be cleared to support various development activities hence contributing to loss of LC. This supports Dindi's (2013) claim on pressure put on the land in rapid expansion of universities on their neighbourhoods.

The fear of living with stranger emanates when land is sold to strangers. The community claimed through focused group discussion that they nowadays live with people whom they don't understand their background at all. They are people they can't trace their origin if in any case anything happens. Similarly, they fear that these people could be having strange characters like one respondent mentioned they could be living with night runners or people who might have escaped from their places of origin having committed some crime. Environmental implication noted under this factor is that it becomes difficult to some of these intruders (strangers) to understand and preserve culture of the natives or the indigenous people they found in the study area. This in turn leads to destruction of some genetic resource like particular indigenous tree/vegetation species.

Apart from the information gathered from the public through questionnaire, photographic data collected also showed a social implication where some people live in dilapidating structures as portrayed in plate 4.2. The informal settlement, former Kitere shopping centre is bushy in some places and lacks proper access routes of avenues at particular points which can ease movement. It is growing into a small urban centre which is not planned at all. The challenge is that the government is silent about it and yet it would be difficult to plan or modify them in future when it will be too late. Nabutola (2012) argued that timely planning ever remain the best remedy in saving environmental resource from the danger of overexploitation and degradation. If such an action is to be taken then many people will incur a lot of losses. Similarly, there is poor waste management at the moment and nobody is concerned until it creates a problem like cholera. Plate 4.5 was used to show bushy areas which are used in waste dumping. The bushy areas pose security and health threats to the residents of Kitere as some people may take advantage to through human waste in such bush areas.

The study was concluded by seeking to know from the public the way forward having recognized that establishment of RU has led to LULC changes. Results portrayed in Figure 4.29 presented some of the public opinion on the measures that can be adopted to realize sustainable development in the study area. Majority of the people (96.1%) proposed monitoring LUs and development project in the area to be one of the ways sustainable development can be realized. This proposal concurs with that of Florian and Norma (2019) who saw the need to monitor and put under control development activities in order to achieve sustainable development. Through monitoring we may detect the exact or real impacts of the project on the environment. It also reveals where changes and adjustments need to be made. Monitoring development projects may make individuals act at the right time when the impact of an activity is still at manageable level. When we monitor LUs, we are able to see particular uses that are injurious to the environment. Appropriate mitigation measure of the real impacts of the activities can be designed having known these real impacts through monitoring. The major purpose of monitoring as provided by the National Environment Management Authority is to ensure that development impacts do not go beyond the legal standards. Monitoring also helps to provide early warning of our activities which have the potential to cause environmental damage. Through monitoring, we are able

to check on compliance with conditions of project approval and adherence to the plans provided before implementation of projects.

The second suggestion from the public was creation of public awareness on environmental planning and management. The 2010 Constitution of Kenya in its Article 69d provides for public participation in the conservation, management and protection of the environment. It is critical to enlighten and empower the public for their active and effective participation to be registered. The study noted that there is a higher percentage of ignorance on environmental issues among the community. This was noted when they were subjected to a question on the direction of change in development. As demonstrated in figure 4.10, 64% of the respondents were of the opinion that the change was taking the right direction that is from bad to good. As was mentioned earlier, they considered the area to be bushy initially. Now that buildings are replacing the vegetation and other LC is lost, the community perceives this change to be taking the right direction. It appears to them that the new housing structures are more beautiful than the natural environment which used to exist. This reveals the amount of sensitization required by the community in terms of environmental issues. At this state the study considered creation of awareness on environmental issues to be critical. The community need to be capacity built and empowered on environmental management and conservation issues. Through this, they will be able to understand for example that there can be no life on earth for animals which are basically consumers without vegetation (LC). This is not only for food but also for air purification. Similarly, there can be no life on earth without water. Water is an essential resource that supports all life forms. Creation of awareness and engaging the community on environmental planning, management and conservation is surely a critical idea. This is because it is not possible to manage and conserve what you do not understand how it helps you. You have to understand the importance of a resource and the need to conserve and manage it, is when it becomes easy to take part in its management. Mwathi (2016) also recommended capacity building and empowerment of public in environmental management.

Planning for development activities was also proposed. The study noted that through planning for development activities, we avoid haphazard development that could cause

harm or threaten the existence of environmental resources. According to Nabutola (2012), planning ensures that development activities are done in accordance with the required standards as stipulated in the policies guiding development activities in Kenya. An organized use of resources can only be achieved through planning. Planning also controls the time for resource exploitation and utilization. According to the respondents, planning enables ease in supply and service delivery. The respondents were of the opinion that it is through lack of planning in the area that has led to loss of tree cover and poor management of waste. Besides this lack of planning in the area has led to the development of several structures which do not conform with the neighborhood. Proper planning reduces conflicts as it enables equal distribution of resources.

The study noted that it is also imperative to ensure that the legal frameworks guiding development are implemented and monitored was another proposal from the public. Despite the weakness and inadequacies realized in the legal framework assessed in objective one, their stipulations can still guide and ensure sustainable development in the area. The provisions of the EMCA (1999) are very clear that all development projects are supposed to be subjected to an Environmental Impact Assessment before their initiation. This in most cases helps to control the implementation of the project which has the potential to cause harm to the environment. Through undertaking an EIA, the impacts can be anticipated and mitigation measures for such impacts developed. The EIA also provides for analysis of alternatives for the project is not forced in an area which might be an ecologically fragile zone. It also ensures compliance and conformity of the project in areas they are established. Section 36 of the Physical Planning Act Cap 286 is also clear on what the project owner/proponents should do. It provides for submission of the EIA report before the approval of the development plans. Other specifications guiding development including the development of neighborhoods are very clear. Similarly, the Public Health act Cap 242 section 115 prohibits any form of nuisance and development activities which have the potential to cause harm to human in the environment. The provisions of other legal frameworks such as the County Government Act No.17 of 2012, the Urban Areas and Cities Act No.3 of 2011 and the University Act Cap 210B of 2012 are clear in guiding development of structures to be used in institutions of higher learning. The only challenge or inadequacy realized is that they have not taken into account the sprawling developments

around these institutions and externalities associated with their establishment such as the rise of university neighbourhood satellite slums. The study still notes that if these policies are well implemented together with development control and proper monitoring and other follow up activities enforced, sustainable development can be achieved.

The last suggested strategy was promotion of public participation and consultation in project development. This is crucial as discussed previously that even the 2010 constitution of Kenya recommends it. It is therefore a public right to be engaged in environmental management. Most developers have not considered this and always do not seek the public view during the project conception and implementation. This has always resulted into conflict that negatively impact on the natural environment and its resources. Any project whether owned by the government or individuals must always integrate the opinions and concerns of the public. This will enable them feel part and owners of the project and will work towards its proper implementation. By nature, the public always fight what they are not part of. For instance, the government may not implement afforestation project/programme in an area without involving the locals in that area. The study noted that most development projects such as housing development in the region have not adequately integrated public opinion during their implementation. For example, development of very tall structures near some people's homes without a building of the same kind might be a security risk or may deprive the neighborhoods of their privacy. In cases where the neighbors have roofless bathrooms, such fears of being deprived of their privacy may prevail.

# CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

This chapter presents conclusion on the findings and recommendations which can be adopted to help realize sustainable environmental management and development in the study area.

## 6.1. Conclusions

From this study, the following conclusions are made:

(i) The existing policies and by-laws guiding development of universities in Kenya have not provided for the sprawling developments around the universities, in which Rongo University is not an exception. Consequently, haphazard development within Rongo University neighbourhood has occurred without compliance to sustainable environmental conservation.

(ii) Rongo University establishment has significantly influenced LULC changes as a result of increased settlement as evidenced by available data which was 284.48ha (14%) in 2010 to 1252.41ha (62.5%) in 2018 implying 48.5% overall increase in settlement including expansion of Rongo University infrastructure.

(iii) The establishment of Rongo University has contributed to LULC changes with attendant environmental degradation practices which include among others, increase in built up environment, loss of habitat for biodiversity as well as natural beauty and aesthetic value.

(iv) While the study acknowledges the existing gaps by the public in adopting required legal framework and policy in LULC changes, great opportunity exists if appropriate environmental planning and management strategies are applied to inform structured development of Rongo University and its local environment.

## 6.2. Recommendations

The study makes the following recommendations based on the findings:

i. In consistence with the national government land use policy and related policies, Rongo Municipality Board of Migori County should develop, implement and put in place a monitoring and evaluation system that adheres to policy driven sustainable

development to avert environmental degradation resulting from uncontrolled sprawling developments occasioned by the establishment of Rongo University.

ii. Rongo University as a repository of knowledge should showcase environmentally sustainable development initiatives in partnership with Rongo Municipality and Migori County government through outreach and information dissemination system.

iii. Rongo Municipality and Migori County government in partnership with RU should implement land use policies and physical planning laws and regulations to safeguard environmentally sustainable development to reduce negative impacts on the environment.

iv. Rongo Municipality Board in partnership with County government of Migori and RU should build stakeholders' (including policy makers) capacity to enhance environmental awareness creation as relates to land use policy and sustainable environmental conservation and development within its jurisdiction.

v. On the basis of the findings of this study, Rongo Municipality Board in partnership with Migori County and Rongo University should domesticate the recommendations of this study in their spatial and environmental management plan for Rongo University and its neighbourhood.

### 6.3. Implications for Further Study

The study considers the following areas for further investigation:

i. An assessment of Rongo University establishment on the use and management of natural resources such water, forests and biodiversity as well as other forms of energy.

ii. There is need for further investigations to determine the relative impacts of other factors such as climate change, mining and infrastructure development among other considerations.

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# APPENDICES

## Appendix 1: Letter of Introduction

Dear Respondent,

I am **George Ouma Ochola**, a PhD student at Rongo University in the school of Agriculture, Natural Resources and Environmental Studies. As a requirement by the University, a PhD programme must be done with a research. I am conducting a research titled **Rongo University Establishment as Driver to LULC Changes in Rongo Sub-County, Migori County, Kenya.**

Kindly assist me fill this questionnaire and provide the answers based on your knowledge if you don't mind please. Your positive response on this request will be highly appreciated. Kindly note that the information needed here is meant for academic purpose and not any other use. Therefore feel free while responding to this questionnaire. Your contributions and answers will be treated with utmost confidentiality. Otherwise thank you and stay blessed.

Yours faithfully,

**George Ouma Ochola**

**Appendix 2: Questionnaire**

Kindly fill it appropriately.

**PART A: Demographics**

**Gender:**

a) Male [ ] b) Female [ ]

**Age Group:**

a) Below 25 **[ ]** b) 26-30 **[ ]** c) 31-35**[ ]** d) 36-40 **[ ]**

e) 41 and above **[ ]**

**PART B: Originality of the Respondent**

**1.** For how long have you stayed in your present place of residence?

a) Below 1 year **[ ]** b) 2-3 years **[ ]** c) 4-5 years **[ ]** d) 6-7 years **[ ]** e) 8 years and above **[ ]**

**2.** What made you to come to this place?

a) Schooling **[ ]** b) Business **[ ]** c) Job **[ ]** d) Opened place for development **[ ]**

e) Born here **[ ]** f) Any others, specify……

**3.** How was the environment like when you first arrived at this place?

a) Covered with trees **[ ]** b) Open lands **[ ]** c) Built up everywhere **[ ]** c) Occupied by crops/plantations **[ ]** d) Forested **[ ]**

**4.** How is the environment like at the moment?

a) Cleared **[ ]** b) Forested **[ ]** c) Transformed into buildings **[ ]** d) Still at its Original state **[ ]** e) Lost its original form **[ ]**

**Objective 1: The policies guiding university establishment in Kenya and how they applied to establishment of Rongo University and its satellite campuses**

**5.** Are you aware of any legal framework guiding university establishment and other development activities in Kenya? a) Yes **[ ]** b) No **[ ]**

**6.** If Yes, **k**indly name legal frameworks that you are familiar with.

a…… b……

c……... d…….

e…… f……..

**7.** Do you think development around the university follow the legal framework stipulated in Kenya? a) Yes **[ ]** **b)** No **[ ]**

**8.** If No, what are some of the reasons you can attribute to this?

a) Lack of knowledge on provisions of the legal framework by the public **[ ]**
b) The provisions in the legal framework are costly to implement **[ ]**
c) Many people are not willing to implement the legal framework provisions because they slow the development process **[ ]**
d) The provisions of the legal framework are not easy to understand **[ ]**
e) Any other, specify…….

**9.** In your opinion, is it appropriate to initiate development projects without following the legal framework provisions? a) Yes **[ ]** b) No **[ ]**

**10.** Is the government monitoring the development activities in Rongo University and its environs? a) Yes **[ ]** b) No **[ ]**

**11.** If No, what are some of the implications on this?

a) Haphazard development **[ ]**
b) More destruction on the natural environment **[ ]**
c) Unsustainable use of natural resources in the region **[ ]**
d) Rapid degradation of the natural resources and the environment **[ ]**
e) No implication at all **[ ]**
f) Any other, specify

**Objective 2: The nature and extent of LULC changes caused by establishing Rongo University in Rongo Sub-county**

**12.** In your opinion is the state of environment changing? a) Yes **[ ]** b) No **[ ]**

**13.** What is the direction of change? **a)** From good to bad **[ ]** **b)** Bad to good **[ ]**

**14.** What do you attribute to the changes from good to bad as portrayed in question 13?

a) There is rapid development of housing **[ ]**
b) The university draws many activities that lead to rapid transformation of the natural environment **[ ]**
c) More agricultural, tree cover, grassland and open lands are transformed to built-up environment **[ ]**
d) The changes are brought about by the expansion of the University itself **[ ]**
e) The changes are brought by the private developers who seek land near University for development **[ ]**

f) The region is undergoing normal growth **[ ]**
g) Any other, Specify……

**Objective 3: The impacts of establishing Rongo University on LU/LC changes on environmental conditions in Rongo-sub-county**

**15.** In your opinion how do these changes affect the well-being of the environment and other life forms?

**a)** Destruction of natural habitat **[ ] b)** Loss of aesthetic value **[ ] c)** Contribution to air pollution **[ ]** d) Interference with atmospheric moisture recharge **[ ] e)** Lead to development of University slum **[ ] f)** No effect at all **[ ] g)** Any other specify

**16.** What socio-economic implications do these changes have on the neighborhoods?

a) Land fragmentation **[ ]**
b) Loss of agricultural land **[ ]**
c) Fear of living with strangers **[ ]**
d) Family conflicts **[ ]**
e) No implication at all **[ ]**
f) Any other specify

**Objective 4: Development of an environmental management plan in order to help mitigate adverse effects of the University on the environment in Rongo sub-county**

**17.** In your opinion, what can be done to ensure sustainable management of the environment in Rongo University and its environs?

a) Planning for development activities **[ ]**
b) Monitoring LUs and development project **[ ]**
c) Creation of public awareness on environmental planning and management issues **[ ]**
d) Promotion of public participation and consultation on development projects **[ ]**
e) Ensuring that the legal framework guiding development are implemented and monitored **[]**
f) Nothing can be done.
g) Any other, specify

**Appendix 3: Interview Schedule**

1. Please comment on importance of Rongo University.

2. How has the establishment and development of this University affected the neighborhoods?

3. What implications does the establishment have on the environment (LC)?

4. How has the establishment of the university affected LUs in Rongo Sub-County?

5. In your opinion are there changes in LULC since the establishment of the University?

6. If the answer to number **5** is **Yes,** what do you attribute to these changes (drivers of LULC changes)?

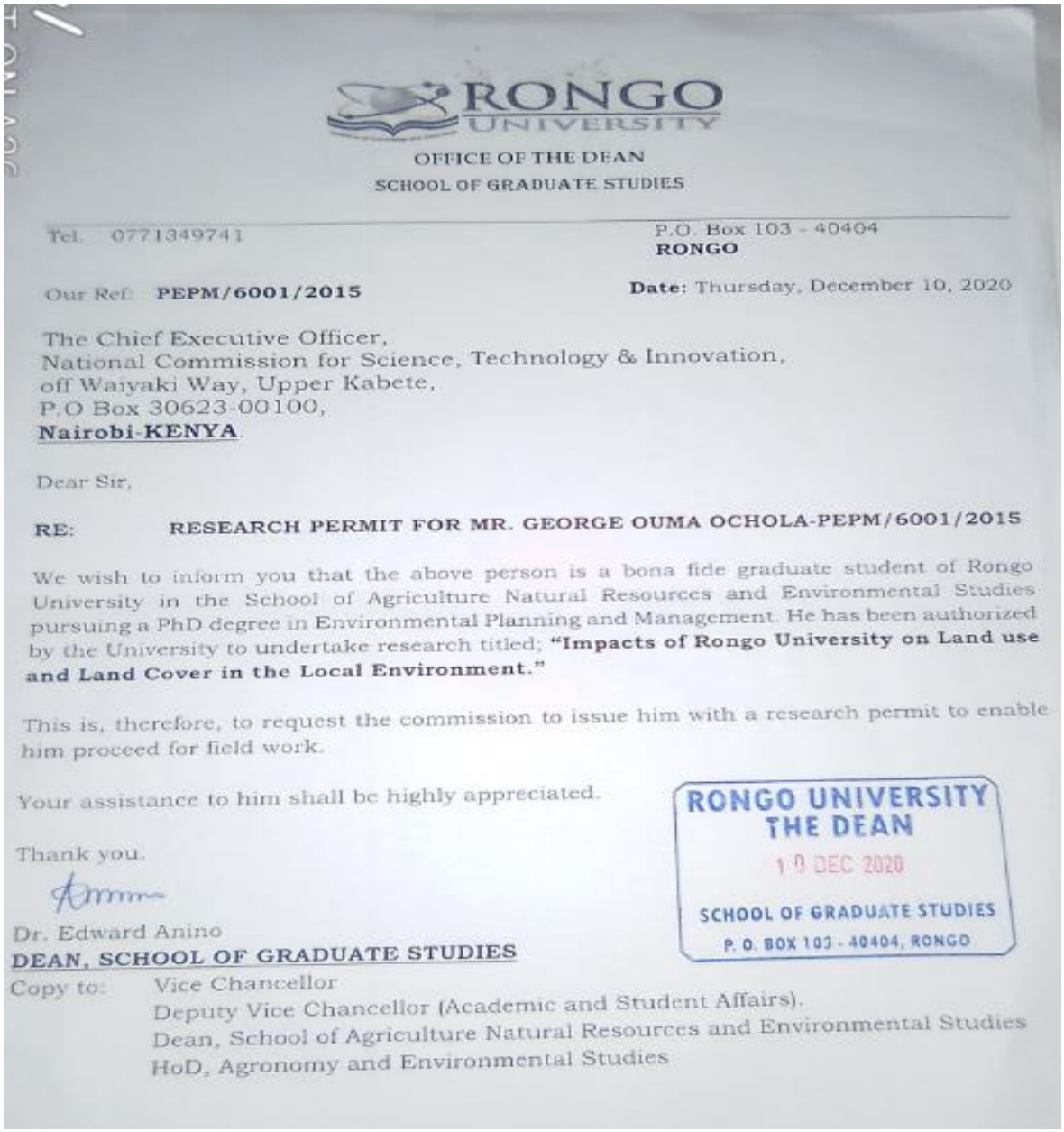
7. Do you think development within and around Rongo University follow the Kenya National laid down procedures (Legal and Institutional Framework?

8. If your answer to number **7** is **No,** How has this impacted on the environment?

9. What are some of the socio-economic implications associated with the establishment of this university (implications on the neighborhoods)?

10. What strategies can be put in place to help realize sustainable utilization of resources and management of the environment in Rongo University and its environs?

## Appendix 4: Request for Research Permit



RONGO UNIVERSITY

OFFICE OF THE DEAN
SCHOOL OF GRADUATE STUDIES

Tel. 0771349741

P.O. Box 103 - 40404
**RONGO**

Our Ref: **PEPM/6001/2015**

**Date:** Thursday, December 10, 2020

The Chief Executive Officer,
National Commission for Science, Technology & Innovation,
off Waiyaki Way, Upper Kabete,
P.O Box 30623-00100,
**Nairobi-KENYA**.

Dear Sir,

**RE: RESEARCH PERMIT FOR MR. GEORGE OUMA OCHOLA-PEPM/6001/2015**

We wish to inform you that the above person is a bona fide graduate student of Rongo University in the School of Agriculture Natural Resources and Environmental Studies pursuing a PhD degree in Environmental Planning and Management. He has been authorized by the University to undertake research titled; **"Impacts of Rongo University on Land use and Land Cover in the Local Environment."**

This is, therefore, to request the commission to issue him with a research permit to enable him proceed for field work.

Your assistance to him shall be highly appreciated.

RONGO UNIVERSITY
THE DEAN
10 DEC 2020
SCHOOL OF GRADUATE STUDIES
P. O. BOX 103 - 40404, RONGO

Thank you.

Dr. Edward Anino
**DEAN, SCHOOL OF GRADUATE STUDIES**

Copy to: Vice Chancellor
Deputy Vice Chancellor (Academic and Student Affairs).
Dean, School of Agriculture Natural Resources and Environmental Studies
HoD, Agronomy and Environmental Studies

## Appendix 5: Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 381384

Date of Issue: 14/January/2021

RESEARCH LICENSE

This is to Certify that Mr.. George Ouma Ochola of Rongo University, has been licensed to conduct research in Migori on the topic: IMPACTS OF RONGO UNIVERSITY ON LAND USE AND LAND COVER IN THE LOCAL ENVIRONMENT for the period ending : 14/January/2022.

License No: NACOSTI/P/21/8582

381384

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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