EFFECTS OF LAND USE AND LAND COVER CHANGE ON PEOPLE'S LIVELIHOODS IN KIRA MUNICIPALITY, CENTRAL UGANDA

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DECLARATION

I hereby declare that this dissertation is my own and that it has never been published or submitted to any of the academic awarding higher institution of learning or university for any award of a Degree.

Sign …… Date …...……...…

BUSOLO PAUL

APPROVAL

This dissertation has been submitted with our approval as supervisors for the Degree award of Master of Arts in Geography entitled ***"Effects of Land Use and Land Cover Change on people's livelihoods in Kira Municipality, Central Uganda"***.

Signed …….....…… Date……

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Signed …….....…… Date……

DR. FRANCIS WASSWA NSUBUGA

DEDICATION

I dedicate this piece of work to my beloved children, Shalom Huldah Neumbe, Precious Favour Namono and Praise Timothy Mafabi J. F.; my wife Anna Nabirye; to my father John .F. Mafabi and mother Zitta Neumbe; my sisters Beatrice, Naume, Judith, Jackline, Betty, Susan, Irene, Rose and Pamela and brothers Godfrey, Ambrose, Nelson, Julius, Richard, Andrew, Collin, and Emmanuel.

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LIST OF ABBREVIATIONS AND ACRONYMS

AA	:	Accuracy Assessment
EO	:	Environment Officer
EROS	:	Earth Resources Observation and Science
GIS	:	Geographical Information System
GOU Vol. I/II	:	Government of Uganda Volume One/Two
GPS	:	Global Positioning System
IUCN	:	International Union for Conservation of Nature
KCCA	:	Kampala Capital City Authority
KMDP	:	Kira Municipal Development Plan
LULC	:	Land Use and Land Cover (Land Use/Cover)
LULCC	:	Land Use and Land Cover Change (Land Use/Cover Change)
MSE	:	Micro Soft Excel
MOLHUD	:	Ministry Of Land Housing and Urban Development
MOWENR	:	Ministry Of Water Environment and Natural Resources
NASA	:	National Aeronautics and Space Administration
NEMA	:	National Environment Management Authority
NWSC	:	National Water and Sewage Corporation
RS	:	Remote Sensing
SOL	:	Standards of Living
SPSS	:	Statistical Packages for Social Science
UBOS	:	Uganda Bureau of Statistics
UNRA	:	Uganda National Roads Authority
USGS	:	United States Geological Survey
WB	:	World Bank
WDLG	:	Wakiso District Local Government

ABSTRACT

Land Use and Land Cover (LULC) changes have been experienced globally due to pressure from the ever-increasing human populations and environmental conditions associated with climate change and the resultant effects on livelihoods derived thereof. This study investigated LULC Change on people's livelihoods in Kira Municipality, Central Uganda. Specifically, the study was set to; (i) determine the extent of LULC Change in Kira Municipality between 2000 and 2021, (ii) establish the perceived drivers of LULC Change and, (iii) assess the impact of LULC Change on people's livelihood types in Kira Municipality. Landsat 7 and 8 images were accessed and downloaded from the United States Geological Survey's earth explorer portal and were used for determining LULC Changes for three periods (2000, 2011 & 2021). The obtained images were taken through pre-processing, processing and post-processing steps in Arc GIS 10.4 software. For LULC Change analysis, a supervised maximum livelihood classification and discriminate analysis computations were done. Additionally, the socio-economic field data was collected from purposively selected households in the study area for analysis of the perceived drivers of LULC Change and their impact on people's livelihood types. The data was analyzed using descriptive statistics and content analysis techniques. The results revealed a marked Change in LULC between 2000 and 2021 with a wide increase in the built-up land (33.5%), a decline in wetland, farmland and forest land. The Change in LULC, were largely driven by demographic and institutional factors related to rapidly growing population and limited supervision respectively. These fueled intensification of settlements, industrial and infrastructural developments. Furthermore, LULC Change impacted on livelihoods by influencing human livelihood types which were largely positive because they are the greatest employers of the majority of the population and so sustaining numerous lives in this Municipality. Such types of livelihoods were mainly transportation, building and construction and trade work/services. It is concluded that there were significant Changes in LULC in Kira Municipality in the last two decades, driven by increase in human populations in this area. It is therefore recommended that vertical development is embraced to check on the escalating urban population and also regulate Land Uses in ecologically sensitive ecosystems like wetlands and forests in this area that are associated with habitant losses in terms of land and its resources.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Land is one of the most indispensable natural resources that sustain people's livelihoods and development, hence its use is an essential factor of any human activity (NEMA, 2009; Diyer et al., 2013; Barasa et al., 2011; Kiggundu et al., 2018). Land Use is any kind of human activity on the land with the purpose of benefitting from the land resources. The rising need for this limited resource has exerted pressure on land and its surface resources/features called Land Cover consequently leading to the alteration of Land Cover features that contribute to a set of numerous properties and environmental processes (Kiggundu et al., 2018).

The designation of the current and prospective predetermined man's activities on an enclave identified as industrial, forestry, leisure, residential, agricultural and commercial constitutes what is known as Land Use. This means the expression of the human activity established for economic, social, political and cultural motives (Mare & Mihai, 2016), Land Use is also defined as numerous activities done periodically on land by people, with a purpose of acquiring outputs or products using land resources (Coffey, 2013), while Land Cover is the vegetation cover either planted or natural as well as the manmade features in form of buildings which exist on the earth's surface. For instance ice, sand, open rock, water and other related surfaces (Coffey, 2013). Similarly, Singh (2017) defines it as the surface cover on the ground like vegetation, urban infrastructure, water, bare soil, etc.

Livelihood is referred to as the ways and means in which people survive in life on the globe. Rather it is the means and ways in which people make a living/survival on earth. This term rotates around resources such as property i.e. land, crops, food, knowledge, finances, social relationships, and their interrelated connection with the political, economic, and socio-cultural characteristics of an individual community (International Encyclopedia of Human Geography-IEHG, 2020). A livelihood consists of capabilities, assets, and activities that are required for living (UK Department for International Development-DFID, 1999; UNDP, 2005).

The UK DFID (1999) further identifies livelihood assets, these are both tangible and intangible assets. The tangible ones include food stores and cash savings, as well as trees, land, livestock,

tools and other resources, while the intangible assets may include claims one can make for food, work, and assistance as well as access to materials, information, education, health services and employment opportunities.

Changes in Land Cover have significance at global, regional and local levels. Often a combination of economic, institutional and political factors drive deforestation, including logging, agricultural expansion, infrastructure expansion, shifting cultivation and the extraction of non-timber forest products and fuel wood (Lambin, 2001; Aye & Htay, 2019). It is asserted that Land Use/Cover Change (LULCC) can be a serious danger to biodiversity due to the deterioration of the natural vegetation together with the partitioning or separation of nature areas (Verburg, 2006). Land Use/Cover Changes are one important human induced activity changing the hydrological system (Chiwa, 2012). It was noted by Bronstert et al., (2002) that the heavy human use of land resources has impacted significantly on the changes in LULC, whereas Chiwa, (2012) and Lambin, (2001) observed that from the epoch of rapid population growth and industrialization, the issue of Land Use Change has greatly increased in a number of developing countries.

Land Use/Cover Change plays a central role in global environmental change. It contributes significantly to earth-atmosphere interactions and bio diversity loss and is a major factor in sustainable development and an indicator of human responses to global change (Meyer & Turner, 1994; Lambin et al., 2001; Barasa et al., 2011). One estimate, for example, holds that the global expansion of crop lands since 1850 has converted some 6 million km^2 of forests/woodlands and 4.7 million km^2 of Savannas/grasslands/steppes. Within these categories, respectively, 1.5 and 0.6 million km^2 of crop land has been abandoned (Lambin et al., 2001; Barasa et al., 2011).

Globally, countries' most parts are presently undergoing a wide range of changes in LULC. Most of these changes are associated with man's interaction with the environment (Gondwe et al., 2021). They further observe that these changes result into negative effect on both people's wellbeing and the ecosystems. These among them include flooding, erosion of soils, degradation of water quality, increase in storm water runoff, loss of Marine/Water resources and others. These negative effects have driven/caused changes on LULC which have brought to the attention of the globe.

Naschen et al., (2019) observed that many parts of Sub-Saharan Africa are prone to Land Use and Land Cover Change (LULCC). In many cases, natural systems are converted into agricultural land to feed the growing population. It was also noted that despite climate change being a major focus nowadays, the impacts of these conversions on water resources, which are essential for agricultural production, is still often neglected, jeopardizing the sustainability of the socio-ecological system.

The magnitude of Land Use/Cover Changes vary from one continent to another; for instance, in the Mediterranean Basin about 50,000 fires sweep from 700,000 to 1,000,000 hectares of Land Cover each year, causing enormous economic and ecological damage (Barasa et al., 2011). It is further extended that most of these fires are human-caused, whereas several others are related to climate dynamics. However, in Africa, massive Land Cover clearances affect an estimated 320 million ha or about one quarter of Africa's dry lands triggering secondary effect such as soil erosion (Barasa et al., 2011; UNEP, 1997). Uganda, still has considerable Land Cover resources which are being exploited such as agricultural land. It was also observed that the conversion of natural resources into consumable products (mainly sawn timber, charcoal, and firewood) was estimated in 1995 to be 20 million tons and at an estimated growth rate of 3.6%. The consumption of wood products would almost be tripled from 20 (the 1995 level) to about 60 million tons by the year 2025 (Barasa et al., 2011).

This is true for example within water basins specifically Lake Victoria basin exhibits both highly spatial and temporal variation. The pattern depends on lithology, geology, topography, the corresponding soil moisture and season of the year as well as human activities (Ochola, 2005). The drastic environmental changes experienced by the Lake Victoria basin over the past eight decades with huge ecological changes are a result of Land Use and Land Cover Changes, poor agricultural developments, industrialization, and destruction of critical wetlands among others. While some of these factors particularly agricultural and industrial expansion are done around the catchments of the lakes, others are intensifying (Muhati et al., 2008; Kiggundu et al., 2018). Land Use Change is noted to be one of the factors correlating with the worsening quality of water in Lake Victoria (Kimwaga et al., 2012; Kiggundu et al., 2018).

Land Use in this basin has been characterized by two-riding trends over the past three decades. Firstly, the land resources are greatly threatened by grave imbalances, in productivity and

environmental integrity. Secondly, the region is undergoing accelerated change with land Stewardship lagging behind economic and social development. Land productivity is being overtaken by population growth. The processes of social and economic development need to be directed towards resolving rather than aggravating land resource issues and concerns (Ochola, 2005).

In the recent years, there has been much concern on the increased destruction and conversion of Uganda's wetlands to other forms of Land Use like human settlement and agriculture (Kamukasa & Bintoora, 2014). Impact of Land Use Change as a study has motivated several researchers to conduct research studies, for example, they have tried to understand Land Use Change, the factors/drivers of Change and its effects (Lambin, 2001; Verburg, 2006; Veldkamp et al., 2004; Chiwa, 2012). Never the less, many of these studies concentrate on the biophysical nature of Land Use Change (Chiwa, 2012; Lambin, 2001). The drivers of Land Use/Cover Change give a basis for essential information required for sustainable management of water resources and Land Use programming. One sustainable major factor supporting people's livelihoods is Land Use acknowledged by Chiwa (2012).

Some studies in Uganda have been done about the changes in Land Use/Cover in both urban and sub-urban areas in particular Kampala and its Metropolitan areas near drainage systems (lakes) more so Lake Victoria system. These among them include (Maitima et al., 2010; Musamba et al., 2011; Kimwaga et al., 2012; Isunju, 2016; Kiggundu et al., 2018; Omagor & Barasa, 2018). However, limited quantitative studies have been carried out about Kira Municipality, yet it is greatly undergoing LULC Change. This investigation about the effects of Land Use and Land Cover Change on people's livelihoods in Kira Municipality, Central Uganda is thus necessary.

1.2 Statement of the Problem

A considerable number of studies (Lambin, 2001; Turner et al., 2003; Veldkamp et al., 2004; Verburg, 2006; Chiwa, 2012) have been conducted about the impact of Land Use Change. These studies tried to comprehend Land Use Change, factors of this change, its effects as well as the biophysical aspects.

In Uganda, Land Use/Cover Changes (LULCC) have been quantified in some catchments of both rural and urban settings of various Lake Systems such as Lake Victoria basin (Mati et al., 2005; Muhati et al., 2008; Maitima et al., 2010; Kimwaga et al., 2012; Mango et al., 2011; Berakhi,

2013; Musamba et al., 2011; Isunju, 2016; Kiggundu et al., 2018). Others like Banadda et al., (2009) have conducted studies around Murchison Bay catchment of Lake Victoria basin where they report the rising levels of pollution, attributed to the expanding Kampala City, wetland area transformation, deforestation and poor agricultural practices.

Quantitative studies about the effects of LULCC in the Metropolitan areas of Kampala are minimal such as Kira Municipality (KMDP, 2019) was reported to have lost 67% of its average wetland cover to mainly large population in the area. Accordingly, the demand for housing and agricultural land has increased. Although there are several environmentally unacceptable activities in wetlands of the Municipality, agriculture and housing pose the biggest threat. This raises interest in finding out about the performance of an urban area such as Kira. Kira Municipality is a residential area experiencing an influx of migrants, who have set up informal settlements. The urban area is experiencing LULCC which needs to be documented and measured. Therefore, it is worth noting to comprehend the effects of LULCC on people's livelihoods at a Municipal level like Kira as indicated in the following objectives.

1.3 Objectives of the study

1.3.1 General Objective

To assess the effects of Land Use/Cover Change on people's livelihoods in Kira Municipality, Central Uganda.

1.4 Specific Objectives

1. To determine the extent of Land Use/Cover Change in Kira Municipality from 2000 to 2021.
2. To establish the perceived drivers of Land Use/Cover Change in Kira Municipality.
3. To assess the impact of Land Use/Cover Change on people's livelihood types in Kira Municipality. .

1.5 Research Questions:

From the specific objectives of this research study, the following were the guiding research questions formulated:

1. What was the extent of Change in Land Use/Cover between 2000 and 2021 in Kira Municipality?
2. What are the perceived drivers of Land Use/Cover Change in Kira Municipality?

3. What are the impact of Land Use/Cover Change on people's livelihood types in Kira Municipality?

1.6 Conceptual Framework

The conceptual framework for this study (Figure 1.1) illustrates the relationship between Land Use/Cover Change (LULCC) and people's livelihoods as well as the perceived drivers of LULCC. The LULC classes/types are viewed as independent variable, while people's livelihood types constitute the dependent variable.

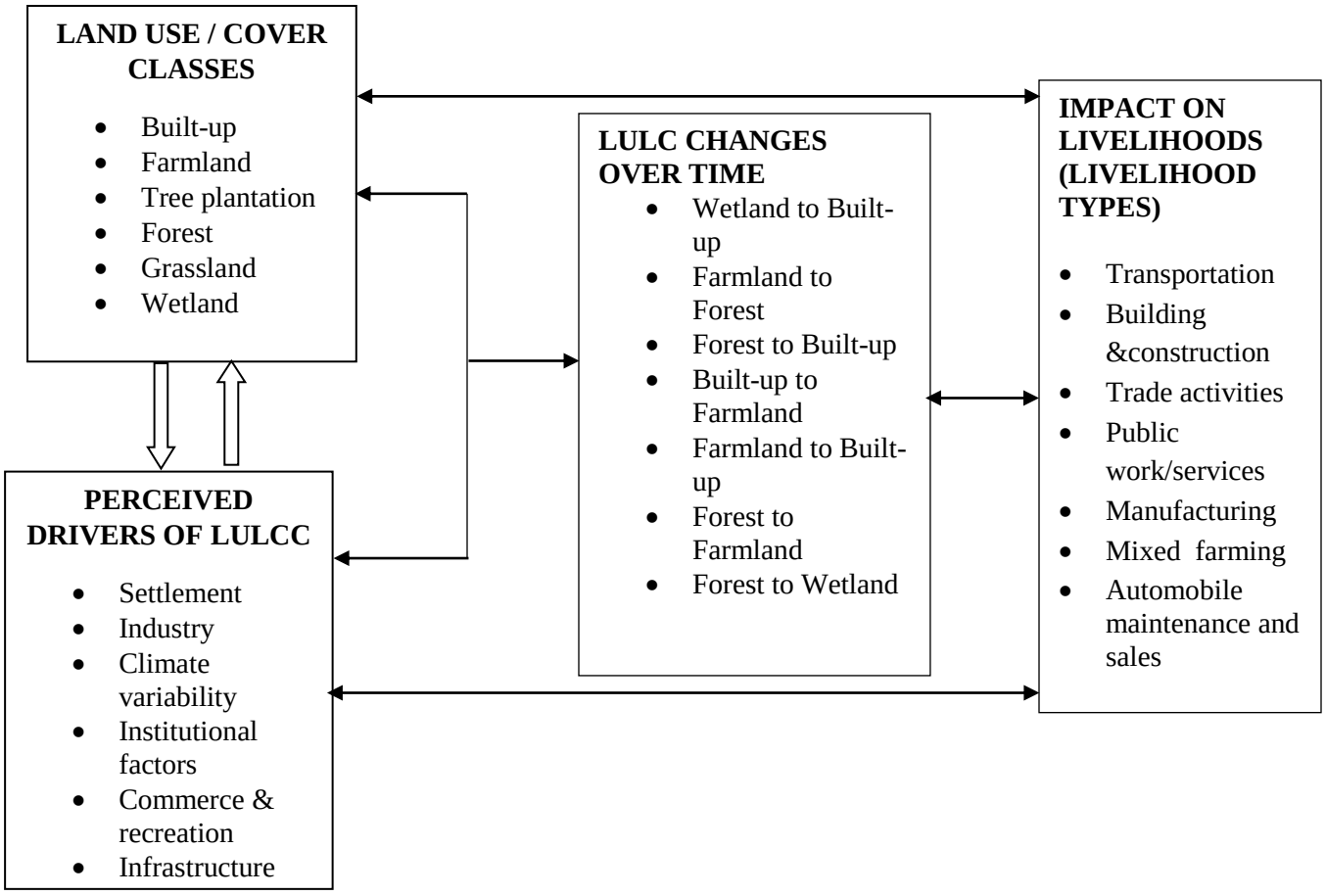


Figure 1.1: Conceptual Framework

Source: Author, 2021

From the conceptual framework (Figure 1.1), the LULC classes/types that is wetland, forest land, built-up and farmland, form important livelihood sources for the people living in the community.

External pressure over the land, results in change of both LULC. External forces are the perceived drivers responsible for change including farming, settlement, infrastructure, industry, commerce and recreation, climate variability, demographic, soil and land factors. Once these set in, the form of LULC, change too. Because of human dependence on LULC for food, jobs, trade activities, building and construction, fiber and fodder for their livelihood, any changes initiated on Land Cover and Use affect the livelihood types. The impact on livelihoods can be positive and/ or negative.

1.6 Research study Significance

The research indicated that Kira Municipality has greatly changed in LULC by majorly expanding settlements and its associated socio-economic services/infrastructure. It is therefore significant to have all public land and its nature resources clearly demarcated (opening up boundaries) and well planned to avoid land conflicts and degradation of these resources by the encroachers as well as regulating their land uses. This should be done by top leaders at both the Municipal and Ministry levels such as policy makers and stakeholders of some of the following legal bodies including Ministry of Water Environment and Natural Resources (MOWENR), Ministry Of Land Housing and Urban Planning (MOLHUP), as well as the National Environment and Management Authority (NEMA) and Uganda National Roads Authority (UNRA).

The study provides the policy makers, stake holders and the local leaders primarily the Environmental Managers with information to sensitize the communities in particular those living in shanty catchment areas. Being urban, they are to develop such areas strategically and better management in order to avoid long term disasters that occur because of the draining of catchments. The Municipal Physical Planners and Environment Officers should take up the responsibility of licensing land developers who can cope with vertical housing plan, but not horizontal development to reduce on land shortage and their effects: on nature resources and human livelihoods.

The study contributes information to the fields of Lands and Urban Development, Environment (Ecology) and Natural Resources. The study calls for better control measures on spatial development, for example embracing vertical development. This study therefore clarifies that the Urban Authorities including the Land Board, Environmental Conservation and Management

Institutions like NEMA and Uganda Wildlife Authority (UWA), should be more empowered (strengthen the institutional framework) and well facilitated in order to check on the escalating effects of the changing LULC on land and its surface resources.

This study also adds a voice to that of the Government of Uganda (GOU, VOL II, 2016) by providing information to Municipal Councils (Local councils) and Environmental Conservation and Management Institutions. Better management, programming and implementation of laws/policies. For example, subduing of unlawful activities done in the surroundings of nature resources, especially the reserve resources should strongly be managed by the respective management institutions/organs. The enactment of some of the proposed ideas can best be achieved by policing and sensitizing the community which is a mechanism suggested by the Department of Wetland Management.

1.7 The Scope of the Study

The study was conducted in Kira Municipality of Central Uganda. The choice of this study was motivated by the rapidly growing population (UBOS, 2014) and urbanization associated with various expanding socio-economic infrastructure responsible for significant changes in LULC. This is evidenced by a series of transport and communication networks in form of roads such as Naalya – Banda, Upper estate, Kiwatule roads (Northern By Pass); Kasangati – Kira; Naalya – Kyaliwajjala; Najjera – Kirundambaata; Najjera – Kira; Kiwoologoma – Kimwanyi – Gayaza; Kitukutwe – Nakwero; Kijabijo - Natonko roads in and across this Municipality. The study scope for socio-economic survey was restricted to two Divisions of Kira and Namugongo where the four wards were considered main study sites including Kira, Kimwanyi, Kyaliwajjala and Kireka respectively. Some eight cells/sub-wards (sub- study sites) from these wards were considered for photography of Aerial /Google Earth images (Figure 4.1) and Ground images/Plates details in Chapter 4. These were key in identifying the Changes in LULC, perceived drivers of these changes and the change impact on people's livelihood types evident during ground truthing namely: Kireka, Kamuli, Naalya, Kyaliwajjala, Kira, Bulindo, Nakwero and Kijabijo cells/sub-wards. These were selected because these specific areas are highly urbanized and some are urbanizing causing changes in LULC hence driving and determining some of these livelihood types and their associated benefits (Figure 4.2 & Plate 4.1-4.4). For example farming, building and construction, trade, transportation, manufacturing work/services and others result into

accidents, insecurity as well as floods, pollution, storm water runoff and erosion which are mainly experienced in the shanty lowland South such as Kireka and Kamuli whenever it rains. This is why the choice of the location of study sites was made. Besides that, the financial and time factors, also constrained the study scope and so the sample size. Purposive sampling was done for selection of four wards and their cells/sub-wards on grounds justified above. However, the LULC analysis extended to the environs of Kira Municipality to include cover areas of Wakiso and Kampala districts and a small portion of Mukono (Figure 4.2; 4.6-4.7). The study was set to run for a time scope of ten months, from January to October, 2021 (sub-sec 3.3). In most of the study sites, the housing nature including real estates, are spatially developed where the Physical planners of this Municipality need to check on this nature of development to avoid future endangerment of ecological resources.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Chapter two here under demonstrates the literature in a view of what other researchers have written regarding the subject under study. The review was guided by the set objectives of about the extent of Land Use/Cover Change (LULCC); the perceived drivers of LULCC; the impact of LULCC on people's livelihoods.

2.2 Land Use/Cover Change

Land Use/Land Cover refers to the classification of man's activities and natural elements on the landscape within a specific time frame based on the laid down numerical and scientific methods of analysis of rightful source materials (Singh, 2017).

The moderation of the earth's surface by man's activities is popularly known as Land Use/Land Cover Change (Fan et al., 2007; Ellis, 2013; Kiggundu et al., 2018). Although moderation of land by people to acquire livelihoods and other necessities has been there for thousands of years, the intensity, rate and level of LULCC are far greater today than were in the past. These changes are driving forces for local, regional and global level unprecedented changes in eco systems and environmental processes. Thus LULCC play an important role in the study and analysis of global changed scenario today as the data available on such changes is essential for providing critical input to decision making of ecological management and environmental planning for future (Fan et al., 2007).

Using satellite remote sensing data is a practical option to identify and map Land cover categories. GIS tools are used to create the geo-data base and integrate data extracted from satellite images with classes from the currently available Land Cover Models. The data layers are overlaid, analyzed and assessed using GIS techniques ascertained by Mare and Mihai (2016).

Many regions globally are going through wide-ranging and fast changes in LULC (Fallati et al., 2016). Rural to Urban land transition is taking place at a level unprecedented in recent history because of development and is having a drastic effect on the functioning of natural ecosystem (Lambin et al., 2001; Fallati et al., 2016).

Around the world, the loss and degradation of wetlands have led to reduced livelihood options, social tensions and human displacement. Therefore, we call for the mapping of wetlands ecosystems that act as regions 'Peace Keepers'. We also call for shifting to sustainable water management rather than the traditional development and hard infrastructure schemes in agriculture and hydropower that play havoc with regions' hydrology (wetlands International, 2018).

The scarcity of LULC information/data leaves remote-sensing as the only actual means of providing quantitative/numerical, complete, cost effective time-series and accurate data for proper mapping and monitoring of spatial and temporal LULC dynamics through Geographic Information System (GIS) and image processing (Were et al., 2013). Historical archives of remotely sensed data give the chance to interpret and analyze LULCC over long period of time, which consequently allows assessing the geographic system of these transitions in connection to human factors (Fallati et al., 2016).

Land Use/Cover analysis can be obtained from processed Landsat images, Google Earth images and Quick bird images. Because remotely sensed information from the earth path can be got several times over one place. These have been very significant in the analysis and monitoring of LULCC in different regions of the globe. These are essential in the management and programming of the resources in existence in particular, the developing countries where other forms of heritage information are sometimes missing or limited (Tilahun & Teferie, 2015).

2.3 Drivers of Land Use/Cover Change

The Land Use/Cover Change is primarily influenced by economic, social and natural factors (Malaki, 2018). The main five drivers of Change in Land Use are technology, economics, institutions, culture and population (Lambin et al., 2003). The identified drivers operate co-operatively in different assemblages instead of acting alone at collective level impacting into substantial effects on prospective Land Use/Cover (Chiwa, 2012; Malaki, 2018; Lambin et al., 2003).

According to Lambin et al., (2003) the factors responsible for LULC are summarized in two broad types thus underlying or indirect and direct or proximate factors of Change in Land Use. Direct/proximate factors are those that constitute instant actions/responses that originate from planned Land Use which result into change of Land Cover and work at micro levels for instance

settlements, deforestation, farming and others, while underlying/indirect factors are extrinsic forces that bear out the direct/proximate forces for example policies/ laws on Land Use.

The forces of Land Use/Cover Change differ in dimension and character from one territory to another. Tropical regions for instance, LULCC is mostly compelled by weak policies and laws on environment, large scale farming practices, infrastructural developments and rising rates of population (Barasa et al., 2010). It was further noted that shifting cultivation and functional rising population are informally connected to degeneration of the environment and deforestation.

Deforestation is a primary challenge of environmental change, and the trending of LULC in South East Asia, main land. This is usually brought by the law/policy of the nation/ government on pursuit of economic progress for example the extension and advancement of farming products together with the necessary infrastructure (Thongphanh et al., 2017).

The rising levels of deforestation in a number of developing and growing areas are primarily caused by poverty and population growth. Deforestation in most tropical areas occurred by the rising need for more food and the pressure from the increasing population. Without underestimating the purpose of increased population or neediness, many research studies neglected to justify this rationalization instead of more significant, possibly the more difficult forces of deforestation (Chiwa, 2012). It has been further noted that results of critical research studies/surveys of deforestation in the tropics underpinned the idea that increased population was certainly not the only one, at times not even the primary underlying/indirect factor of change in forest-cover (Angelsen & Kaimowitz, 1999).

Census show that increased shifting cultivation and weak national policies have driven deforestation (Chiwa, 2012). The rises and declines of a certain population in addition, have an enormous effect on Change in Land Use and Land Cover moreover at lengthy time scales, he adds. This has been modified by Malaki (2018) as deforestation is reported to be driven quite often, essentially by the increase in timber trade and market together with failures in market. Tropical deforestation is noted to be experiencing outstanding assemblages of cooperative drivers instead of drivers acting alone at collective scale.

Lack of institutional arrangement that there is need for a coordinator that harmonizes the relationship among the stakeholders and sets better management of wetlands. The absence of an

institution duly empowered to issue and implement wetland laws and coordinator management activities is the underlying cause for the deterioration of the wetlands (Omagor & Barasa, 2018). Institutional factors for example offers for land oriented activities, issues of property rights, aspects of open-access resources, landless farmers' motility, shortage of sufficient governance systems, land ownership, policies/laws on economic progress and land use as well as transportation are the leading driving factors of Change in Land Cover (Malaki, 2018).

Population change also means the transition from low to high levels of death and birth rates, instead of only relating with the progress of house units and characters of series of stages in life of households. The need for wood fuel by house units in Africa contradicts between units of each family, which are nuclear in nature and the other consuming larger units hence leading to more forest degeneration, more so in peri-urban environment (Chiwa, 2012). Clearing of forests is caused by several factors with differing effects. Among them include, diversified production by long settled families; mixed farming connected with rising levels of deforestation by large families; recent immigrants do cut and burn farming; their children and grandchildren practise fallow farming (Walker et al., 2002). Increase in economic development and rapid population some of the leading drivers to rapid change in LULC occurring in most parts of the globe. These drive changes in land use in order to satisfy the need for food, energy and other capitals to sustain the increasing population (Gondwe et al., 2021).

Natural rise in population or immigration is one of the population factors driving change in Land Use. Its major elucidation ability is drawn from interconnections with those other indirect/ underlying drivers in particular, the total interaction of the entire primary drivers (five of them). One of the significant factors of demographic nature is migration. This is responsible for change in spatial distribution, demography and Land Use, have great effect on land acreage for farming (Indian et al., 2001; Chiwa, 2012; Malaki, 2018). Additionally, it is clarified that this is one major driver of LULCC with other non-demographic driving factors, for instance economic integration, globalization, government policies and changes in consumption levels.

The major factor causing encroachment into wetlands is the rising population. These have been the rate of population growth is high, annually standing at 3.2% (UBOS, 2014). It was added that drained purposely for agriculture, settlement and for other resources. In Uganda, census recently indicated that the growth rate has increased three times to 34.8 from 12.6 million people between

1980 and 2014. Further observations indicate that Uganda is getting urbanized at a very high rate of 6.6% in the year 2014 clarified by UBOS (2014). The rising population contributes to high need for land and heavy pressure on nature resources for medicines, brick making from clay, food, wood fuel among others (GOU, VOL II, 2016). Informal settlement, have slum occupants, make a significant portion of the urban structure and constitute a considerable contribution to the urban enterprise, nevertheless it is usual for these dwellers to occupy reserve areas including marginal lands with health challenges under extreme conditions and serious environmental issues (MOLHUD, 2013).

Most commercial cities like Blantyre, urbanization is caused by natural increase, increase in young population and rural-urban migration. Such cities have various economic opportunities for example construction, retail industry, food production and manufacturing, automobile sales and maintenance, transportation, textile industry, public administration attract a large number of people to migrate to such cities to exploit such opportunities (Gondwe et al., 2021).

Urban use is identified as the most significant factor of wetland degradation and loss. Urban use occurs in Kwazulu-Natal at Pietermaritzburg where wetlands are cleared for construction of road and industrial purposes (Mercer, 1991). Wetlands are sometimes drained and turned into settlement purposes in order to keep up with the population growth that is increasing rapidly in South Africa (Phethi & Gumbo, 2019).

Population explosion relates with urbanization and points out the urban characters of Kampala city, Mukono and Wakiso districts justify that land is so valuable, therefore the low income earners get evacuated and eventually are forced to settle in wetlands because upland areas, which are dry are grabbed for commercial purposes (GOU, VOL 1, 2016). Industrialization with time, has resulted to the massive numbers of migrants into Kampala city. The labour which is unemployed has been compelled to enroll the unplanned and faster growing informal socio-economic group. The large scale labour has attracted a housing sector transforming swiftly, but disorganized, today is an environmental time bomb (Nyakaana et al., 2007).

Uganda’s present population is growing at the rate of 5.1% unlike the growth of the national population, rates at 3.03%. The city of Kampala alone is made up of 25% of the entire urban population in Uganda (Isunju, 2016; UBOS, 2014). The pressure on Kampala city is attributed to population, has consequently led to endangerment of wetlands and other preserved/marginal

lands, overcrowding, slum development and others (Nyakaana et al., 2007; Emerton et al., 2003; WB, 2015; Isunju, 2016).

Kira Municipality in general does not present a uniform settlement pattern; the existing pattern is unplanned and organic often influenced by the private sector and individuals especially the real estate developers and there is no uniform pattern of development growth hence un-organized. The prevailing planning and settlement challenges such as poor application of planning standards, location and placement buildings, mixed incompatible uses though not easily noticed due to good appearance of the houses, encroachment on the ecologically sensitive zones are attributed to the failure by the Municipality to adequately implement the municipal physical development plan which is bound to expire soon. The expansion of human settlement and industry, wetlands have been destroyed or altered through pollution change as in local drainage, conversion to farmland or other uses including human settlement. This has resulted in effect on wetlands hydrological role, plus the effects on plants and animal species for which wetlands are critical habitats for various life circle activities such as feeding, nesting, breeding and rearing (KMDP, 2019).

2.4 Impact of LULCC on people's livelihoods

The only difficult processes that emanate from moderations of Land Cover to transition process of Land, are the changes in Land Use. This has been substantially one significant factor supporting people's livelihoods (Maliki, 2018). The change in Land Use and agricultural practice affects the performance of the rivers and so their hydrology resultantly, impacts the livelihood mechanisms of farmers (Malaki, 2008; Veldkamp & Lambin, 2001).

The heavy utilization of land resources by humans has resulted into changes which are important on LULC (Lambin et al., 2003; Malaki, 2018). The existence of mankind on the planet earth and his moderation work on the land resource, has had a tremendous impact on it. Man's activities such as change in farming systems have contributed to degeneration of natural resources including Land (Malaki, 2018), further added. Farming too, has extended into savannahs/grasslands, steppes and forests in all regions on the globe to meet food necessity due to human need (FAO, 2010). It is approximated that cropland worth 1-2 million hectares annually are being cleared out of production in developing countries to qualify for land need for infrastructure, housing, recreation and industry (Malaki, 2018). There is a likelihood of this

taking route on major farming lands situated in several drainage basins and river valleys where in the neighbouring dry land ecosystem, there is available water supply on regular basis (Mertens & Lambin, 2000).

Worldwide issues about Land Use/Cover Changes rose up because of the discovery that processes of land surface affect climate and that these processes of change impact on goods and services on the environment (Lambin et al., 2003). The results that have been of major concern are the impacts of Change in Land Use on biodiversity, degeneration of soil and the potential of biological structures to sustain human demands. Harvests in crops have decreased, compelling people to plough or till land much more for their demands to be met (Maitima et al., 2009).

The excessive reliance of people's livelihoods on natural resources, obviously impact into over fishing, over grazing and over use of reserve/marginal land is a major driver of environmental degeneration that limits regional and or multinational sustainability; the loss or reduction of ecosystem functions, also damages people's wellbeing and forces households to look for alternative livelihoods (Gelsdorf et al., 2012). In South Africa, major wetlands are endangered in a way that they are considered waste lands. This consequents to wetland reclamation and demolition due to several activities of Land Use that have been carried out in wetlands (Phethi & Gumbo, 2019).

In Kenya, extensive areas of land have slowly been altered to farm land as well as crop production whenever there are necessary transport and communication systems. This is because of the internally growing population and migration happening today (Malaki, 2018; Campbell, 2003). Increased population exerted heavy pressure on the resources of the earth's surface more so in crop lands that contributed to the extension of farming activities on rangeland borders which are wetter and decrease of grassland because of Land Uses which are not sustaining as well as overgrazing of the rangelands (Malaki, 2008; Campbell et al., 2003).

It has been observed by Chiwa (2012) that little flows of water tend to decline in urban catchments, for instance, averting gradual infiltration of water and in reverse slowing down ground water recharge of infiltration, evapotranspiration and impervious surfaces upon direct runoff in urban settings. Chiwa (2012) further noted that human encroachment on the forest land in the highland region of Kilimanjaro, was driven by agricultural extension; settlement development and logging, had been cross ponding with the major LULCC. In Uganda, the rising

need to make more food, together with the reliance on rain-fed farming are approximated to have compelled out up to 30% reduction of sum total of wetland area in Uganda from 1994 to 2009 (Turyahebwa et al., 2013). Degeneration of catchment areas of Water has been because of the degazetting of reserve areas and cutting down of vegetation near or around catchments. This has contributed to erosion of soil, Water soil which has led to fast siltation of the rivers. Degeneration and eventual disappearance of water catchment areas has too originated from the extension of farmland according to the Ministry of Land Housing and Urban Development (MOLHUD, 2006). It has been also observed by World Bank (WB, 2015) that micro utilization of goods and service from wetlands is a significant outlet of livelihood for the local people; these activities as well contribute directly to degeneration of the performance of wetland together with its functions.

In cities, urban farming is highly gaining focus in the system of self-supporting cities, which contend that a self-supporting city should afford to make food locally to back up food security of its residents. Because of shortage of space, large number of urban farming in Uganda is carried out in catchments. The moist soils in drainage areas of Kampala city and the environs, which are as well having rich nutrients because of the waste materials mixed with wastewater emerging from the urban areas; they resultantly sustain crop cultivation year out (Kabumbuli & Kiwazi, 2009; Isunju, 2016).

According to Wakiso District Local Government (WDLG, 2018) justifies that a lot of agricultural activities are being practised in Wakiso wetlands. This is evident in Lumansi wetland of Nansana Municipality, Gombe Division where by farmers have cultivated eucalyptus trees and sugar canes for purposes of trade. The same study adds that the infringement on wetlands for farming use and often times housing (settlement) need for space, has influenced change in micro climate. It has been also clarified by Kira Municipal Development Plan (KMDP, 2019) that Kira Municipality is reported to have lost 67% of the average wetland cover in the Municipality. The degradation was mainly due to population influx in the area. Accordingly, demand for housing and agricultural land has increased. Although there are several environmentally unacceptable activities in wetlands of the municipality, agriculture and housing pose the biggest threat.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents a description of the study area and the methods that were used in data collection and analysis. It also includes the research design, sample frame and size, sampling procedure, tools and instruments used in the field. The study was conceived and designed to analyze the extent of Land Use/Cover Change (LULCC) and its impact on people's livelihoods in Kira Municipality, Central Uganda.

3.2.1 Location

Kira Municipality is approximately 5.3 km North West of the Capital city of Uganda, Kampala by road qualifying it to be part of the Greater or Metropolitan Kampala (KMDP, 2019).It is one of the five Municipalities that make up Wakiso district, Central Uganda (WDLG, 2018). It covers approximately 26,300.67 hectares in land area. It geographically stretches between 0^0 20'0'' to 0^0 33'22'' North and 32^0 32'5'' to 32^0 40'30" East (Figure 3.1). However, the LULC analysis extended to the environs of Kira Municipality to include cover areas of Wakiso and Kampala districts and a small portion of Mukono.

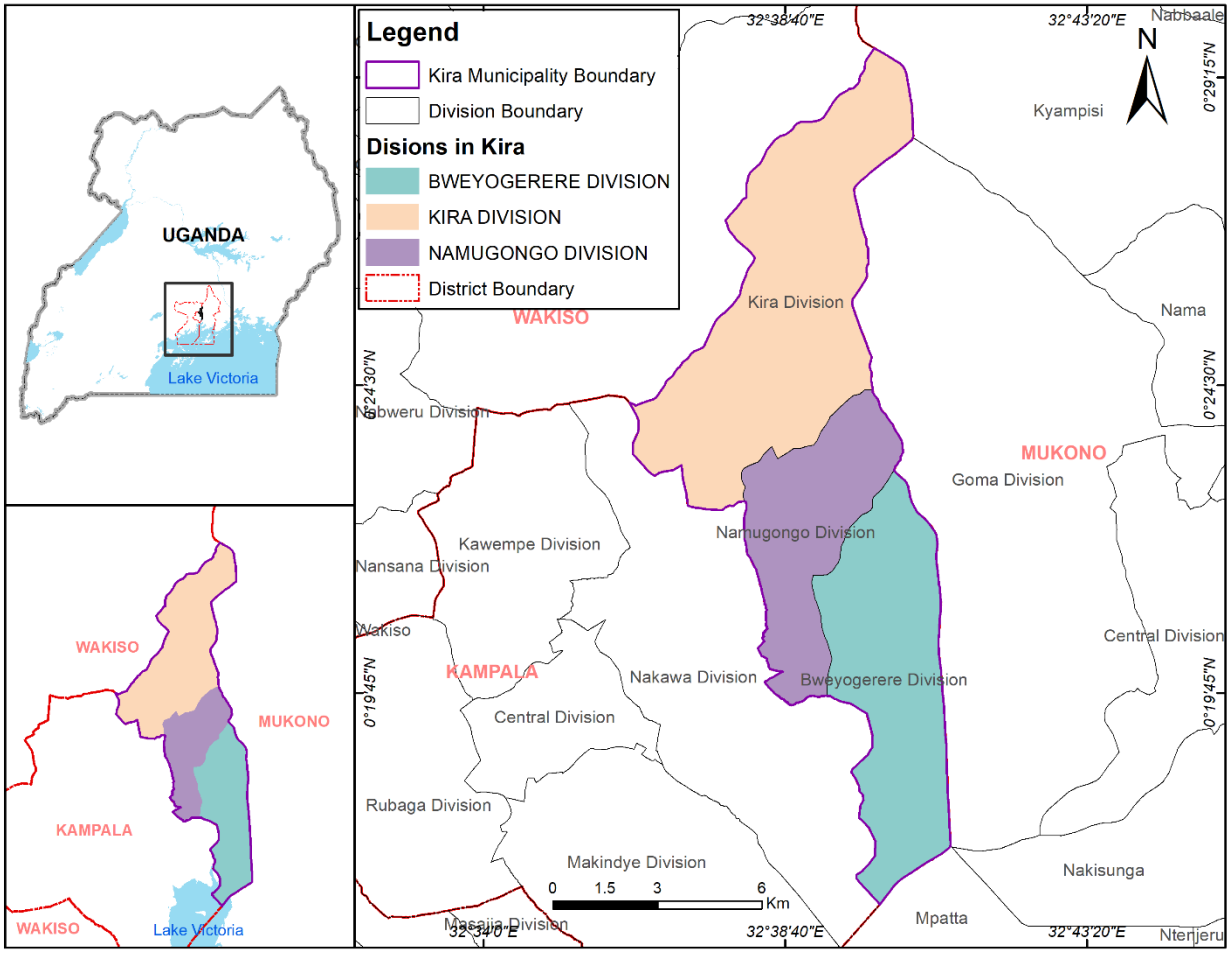


Figure 3.1: Location of Kira Municipality at National Context

Source: Author, 2021

3.2.2 Climate

Kira Municipality falls in the Greater Kampala and like any other place near the Equator experiences the equatorial climatic type. It is characterized by clearly two distinct seasons of rainfall coinciding with ITCZ. This occurs in March to June, then August to November months of each year (KMDP, 2019). This area experiences wet and warm climatic conditions with high relative humidity and the rainfall distribution mode is bimodal in nature (Lwasa et al., 2010; Isunju, 2016; KMDP, 2019). It also experiences two wet seasons with the first one running between April and May, whereas the second one, runs between October and November. Its dry months include January, June to July, then December. The mean annual range of rainfall is between 200 to 2500 mm, while its temperature is 55.0^0 F (minimum) and 82^0 F (maximum) (KMDP, 2019). It was further clarified by KMDP (2019) that this area experiences a small range

of temperature annually with only two peaks of temperature and the first one runs from January to May, while the second one is between July and September.

3.3 Research Design

The research design was cross-sectional in nature because the Landsat images for study period 2000-2021 would be accessed and downloaded in a single moment in time. The perceived drivers of LULCC and their impact on people's livelihood types would also be studied at any single field study/moment in time and would provide a snap shot of all in question. Therefore, Objective 1, was aimed at determining the extent of Land Use/Cover Change from 2000-2021, its data was obtained by use of Remote Sensing and GIS techniques. Findings for this objective were obtained by: acquiring the Remote Sensed data (Landsat images), Ground Truthing which was carried out to get coordinates for geo referencing of these images (for Supervised Classification of these images). In that process LULCC maps, were derived and were finally used to create training samples for Accuracy Assessment. The study was designed to run for ten months, from January to October, 2021. It involved the following: January-March, 2021 was for acquisition of Landsat images, Ground Truthing/Field Survey and processing of LULCC maps; April-June, 2021 was for designing the questionnaire, moderating it, administering and feedback collection of the same; July, 2021 was for data presentation, interpretation and analysis; then examination ran from August to October, 2021.

The results for objective 1, gave a basis for designing a questionnaire for socio-economic survey to establish the perceived drivers of LULCC (objective 2) and the impact of this Change on people's livelihood types (objective 3). Data concerning the perceived drivers of LULCC and the impact of this Change were collected using the questionnaire (Appendix A). Documentary analysis was also done supplemented by field observations and photograph interpretation of both aerial (Google Earth images-Figure 4.1) and Ground images or Plates reflected in Chapter 4. The questionnaire was used in this study because studies on LULCC (drivers of change and its impact) is best identified by face to face interaction or communication which is direct (questionnaire use) between the respondent and the researcher. The researcher for that case was able to frame or set questions to enable respondents to comprehend them and so minimizing mistakes in reply. By the mere fact that this method consumes a lot of time to sample the entire population and also costly practically, so sampling the population in different categories was

applied. Therefore, the respondents' ideas together with perceptions developed were unspecialized/generalized and applied to the entire population. According to Yamane (1967), a number of 80 respondents was established as the sample size. The study applied both purposive and random sampling to determine the sampling frame and sample selection. This was accompanied by the number of methods, using both qualitative and quantitative techniques. All in this context has been summarized in Figure 3.2 here under.

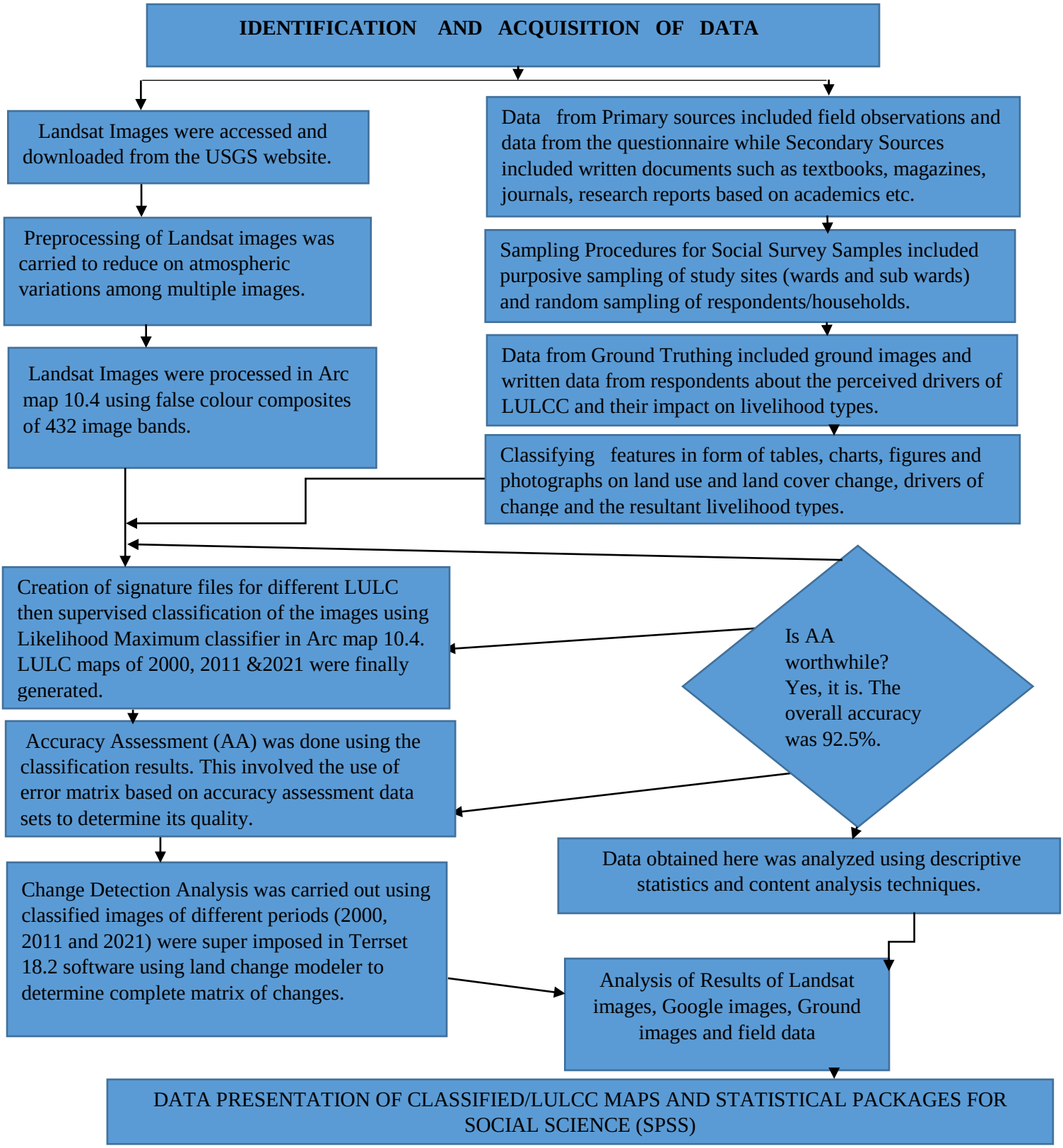


Figure 3.2: Research/Methodological flow chart

Source: Author, 2021

3.4 Sample Frame

The main locations for field investigations (for socio-economic survey) and sample collection are in the urban and sub-urban (rural-urban) areas of Kira Municipality which are either highly or lowly populated. However, the study for household sampling was restricted to two Divisions of Kira and Namugongo (Figure 3.1) and their four wards were considered main study sites including Kira, Kimwanyi, Kyaliwajjala and Kireka respectively. Some eight cells/sub-wards (sub- study sites) from these wards were considered for photography of Aerial /Google Earth images (Figure 4.1) and Ground images/Plates detailed in Chapter 4.These were key in identifying the Changes in LULC, perceived drivers of these changes and the change impact on people's livelihood types evident during ground truthing namely: Kireka, Kamuli, Naalya, Kyaliwajjala, Kira, Bulindo, Nakwero and Kijabijo cells/sub-wards. These were selected because these specific areas are highly urbanized and some are urbanizing causing changes in LULC hence driving and determining some of these livelihood types and their associated benefits and challenges (Figure 4.1; 4.2; 4.10 & Plate 4.1-4.4). For example farming, building and construction, trade, transportation, manufacturing work/services and others result into accidents, insecurity as well as floods, pollution, storm water runoff and erosion which are experienced in some of the shanty lowland South, whenever it rains. This is why the choice of the location of study sites was made. Besides that, the financial and time factors, also constrained the sample size. Purposive sampling was done for selection of four wards and their cells/sub-wards on grounds justified above (Sub-sec 1.7).

3.5 Methods

The methods which were used in data collection included the following:

3.5.1 Documentary Analysis

Data was collected by visiting various offices and libraries for secondary information from reports including Newspapers, Research based on academics coupled with Consultancy and Documents. Relevant information from libraries and offices whereby textbooks, reports and documents were signed for, then read immediately or photocopied for later reading and analysis. Some were down loaded from respective Google websites and whenever found relevant, were saved in the system or recorded in the note book for further analysis. This is acknowledged by a list of references between pages.

3.5.2 Field Observation

Field observation was applied to ascertain the existing LULC in this Municipality during the transect walk, Ground truthing and administration of the questionnaire. This is evidenced by a variety of photographs shown in chapter 4 which were captured during this session in the field.

3.5.3 Documentation

This was done by documenting in the note books or camera. Further still, document analysis/written literature, observation sheets of field phenomena, especially about LULCC types or classes of this Municipality was done. It was also applied in the compilation of data and making a final research report (dissertation).

3.5.4 Questionnaire Administration

The household questionnaire was designed with questions framed by the researcher to gather data that addressed the perceived drivers of Change in Land Use/Cover (LULCC-objective 2); impact of LULCC on people's livelihood types (objective 3).The questions were both open ended and some closed ended, which depended on the attribute each tried to discover. The target in the questions was structured for both formal and informal communities who are either land owners or tenants and have lived here for five (5) years or more. Respondents were randomly selected, while the study sites (wards and cells/sub-wards) were purposively sampled. The entire work/process of this questionnaire took three (3) months, from April to June of 2021 as detailed in sub sections 3.3 and 3.6.2.

3.5.5 Techniques of Sampling

Purposive technique of sampling was used in choosing wards and cells/sub-wards for socio-economic survey data on the perceived drivers of LULCC as well as the impact of this change on people's livelihood types. The major purpose for the choice of the four wards that is Kireka, Kyaliwajjala, Kira and Kimwanyi. The south zone consisting of Kireka and Kyaliwajjala wards are largely urbanized and highly populated dominated by shanty clustered settlements of both informal and formal communities. Kira and Kimwanyi of partly central zone and largely northern are urbanizing with the least population of less clustered and more grid settlement patterns. They also have both informal and formal communities. All the identified wards are undergoing a shift in LULC where most of the following livelihood types are evident: building and construction, farming, trade and manufacturing justified in 3.4. Respondents were randomly

selected and the numbers of respondents in each ward was chosen according to its population size through quantitative computation (Table 3.1). A respondent who was selected was any member of the sampled household either a head of that household or any responsible adult of above 18 years of age present at home during the administration of the questionnaire. This respondent should have stayed/lived in this area for five (5) years or more (5-21 years), either a landlord/lady or tenant and female or male which is also identified in sub-sections 3.3 and 3.6.2.

3.5.5.1 Determining the size of the Sample

Choosing the sample size for the study involved the informal and formal communities found in the selected wards of Kira Municipality. The sample was therefore determined based on the total numbers of house units/households in the four wards. In establishing the size of the sample, the following working was applied (Yamane, 1967) thus:

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

Where *n* = sample size, N = population size and *e* = level of precision.

An 11.2% level of precision was considered (i.e. *e* = 0.112).

For example, (UBOS, 2014), the four wards which make up Kira Municipality had a population of 210,315.

Thus the total number of zones, which is 3 representing households 210,315 with a number of members per every household, which was 6.

Therefore, the sample size was computed as follows:

$$\frac{210315}{6} = 35{,}052.5$$

$$\frac{35052.5}{1 + 35052.5} = (0.112)$$

$$\frac{35052.5}{1 + 35052.6} \times 0.012544$$

$$\frac{35052.5}{1 + 35052.5} = (0.112)$$

$$\frac{35052.5}{439.699144} = 79.719160327$$

This is approximately 80 which became the sample size that was used in the socio-economic survey.

3.5.5.2 Sampling Procedure

The size of the sample was proportioned basing on the estimated number of house units/households within the wards border/boundary in every ward indicated in Table 3.1 below.

Table 3.1: Sample wards, Population and Sample Size

Ward	Population	Sample Size (n)	Percentage
Kireka	97,895	37	46
Kyaliwajjala	51,921	20	25
Kira	47,038	18	23
Kimwanyi	13,461	5	6
Total	210,315	80	100

Source: Computed from UBOS, 2014

3.6 Tools used

The tools that were used in this study included:

3.6.1 Global Positioning System (GPS)

The study used a Garmin Map 60 S GPS. This was used during Ground Truthing to obtain coordinates in order to do geo referencing of Landsat images as well as ascertaining the accuracy of Landsat images (Classified ones).

3.6.2 Household Questionnaire

This was designed with questions set by the researcher to gather data that addressed the perceived drivers of Change in Land Use/Cover (LULCC-objective 2); impact of LULCC on people's livelihood types (objective 3).The questions were both open ended and some closed ended, which depended on the attribute each tried to discover. The questions targeted communities of slummy and clustered or grid and /or scattered settlement pattern (formal and informal in nature) found in the selected wards of Kira Municipality. The rightful respondent considered for sampling was one who was either a landlord/lady or tenant and had lived here for

five (5) years or more, male or female and an adult of 18 years or more. Respondents were randomly selected, while the study sites (wards and cells/sub-wards) were purposively sampled more details shown in Sub sections 3.3-3.5.5).

The perceived drivers of change in LULC were categorized in two ways thus: direct/proximate and indirect/underlying drivers. Perceived proximate drivers are direct causes which comprise of immediate actions such as human activities that emanate from targeted Land Use thus affecting Land Cover and run at micro level. Examples of perceived proximate drivers included infrastructure, farming, industry, settlement, commerce and recreation. The perceived underlying/indirect drivers are extrinsic causes that bear out the proximate/direct cause. Examples considered for this category included institutional factors, technological factors, soil and land factors, demographic factors and climatic variability factors. The respondents were asked to agree with what was given on the frequency or priority scale for each of the perceived drivers identified. The sub-section (002) (a) (ii) for each of the table for perceived drivers (Appendix A) was for reasons/indicators in support or against each of them to be suggested by the respondents.

The other purpose was to examine the impact of this change on people's livelihood types. These were designed such that a respondent was required to identify each rank of the seven (7) livelihood types and their associated benefits and challenges. Accordingly, every respondent selected, was to give his or her ideas, views and perceptions by prioritizing each livelihood type and its/their challenge(s) as high or moderate or low and also propose any other reason (s) against or in support of the livelihood type in (004) (a) seen in Appendix A.

3.7 Collection of Data

Data collection involved acquiring and processing by downloading and processing Landsat images; backtracking and downloading Google Earth images; Field observations/ground truthing; Questionnaire administration, collection and result processing/computation shown below:

3.7.1 Acquisition of Landsat images

Table 3.2: Features of Landsat Images

Name/type of Satellite Image	Spatial Resolution	Date of Acquisition	Author/Source	Path and Row
Landsat-7 TM	30m x 30m	03/01/2000	USGS	171060
Landsat-7 ETM+	30m x 30m	06/01/2011	USGS	171060
Landsat-8 OLIS/TIRS	30m x 30m	27/02/2021	USGS	171060

Source: April, 2021

Determining the extent of LULCC involved the following activities: Image Acquisition, Ground Truthing, Supervised Classification, Change Detection and Accuracy Assessment. Cloud free satellite images of Landsat nature were downloaded from http://www.earthexplorer.usgs.gov. Details for the images are; Landsat TM date 03/01/2000, Landsat ETM+ date 06/01/2011 and Landsat (OLIS/TIRS) date 27/02/2021 (Table 3.2). The scenes corresponded with Path 171 and Row 060 of WGS 84 UTM Zone 36 N. All the images had 30 meters spatial resolution and all these images used, were obtained during the dry season. The selection of satellite images in the same season allows for comparability of vegetation phenology, and it further minimizes discrepancies in reflectance caused by seasonal variation in vegetation to reduce seasonal variation related effects (Jensen, 1996). Landsat images were used in the study because Landsat images are now freely available to the public from the USGS website.

3.7.2 Acquisition of Historical Google Earth images

To visualize the perceived drivers of LULCC, clear rather cloud free Historical Google Earth images were downloaded from Google Earth Archives (website) for use in this study. The process of acquiring these images involved backtracking images for each of the specified time/year for this study (2001, 2011 and 2020), they were loaded and finally downloaded using Google Earth Software (Google Earth Pro). These were acquired for purpose of photograph interpretation to supplement the classified maps to identify the changes in LULC, their driving forces and the impacted livelihood types (Sub-section 3.4 & Figure 4.1).

3.8 Data Processing (Processing of Landsat images)

3.8.1 Image processing

False color composite images of Landsat Thematic Mapper (TM) date 03/01/2000, Landsat Enhanced Thematic Mapper+ (ETM+) date 06/01/2011 and Landsat Operational Land Imager/Thermal Infrared-Scanner (OLI/TIRS) date 27/02/2021, made and processed in Arc map 10.4. The widely accepted and used false color composite of Infrared, red and blue (432) image bands was adopted for vegetation discrimination.

3.8.2 Ground Truthing

Fieldwork was conducted to collect Ground Truth data in order to create the LULC classes represented in Kira Municipality. The Ground Truth data was used to establish training samples, and for Accuracy Assessment of maps from Supervised Classification. Training samples are representatives of the desired Land Use Class (Eastman, 2003). The types/classes used in this study were based on FAO (2010) seen in Table 3.3.

3.9 Data Analysis

3.9.1 Techniques of Remote Sensing (RS) and Geographical Information System (GIS)

Remote Sensed data from the USGS website was downloaded and processed using GIS techniques to establish the changes in the LULC over 21 years in Kira Municipality. GIS was also used to acquire the Historical Google Earth images (Remote Sensed data) from Google Earth Archives to visualize changes over time to back up the drivers of Change in LULC.

Table 3.3: FAO Classification Scheme

Land Use & Land Cover	Type/ Class Description
Forest land	Land spanning more than 0.5 hectares with trees higher than 5m and tree crown cover equal or more than 10%. Trees to be at a height of 5 meters minimally excluding land that is predominantly under urban or farmland.
Wetland	Areas that have water at or on the surface for at least the major part of the growing season. The water is sufficiently shallow to allow the growth of wetland crops and natural vegetation.
Built-up	Roads or lanes, open spaces needed for storing equipment and products, buildings, parks and ornament gardens, commercial, mines and dumping sites.
Farmland	Heterogeneous agricultural land/areas, cropland for both permanent and seasonal crops and pasture.

Source: Extracted from FAO, 2010

3.9.2 Land Use and Land Cover (LULC) Classification

The reference data collected during the Ground Truthing exercise was loaded into Arc Map 10.4. This data was used to create signature files for the different Land Uses. A signature file is a file that stores the statistics for each Land Cover (Eastman, 2003). The false color composites of the different years depicting the vegetation image pixels were trained into appropriate classes using the dataset for classification. Supervised Classification using Maximum Likelihood Classifier in Arc map 10.4 was employed on the false color composites of 2000, 2011 and 2021. The classification was based on the classes in (Table 3.3). Several other classifier techniques for Supervised Classification exist such as parallel piped, minimum distances among others. But Maximum Likelihood Classification was used because it produced the best results with higher accuracy compared to other techniques of classification. Land Use maps of 2000, 2011 and 2021 were generated (Figure 4.2).

3.9.3 Accuracy Assessment

Table 3.4: Confusion Matrix 2021

Error matrix	Forest	Farmland	Wetland	Built-up	Total pixels	User Accuracy %
Forest	7			3	10	70
Farmland		10			10	100
Wetland			10		10	100
Built-up				10	10	100
Total ground	7	10	10	13	40	
Producer accuracy	100	100	100	76.9	100	Overall Accuracy = 92.5%

Source: Author, April 2021

Accuracy Assessment of the Classification results was done using error matrix based on the Accuracy Assessment Dataset to determine the quality of the resultant maps of 2000 and 2021 images. The error matrix involves a comparison of the result obtained by the image interpretation as columns and that obtained in the reinterpretation as rows (Eastman, 2003). Error matrix was constructed for the map of 2021 (Table 3.4). The overall Accuracy was 92.5 %.

3.9.4 Change Detection Analysis

The Classified images of different periods were superimposed in Terrset 18.2 software with the objective of determining the spatial distribution of Land Cover conversions over the years and filling a matrix showing transitions between the Classified Land Cover types/classes. Using the Land Change Modeler in Terrset 18.2 software, LULCC maps (Figure 4.6 & 4.7) depicting a comprehensive matrix of changes. For example, changes from forest to grassland, were generated. Quantitative area data in hectares were later compiled (Tables 4.2 & 4.3).

3.9.5 Analysis of Descriptive Numerical Data

Both qualitative and quantitative analysis were applied to analyze information which was acquired through questionnaire and observation. Quantitatively, statistical/frequency tables and charts as well as maps and photographs were qualitatively applied to analyze the perceived drivers of Change in Land Use/Cover (objective 2) as well as the Change impact on people's

livelihood types (objective 3). The application of Statistical Packages for Social Science (SPSS), a quantitative technique used in analyzing questionnaire responses obtained from the field during the socio-economic survey period, was done purposely to achieve objectives 2 and 3. Accordingly, the sampling frequencies, percentages and other numerical data measures were used, then computations were done (Figure 3.2; Sub-sec 3.5.5.1; Tables 3.1; 4.1-4.8) later for further analysis of the results.

3.10 Limitations

Several restrains were intersected in the course of data collection and field survey whereby the following were considered significant:

During Ground Truthing and Surveying, some respondents were not willing to respond to the questions asked (answer the questionnaire) and some of them gave us hard time in taking photographs which were necessary to back up some study findings.

The three years of 2000, 2011 and 2021 were selected because very high resolution data is very expensive, so could not correspond with the available/accessible funds and the time to process them. Therefore, it was a challenge acquiring data and processing it to its final stage, due to high costs involved in terms of skill, capital and time.

Some places were inaccessible especially in some places, north of this Municipality to capture photographs and access respondents in this part of the area which was very isolated, bushy, a little swampy and forested that hindered accessibility during field survey. This was partly overcome by use of Google Earth Pro, Historical imagery.

The socio-economic effect of COVID 19 pandemic in both the first and second waves of 2020 and 2021 respectively prolonged the academic programme, delayed the funds to facilitate the study, delayed data collection and processing as well as the supervision work because most of the concerned offices to aid me, were closed down (were in lockdown).

CHAPTER FOUR

RESULTS AND DISCUSSION

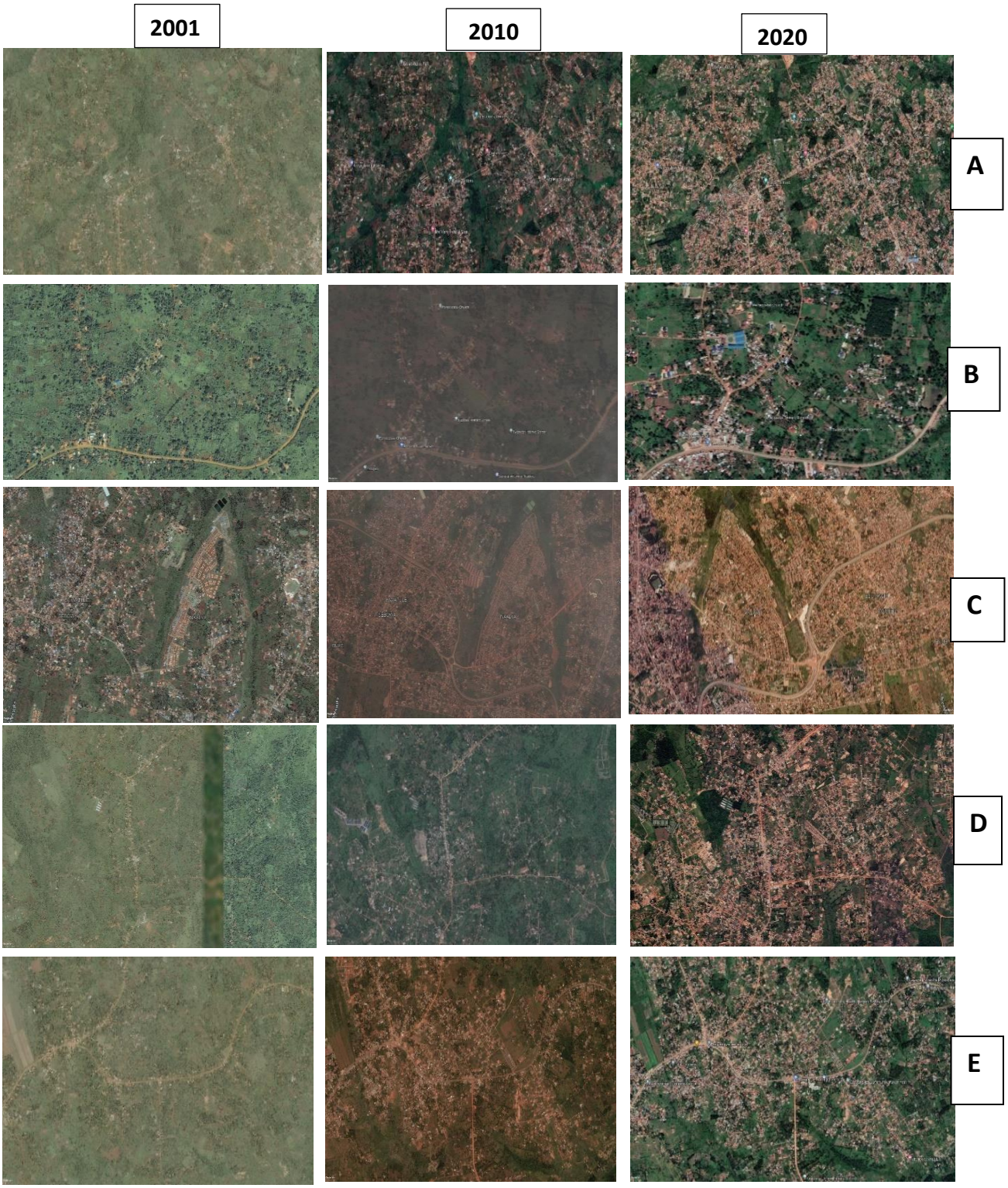
4.1 Introduction

This chapter addresses data presentation, analysis, interpretation and discussion. The data is presented according to the study objectives. The chapter presents and discusses findings from the Landsat images (Classified ones) and field survey carried out in Kira Municipality. The findings of Land Use and Land Cover Change (LULCC), perceived drivers of LULCC as well as the impact of LULCC on people's livelihood types in Kira Municipality.

4.2 Results

4.2.1 Extent of Land Use/Cover Change (LULCC) in Kira Municipality from 2000-2021

According to Figure 4.1 here under of Google Earth images, results depict significant changes identified vividly in all the study sites (4.1 A-E). In particular the study site 4.1 C which is part of the South zone of Kira Municipality demonstrate tremendous changes in Land Use and Land Cover. For example, in 2001 this area was dominated by the green vegetative cover comprising of observant wetland, forest and partly farmland with very minimal infrastructure representing the built–up. In 2010, the extent of LULC change was visually moderate dominated by the built–up land, while in 2020, the rest of the LULC consisting of wetland, forest and farmland greatly converted to built-up land evident of settlements and the associated socio-economic infrastructure. This justifies what is also seen in Figure 4.2 A-C.



A-Kira; B-Kijabijo; C-Naalya; D-Bulindo; E-Nakwero

Figure 4.1: Google Earth Images portraying LULCC and some of the perceived drivers of this change in Kira Municipality from 2001 to 2020 at selected Study sites.

Source: Google Earth Archives

Figure 4.2 below shows the LULC maps for the study period 2000-A; 2011-B and 2021-C. These maps portray that Kira Municipality has changed greatly in the 21 study period. For example initially, the LULC map A was largely covered by farmland, wetland and partly forested with very few spots of the built-up land cited mainly in the South. After 11 years from the initial year of study-2000, the change in LULC seen in LULC map B indicated a great transition in LULC whereby the South and mid Central were dominated by the built-up and in 2021 (LULC map C) almost completely the forest, wetland and farmland disappeared in both South and Central parts of this area with scattered spots of the same found only in the North. The changes identified in these maps correspond with what is visualized in Figure 4.1 A-E.

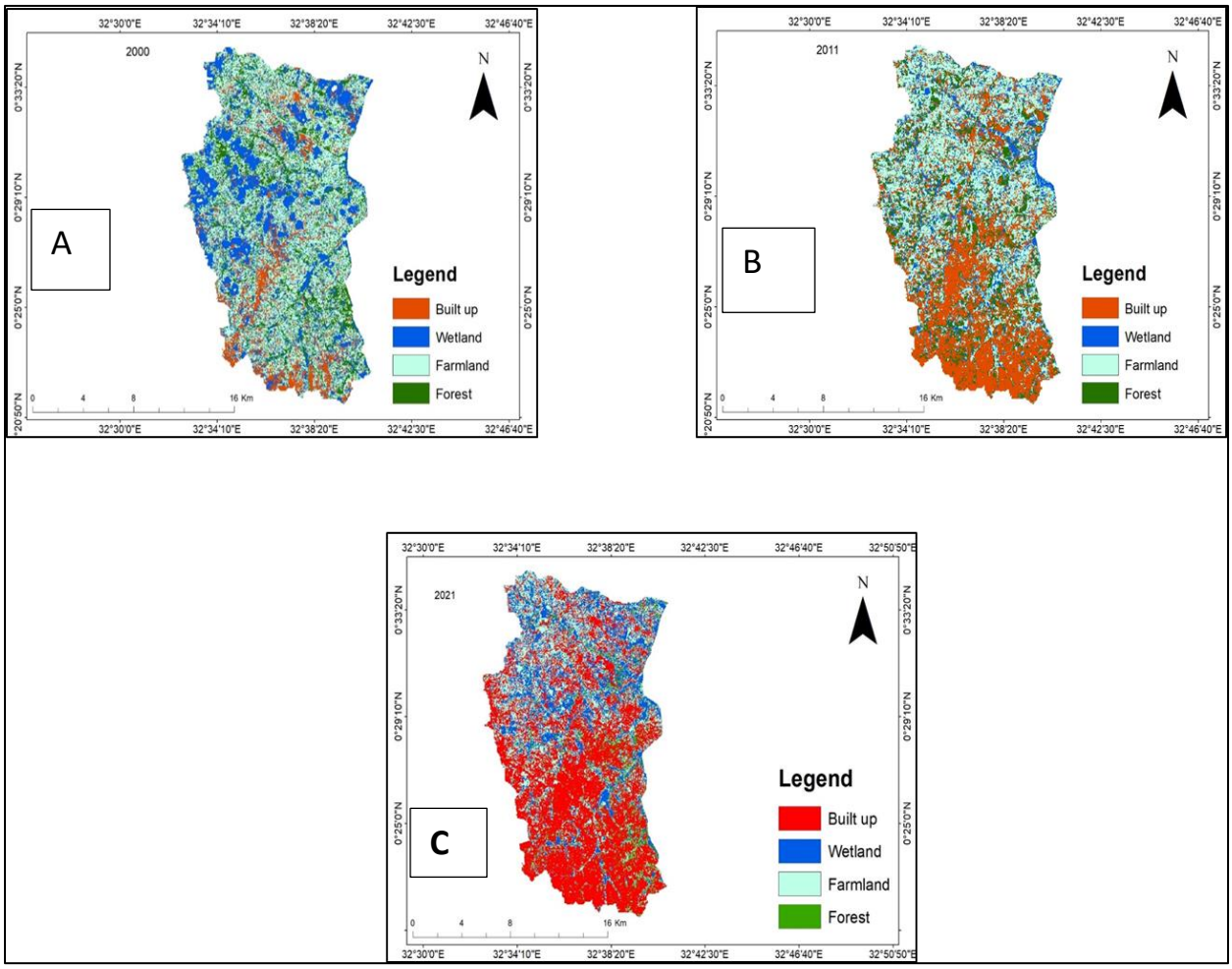


Figure 4.2 Land Use/Cover maps of Kira Municipality from 2000 to 2021

Source: March, 20

Basing on the Classified Landsat images of 2000-A, 2011-B and 2021-C; and the Ground Truth obtained during field survey; the Municipality has under gone various LULCC (Figure 4.2 A-C). The findings shown in Table 4.1 below portray that there has been a huge LULCC in this area from 2000 to 2021.

Table 4.1: Land Use/Cover Change (LULCC) in Kira Municipality from 2000 to 2021

		2000		2011		2021
LULC types/classes	**Area (Ha)**	**%**	**Area (Ha)**	**%**	**Area (Ha)**	**%**
Built-up	3495.77	13.29	9562.31	36.3	12323.1	46.8
Wetland	6804.82	25.87	3520	13.3	4680.27	17.7
Farmland	11634.6	44.2	6384	24.2	7878.66	29.9
Forest	4365.48	16.5	6834.36	25.9	1418.1	5.3
Total	26300.67	100	26300.67	100	26300.13	100

Source: April, 2021

Contrasting LULC classes, statistically represented in percentages are presented in Table 4.1 and Figures 4.3, 4.4 and 4.5 for years 2000, 2011 and 2021. The results show that there has been a significant LULCC in this Municipality where the built-up land continuously increased from 13.29% in 2000 to 36.3% in 2011, then to 46.8% in 2021. This suggests that the change is caused by the increased settlements mainly because of the identified transitions in LULC of the continuous decrease in wetland, farmland and forest land to the tremendous increase in the built-up land in this area.

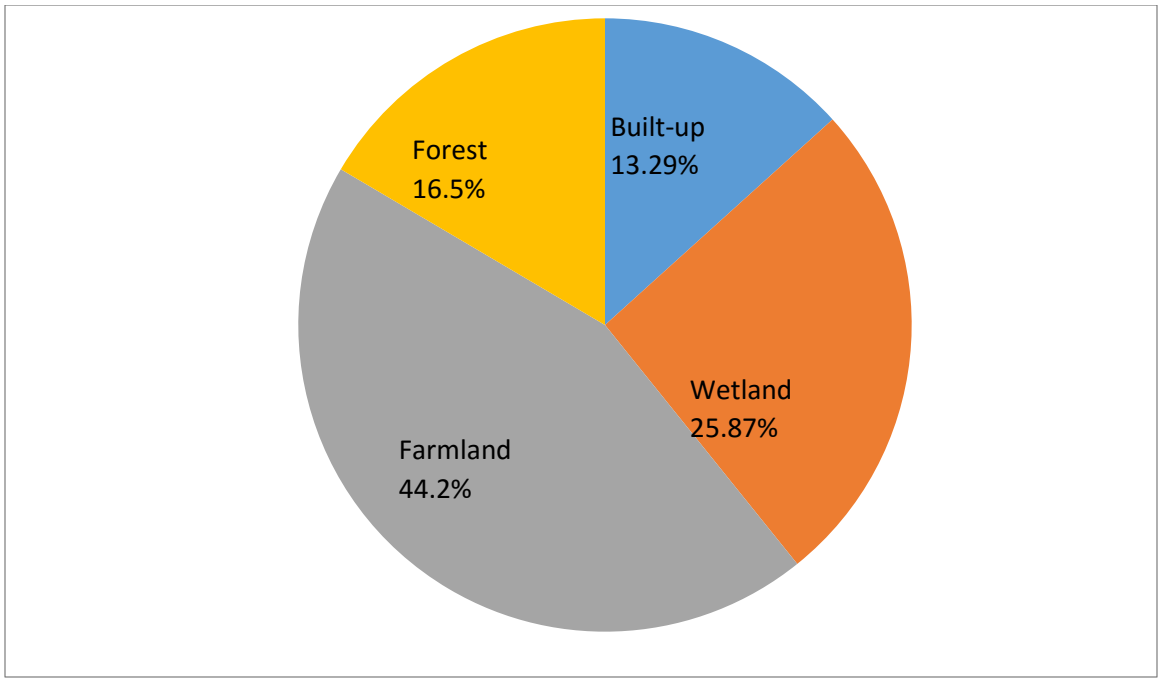


Figure 4.3 Percentage of LULC types for 2000

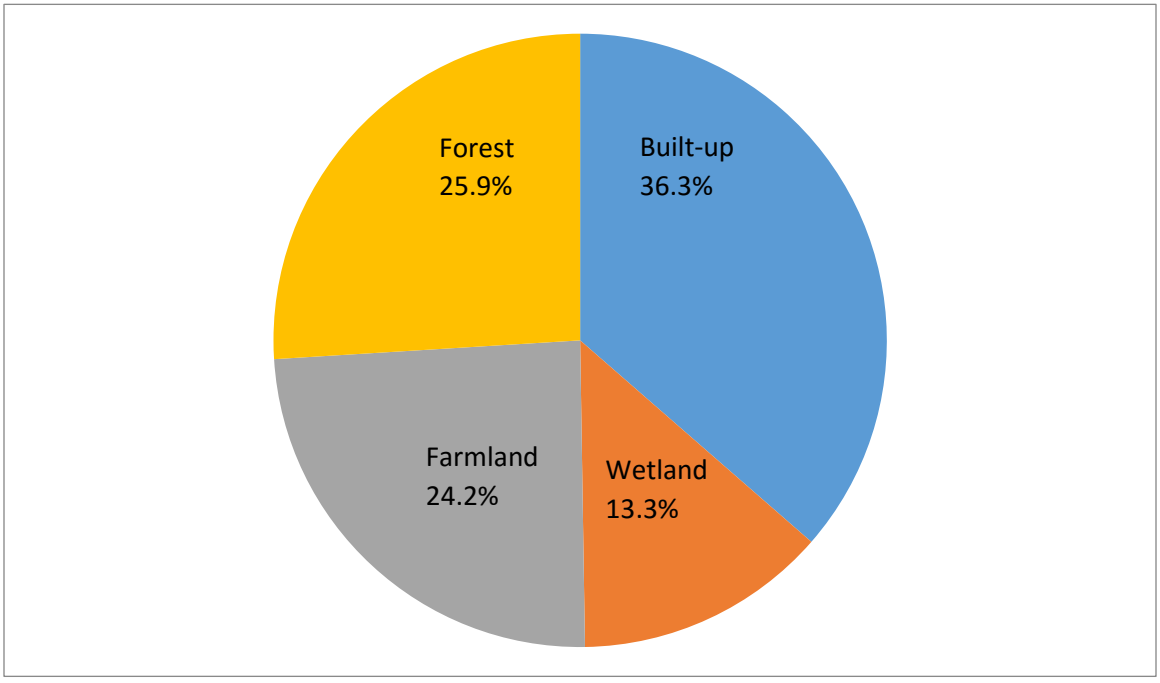


Figure 4.4 Percentage of LULC types for 2011

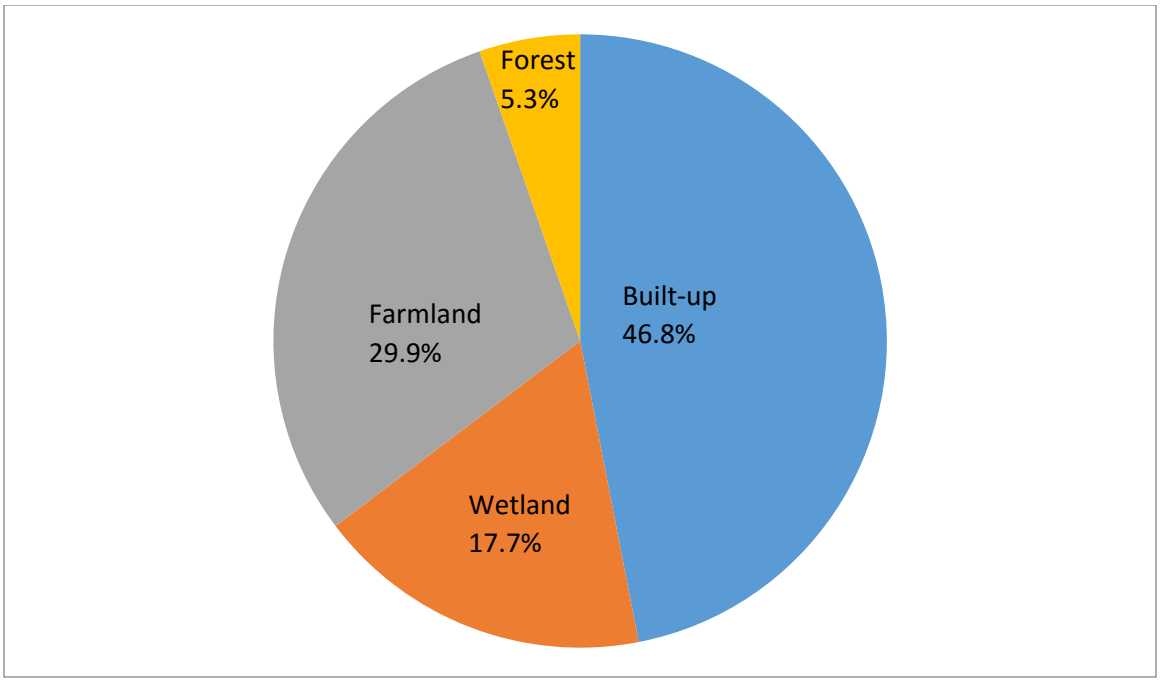


Figure 4.5 Percentage of LULC types for 2021

Source: Author, 2021

However, the results also showed a great increase in percentages for LULC area for forest land in 2000 from 16.5% to 25.9% in 2011, later decreased greatly to 5.3% in 2021.Whereas the area covered by farmland in the initial years, sharply decreased from 44.2% in 2000 to 24.2% in 2011 and slightly increased to 29.9% in 2021. Area decline also applied to wetland with initial 25.87%, 13.3% in 2011 changed to 17.7% in 2021. According to 2000 -A, 2011-B and 2021-C LULC maps (Figure 4.2 A-C), the lowland North, which used to have more forests, have greatly reduced due to more farming and other related activities of development (value) to people in this area (Figure 4.2, 2000- A & 2011-B).

The South, which is an upland in 2021, had more land acreage for built-up Land Use than the lowland North. This has been manifested by more cleared land for farming and other urban activities such as manufacturing/industrialization, trade, building and construction among others in Kira Municipality. However, the built-up land acreage continuously increased in both South and North of Kira Municipality leading to the decrease of the forest land and farmland.

The results in Table 4.2 show the area in hectares (ha) and percentages (%) of LULCC between 2000 and 2021. The findings showed that for 11 years period that is between 2000-2011, built-up

land and forest land increased by 23.01% and 9.4% respectively, while the wetland and farmland decreased by -12.57% and -20% respectively. The reason behind this, is the ever rising population that has in turn contributed to the increase in housing facilities (shelter) in this area at the expense of the forest land and wetland. It has been also justified (Appendix A feedback) that residents in Kira Municipality have cut down forests to establish human settlements by creating space for infrastructural, industrial, commercial and recreational facilities and small farms to support the increasing population with food.

Table 4.2: Percentage Change of LULC in Kira Municipality over the period of 21 years (2000-2021)

LULC types	**2000-2011**	**%**	**2011-2021**	**%**
Built-up	6066.54	23.01	2760.79	10.5
Wetland	-3284.82	-12.57	-1160.27	4.4
Farmland	5250.6	-20	1494.66	5.7
Forest	2468.88	9.4	-5416.26	-20.6

Source: April, 2021

Table 4.3: Transition Matrix 2000 to 2011

	2011					
	LULC types	Built-up	Wetland	Farmland	Forest	Total 2011
2000	Built-up	**3203**	0.00	0.00	292.77	3495.77
	Wetland	2074.95	**3520**	0.00	1209.87	6804.82
	Farmland	3521.52	0.00	**6384**	1729.08	11634.6
	Forest	762.84	0.00	0.00	**3602.64**	4365.48
	Total 2000	9562.31	3520	6384	6834.36	26300.7

Note: ***Area in bold did not change Land Use/Cover class***

Source: April, 2021

The analysis of LULCC types/classes between 2000 and 2011 in this area further indicated that there has been a huge change in LULC. This change has involved substantial conversion of Land Cover in particular vegetation, has greatly reduced in form. As such, around 3521.52 hectares (ha) of the entire Kira Municipality land acreage changed from farmland to the built-up land from 2000 to 2011 and 1729.08 ha converted from farmland to forest land, 2074.95 ha changed from wetland to built-up land area and 1209.87 ha changed from wetland to forested land, 762.84 ha changed from the forested land to the built-up land and only 292.77 ha converted from the built-up land to the forested land (Table 4.3 & Figure 4.6). According to the Historical Google Earth images (Figure 4.1 A-E) coupled with the feedback from the questionnaire (Appendix A) confirm that almost the entire Kira Municipality, especially the Central and the Northern parts of this Municipality were covered with natural forests and farming land in the past 21 years. The reasons behind this LULCC were the cutting down of trees for wood fuel and timber, hence alteration of farmland and natural forests into settlements and their associated socio-economic infrastructure (the built-up land).

Table 4.4: Transition Matrix 2011 to 2021

	2021					
	LULC types	Built-up	Wetland	Farmland	Forest	Total 2021
2011	Built-up	**8210.3**	2056.17	4132	800.56	15199
	Wetland	0	**1213.1**	0	0	1213.1
	Farmland	0	0	**2116.66**	0	2116.66
	Forest	4112.77	1411	1630	**617.54**	7771.31
	Total 2011	12323.1	4680.27	7878.66	1418.1	26300.1

Note: ***Area in bold did not change Land Use/ Cover class***

Source: April, 2021

A similar transition was also observed between 2011 and 2021 (10 years) when about 4112.77 ha of land changed from forest land cover to built-up land use, 1411 ha altered from forested land to wetland, whereas 1630 ha changed from forested land to farmland. Although there was a slight increase in Land Cover by about 2056.17 ha converting from built-up land to wetland, 4132 ha converting from built-up land to farmland and 800.56 ha converting from built-up land to forest

land, Land Use, especially the built-up land continued to increase during the study time indicative in Table 4.4 and Figure 4.7.

The findings further (Table 4.2) showed that in 10 years period that is from 2011 to 2021, the built-up land, continued to increase by 10.5 % as well as wetland and farmland increased slightly by 4.4% and 5.7% respectively and only forest land which registered a great decline of -20.6%. This showed that the need for land in this Municipality has significantly changed, hence converting from wetland, forest land and farmland to majorly built-up including settlement use and the associated Land Uses such as housing and other socio-economic infrastructure. In the study period of 21 years, results portrayed a significant trend in Land Use in this area. For instance, 33.51% of the built-up land area increased, while the wetland decreased by -8.17%, farmland dropped by -14.3%, which was converted to other Land Uses and the forest land also reduced by -11.2%.

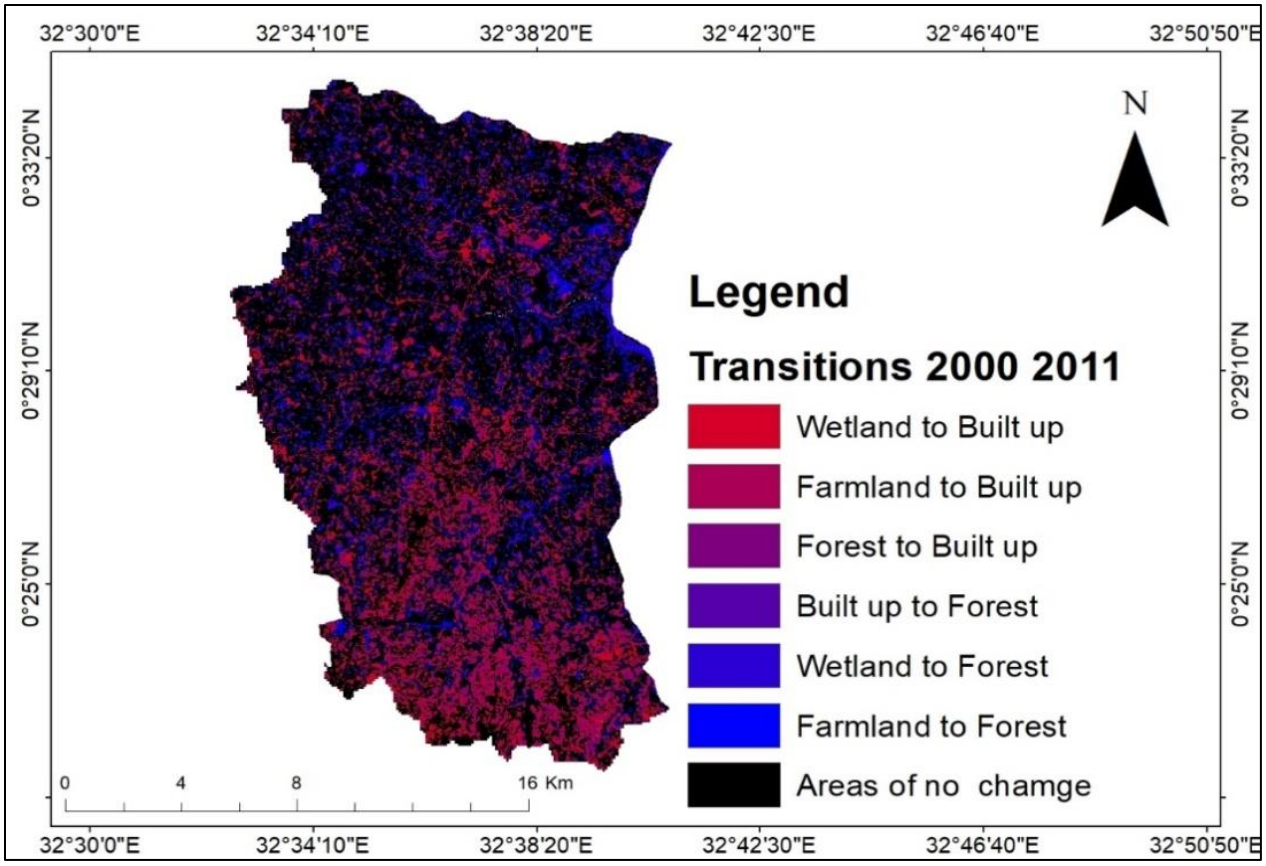


Figure 4.6: LULC transitions from 2000-2011

Source: June, 2021

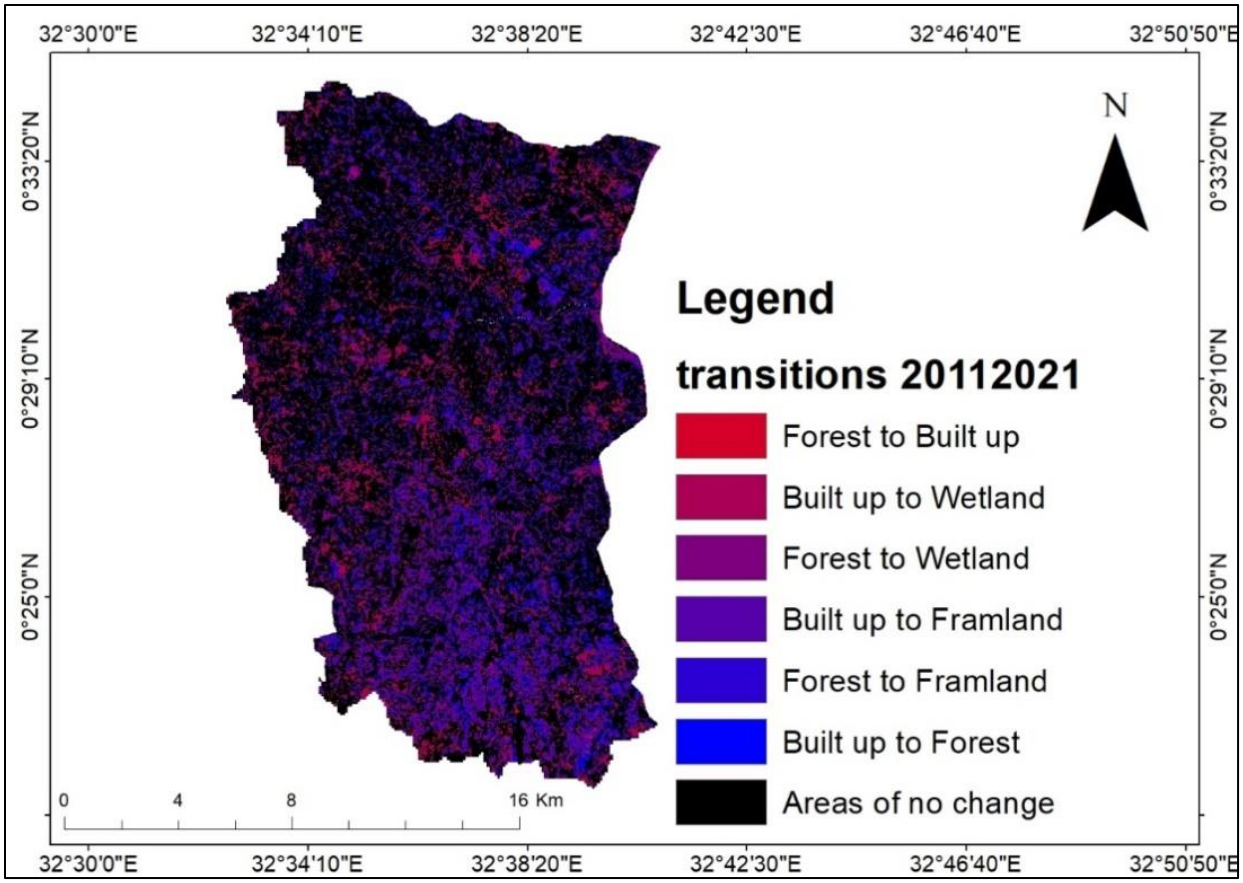


Figure 4.7: LULC transitions from 2011-2021

Source: June, 2021

4.3 The perceived drivers of LULCC in Kira Municipality

Below is a summary of statistics of the 80 respondents from the socio-economic survey that was carried out during the study about the perceived drivers of LULCC in Kira Municipality which is presented in Table 4.5.

4.3.1 The perceived underlying drivers of LULCC in Kira Municipality

Table 4.5: Descriptive Numerical Data of the perceived underlying drivers of LULCC

Rank	Perceived drivers	Frequencies	Percentage (%)
1.	Demographic factors	34	42.5
2.	Institutional factors	19	24
3.	Technological factors	11	14
4.	Climate variability factors	9	11.25
5.	Soil and land factors	7	9

Source: Field data, 2021

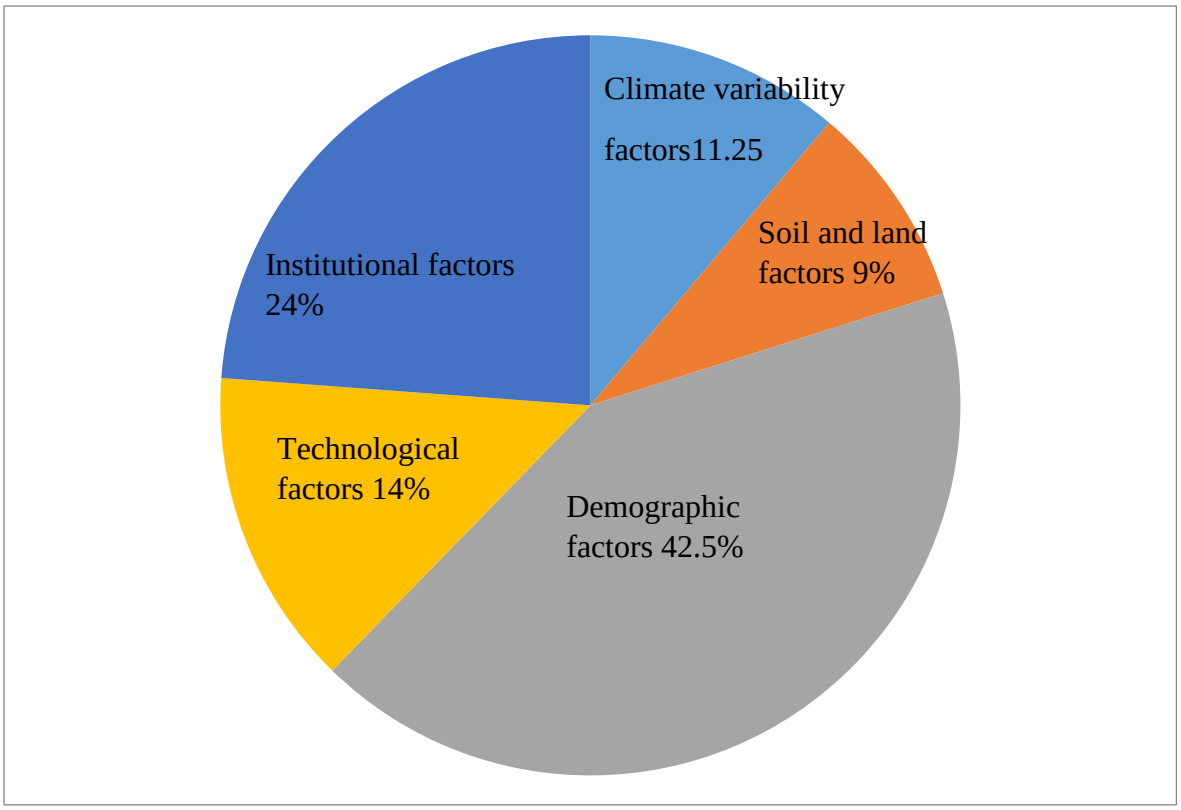


Figure 4.8: Perceived underlying drivers of LULCC

Source: July, 2021

Figures 4.8 and 4.9 portray the perceived drivers of change in LULC, which were assessed by ranking/rating from 1 to 5, basing on the significance or level of change each has caused on LULC classes in Kira Municipality. For Table 4.5 and Figure 4.8 indicate that the most

significant drivers which are the perceived underlying forces of LULCC noticed in Kira Municipality were much related to demographic factors, 42.5%. This means that there is a natural increase in human population in form of immigration in this area. Demographic factors underpinning settlement factors (perceived proximate driver) have caused a shift in LULC types of this area by clearing of forests and degrading of other land/nature resources to acquire land for human settlements. Some of the causes and effects can be identified in Figure 4.1.

Technological factors were ranked 14%. This is identified by the use of technological equipment in the industrial, housing, agricultural and wood sectors. For example, it was noted by respondents that tractors are used to clear easily for example wetlands and uplands to create space for industries, settlements and farms through the modification system of intensification and extensification. Technological changes are also exemplified in the sector of forestry identified by chain saws and other heavy tools for processing of wood. For example timber is processed in the manufacture of furniture products for socio-economic sectors using sophisticated tools from the technological sector. Institutional factors (24%) include policies on LULC and economic development, shortage of sufficient governance systems, issues or concerns of free resources and rights to property, landless farmers' motility as well as ownership of land are perceived as the key driving factors of LULCC. This was considered on account that there is limited supervisory work done on land resource and its nature resources (lack of institutional framework).

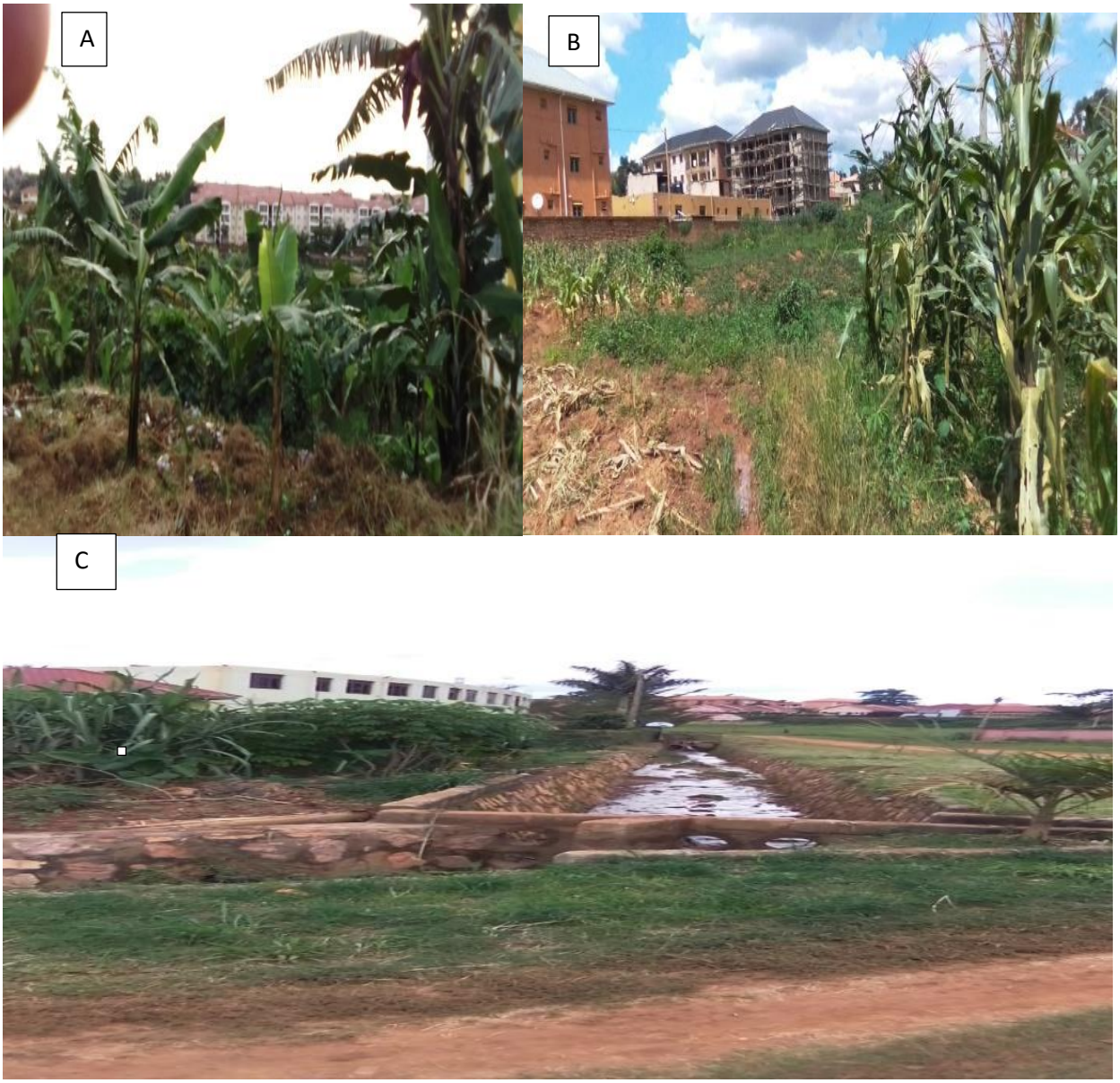


Plate 4.1: Formal settlements and farming extensions at selected sites (A-Naalya; B–Kira; C-Kyaliwajjala)

Source: Field Observations, May, 2021

Other perceived underlying drivers included climate variability factors rated 11.25% and soil and land availability factors rated least with only 9%. Climate was underrated because respondents claimed that settlements are no longer attracted by the climatic factors in this area. The support for this argument was that very few people nowadays are employed in farming due to the

changing weather patterns coupled with the reduced farmland as visualized in LULC transitions in Figure 4.1 A-E.

Similarly, soil and land availability factors were rated so low on grounds that the acreage for farming is now too small. Therefore, a few of the farmers employed in this sector do mainly subsistence farming, portrayed in Figure 4.1 B & E, 2020; Figure 4.2-C and in Plate 4.1 above. Additionally, many of these farmers were identified as squatters and incur costs of applying fertilizers on their farms for any better harvest.

4.3.2 The perceived proximate drivers of LULCC in Kira Municipality

Table 4.6: Descriptive Numerical Data of the perceived proximate drivers of LULCC

Rank	Drivers	Frequencies	Percentage (%)
1	Settlement	41	51
2	Industry	**12**	**15**
3	Infrastructure	12	15
4	Commerce and recreation	10	13
5	Farming	5	6.25

Source: Field data, 2021

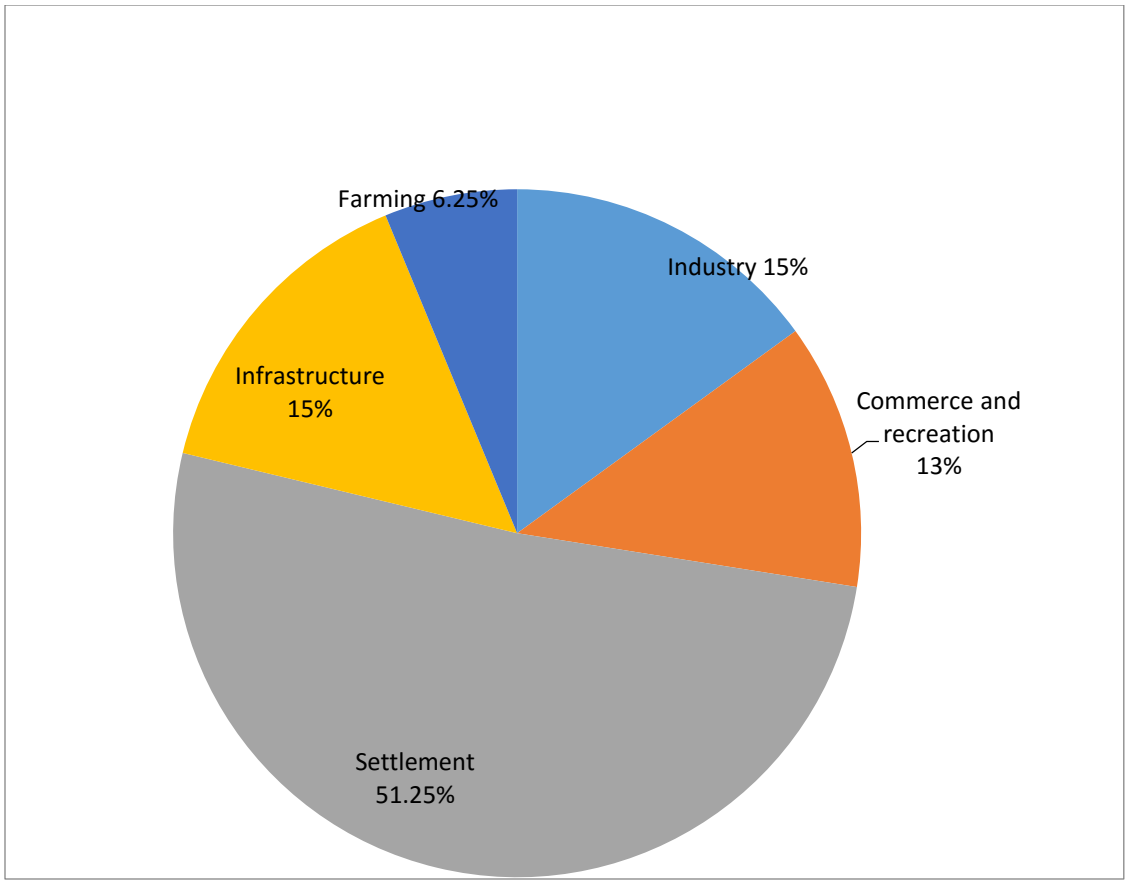


Figure 4.9: The perceived proximate drivers of LULCC

Source: July, 2021

The results in Figure 4.9 above indicate that the perceived proximate drivers of LULCC have been significantly caused by the increase in human settlements and the associated Land Uses. These have taken up the land which was formerly used for farming and forestry visualized in Figure 4.1 A-E, 2001. This justified the lowest rating of farming factor with 6.25% in Table 4.6. The transitions here depict that the level of drive, farming causes on Change of LULC in this area is minimal. This is because, it is surviving in small areas of the North, mainly in the study sites of Kijabijo and Nakwero evident in Figure 4.1 B and E. Commerce and recreation (13%) for the past 21 years have partly caused change in LULC of this area. These were supported with reasons that commercial and recreational facilities have been set-up in this area. This has been caused by the limited land for expansion given their usefulness in providing people with employment opportunities and services (Figure 4.1 A-E, 2010 & 2020).

Plate 4.2: Industrial, Commercial and Infrastructural systems at selected sites (A-Naalya; B-Kamuli)

Source: Field Observations, May-June, 2021

Additionally, it has been observed that settlement expansion has taken a centre stage in the transition of LULC in Kira Municipality. This means that the land acreage has reduced to sustain today's population of this Municipality. This is why many settlements today are found occupying reserve areas like wetlands and forests evident in Plates 4.1 and 4.3. Indicators of transition in LULC in the five study sites were significantly caused by the establishment of settlements justified in Figure 4.1 A-E. The respondents rated it highest (51.25%) on account that the cost of owning a piece of land in catchment areas, is very low. Furthermore, in an attempt to create job opportunities for the unemployed, mainly the youths, have contributed to the draining of catchments and cutting down of forests to setup industries (15%) identified in Plate 4.2; Table 4.6 and Figure 4.9.

Plate 4.3: Settlement and its effect at selected sites (A- Kyaliwajjala; B-Naalya)

Source: Field Observations, May, 2021

Picture evidence reveals how reserve /nature areas have been altered to establish infrastructure to serve the growing population which was rated 15%. This justified that the Northern part/zone in particular Kimwanyi ward specifically Nakwero and Kijabijo cells/ sub- wards of this Municipality, during field survey was inaccessible in the early years of 2000. This is evident in Figure 4.1 B and E, 2001 and today; changes in infrastructure in particular, the road systems in these areas are evident in Plate 4.4 (B&D).

Plate 4.4: Recent/Under construction Infrastructure at selected sites (A-Upper estate-Naalya road; B-Kitukutwe-Nakwero-Gayaza bridge and road; C-Northern by pass road at Naalya round about; D-Kijabijo-Natonko road)

Source: Field Observations, May-June, 2021

Plate 4.4 above indicates that some of the formerly inaccessible areas/parts of this Municipality such as Kimwanyi, Nakwero, Kijabijo to mention but a few, are now easily reachable. This is because of the numerous road systems for example Kitukutwe-Nakwero-Gayaza; Kijabijo-Natonko; Kiwologoma-Kimwanyi; Najjera-Kirundambaata roads and others, have been constructed. These have been set up across the Municipality connecting to most of the neighbouring towns like Kampala and Mukono purposely to serve the increasing settlements/population and their associated livelihood activities in this area. Other infrastructure established in this area include bridges, water and sewage systems (Plates 4.4 B & 4.6). All these identified infrastructure were established due to the expanding urbanization and their associated effects/Land Uses (Figure 4.1 A, C & D, 2020). These have in turn contributed to the alteration of the LULC in this Municipality.

4.4 Impact of LULCC on people's livelihood types in Kira Municipality

The assessment of objective 3 about the impact of LULCC on people's livelihood types. Livelihood types and their associated benefits/ positive impact. This was carried out using the socio-economic survey tool-household questionnaire. The results were statistically summarized in Table 4.7 given here under for analysis.

Table 4.7: Rating of people's responses on the impact of LULCC on people's livelihood types in Kira Municipality

		Priority/Level of measure			
Rank	**Livelihood types/benefits**	**% High**	**% Moderate**	**% Low**	**Total**
1	Transportation work/services	82.5	17.5	0	80/80
2	Building and construction	62.5	30	0	74/80
3	Trade	40	45	3.75	7/80
4	Public work/services	37.5	45	10	74/80
5	Manufacturing	31.25	56.25	7.5	76/80
6	Automobile maintenance and sales	25	55	8.75	71/80
7	Mixed farming	21.25	25	46.25	74/80

Source: Field data, 2021

Table 4.7 above portrays that out of the 80 respondents investigated with expected feedback given in three ways, were: high, moderate and low. They rated each livelihood type (ranked each of them) how they benefit people's lives and the environment. The impact of LULCC in this Municipality range from economic, social and political in nature.

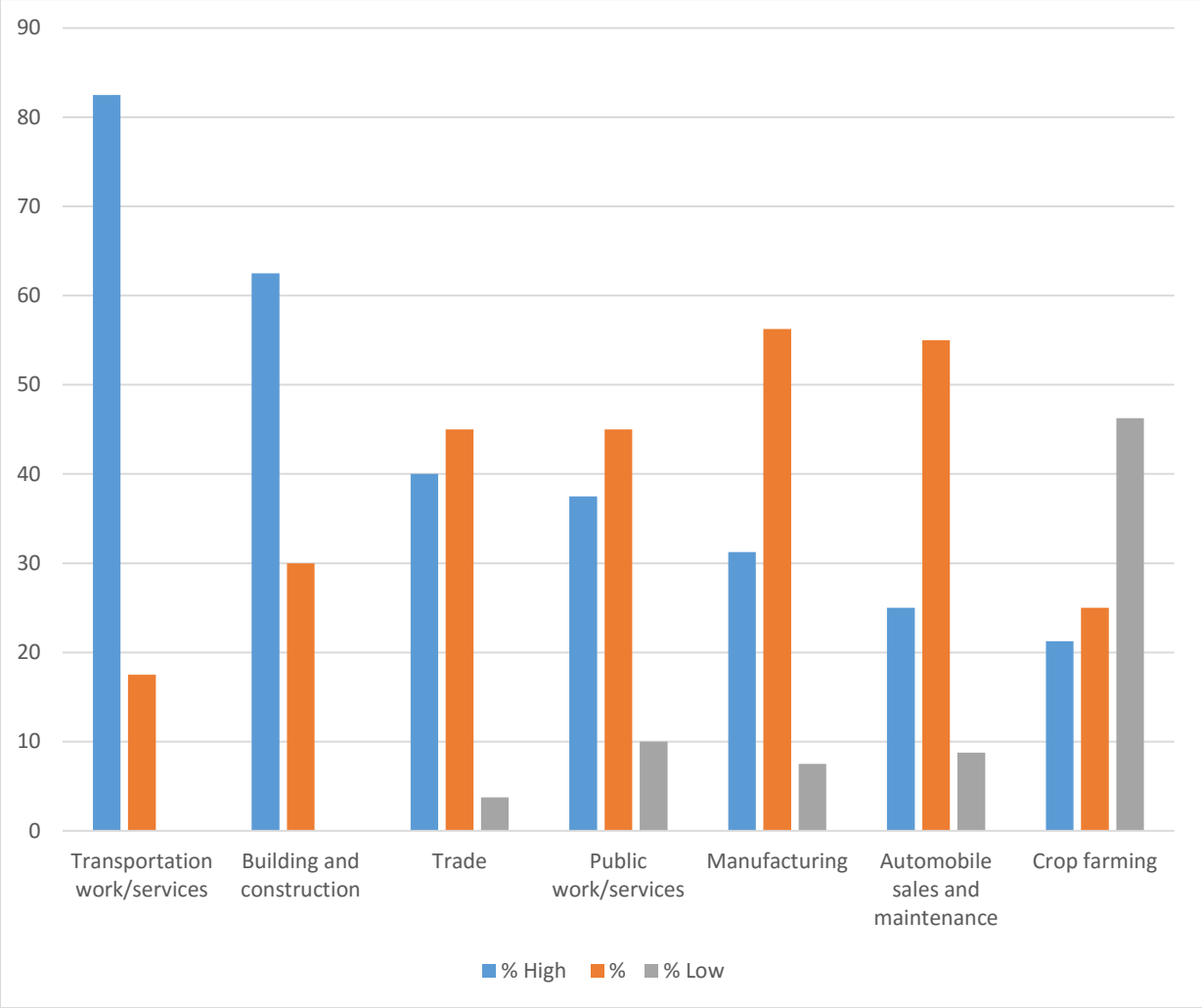


Figure 4.10: Impact of LULCC on people's livelihood types in Kira Municipality

Source: June, 2021

The findings show that transportation work/service with over 82.5%, was the lead livelihood type/employer in Kira Municipality. The majority of household respondents clarified that series of access roads including the Northern Bypass links between Naalya and Kiwatule, Naalya and Banda, Kampala and Jinja road attachment at Naalya Round About in Kyaliwajjala ward. The other road networks connecting through Kira Municipality include Kamuli-Banda; Najjera-

Kirundambaata; Najjera-Kira; Kira-Kasangati; Kitukutwe-Nakwero-Gayaza; Kiwoologoma-Kimwanyi-Gayaza and Kijabijo-Natonko have been set up in this area due to the changing LULC. These roads from this Municipality connecting various places, have eased transport and communication (transportation) work/services here. Many people earn a living working or serving as drivers, transport managers, conductors, road side and taxi park sellers of goods and services among others.

All those roads mentioned above, were constructed in and across Kira Municipality to serve the growing population in facilitating trade, industrial/manufacturing, public work and services. Built-up Land Use type ranked second highest represented by building and construction (Figure 4.10) and highest of all the LULC types (Figures 4.2, 2011-B & 2021-C; 4.4 & 4.5) and also vividly identified in Figures 4.1 A, C and D; 4.8 and 4.9. Another justification is identified in Plate 4.4. The socio-economic infrastructure established in this area aiding the transportation activities to boost the social, economic, cultural and political activities/services, in turn, sustain people's livelihood sources.

Next in rank is building and construction represented over 62.5%, which justified that today a number of people are workers in brick laying, house and road construction, painting, portering, real estates to mention a few. The infrastructural and settlement factors followed one another in Figure 4.1 A-E, 2020 and Table 4.5. This was so because an influx of migrants who work in the manufacturing, construction, commercial, public work and service sectors reside here. Therefore, building and construction work/services have been attracted in this area because of the ongoing changes in LULC. The same livelihood type/source produce all the socio-economic infrastructure or facilities for housing and accommodation, transport and communication, trade and commerce, offices for public work among others. Additionally, it has been discovered in this study that this area is a residential area for Kampala and Mukono urban and industrial centres. The low income earners of clustered settlements, slummy or semi-slummy in nature, especially in the Upland South of this Municipality, reside here. Investors also are given land freely or at a very low cost purposely for industrial and infrastructural development under building and construction to serve and benefit the growing population/settlements here. This was further discovered during the field survey (Appendix A feedback) and also reflected in Plates 4.1-4.4;

Figures 4.2, 2021-C; 4.5, 4.7; 4.1 A, C and D; 4.8 and 4.9. This directly or indirectly determined people's livelihood types/sources.

Another livelihood type was trade, rated above 40%. The respondents here rated nearly half of the total percentage of the responses justifying that a moderate number of people are now a days employed in both retail and whole sale trade in Kira urban and pre-urban areas respectively. LULC changes have led to transitioning of Land Cover mainly forests and wetland to Land Use in particular built-up land consisting of commercial facilities/buildings, market/trading centres, taxi/bus parks and others, which are the main centres where selling and buying of goods and services are done. It was also noted that in Kira Municipality many people today are involved in street and road side vending of goods and services, hence earning a livelihood to them. This was justified by one respondent from Kyaliwajjala ward (Appendix A feedback) wrote "I for one do mediate in land selling and buying, grow crops in my garden and sell it to traders in the market and also have a mobile money kiosk. These have improved my earning status since 2005.'' This means that some people integrate trade activities to better their livelihood status in this Municipality.

Furthermore, public work/service was rated fourth with over 37.5% which is provided by both government and the private companies. For example, many people are employed by security companies or government departments in this Municipality to work or offer a service of overseeing the housing estates, industries and other socio-economic infrastructure. This implies that directly or indirectly has created a peaceful atmosphere and security to the people working and living with in this area. The findings obtained during transect walk and the visualized Figure 4.1 C, 2010 and 2020 are evident that this area is dominated by clustered settlements in the South, while the sloping Central has a number of planned/grid and linear settlement patterns (Figure 4.1 A & D, 2010 & 2020). These settlements offer several public service opportunities such as health care services, educational services and security opportunities to the entire population. This is affirmed by the rising population/housing development and a series of new socio-economic developments/infrastructure for the betterment of people's living standards or livelihoods being brought about by LULC transitions in the area.

It was also discovered that the manufacturing sector has created various job opportunities for people here and was ranked number five with over 31.25% although it was rated with nearly a

quarter of the total percentage of responses. This was underestimated that very few professional engineers and technicians are employed and the majority who are employed as porters /casual workers are paid meagerly in the processing plants/industries. However, a number of respondents gave examples of industries, both local/cottage and national ones in this area such as Basco paints in Kamuli, Buddu metal fabrication works in Kira etc. These employ many people including those who work in the eating and drinking joints (areas) near these industries and the transporters also benefit by offering the transport services to industrial/manufacturing sector (workers). This means that many people employed in the socio-economic services/sectors mentioned above, their standards of living (SOL) have improved indicated by the transitions seen in Tables 4.1-4.6; Figures 4.3-4.5, 4.7; 4.1 A-E, 4.8-4.10; Plate 4.2 respectively.

Automobile maintenance and sales type, was ranked sixth with over 25%. This is justified by motorcycle, motor vehicle, motorboats, and bicycle sales etc and their spare parts. These have been established in the service centres of trade and commerce mainly in the three wards of Kireka, Kyaliwajjala and Kira. Some respondents in support of this livelihood type, identified example of this as spare parts shops and garages found in the busy areas of trade and commerce such as Naalya, Kamuli and Bulindo. These are largely owned and managed privately by individual persons or group companies. These employ mainly family labour because they are primarily owned by families as family names are labeled on most of them. Field observations made backed up by some feedback responses from the questionnaire showed that this livelihood sector is a small scale business venture and it's a new/recent one which was evident in Kira TC. This is why it scored a low percentage from the questionnaire feedback because a few workshops are found here and employ also very few mechanics and technicians as noted by one of the respondents.

Lastly, crop farming registered over 21.25%. This was justified by one respondent who wrote "Very few people today are employed in farming here apart from some rural parts of Kimwanyi because most parts of this Municipality are urbanising''. This was also supported with reasons that food crops grown here are sold expensively due to high demand for them. The subsistence nature of farming carried out, cannot sustain the exploding population here. This is why it was the least prioritized/ranked with the lowest percentage of less than a quarter of the total number of responses, especially in the Southern and Central parts unlike the Northern parts of this

Municipality. This means that there is food shortage in the area due to the reduced farming land versus the rising population (settlements and the affiliated infrastructure). The results shown in Tables 4.1, 4.2, and 4.6; Figures 4.2 2021-C, 4.5, 4.1 A-E, 4.8, 4.9; Plates 4.1 and 4.3, confirm the identified above. However, those who are employed in this livelihood type earn big due to increasing urbanization and its effects on people's livelihood and the environment.

4.5 Discussion of Findings

4.5.1 Land Use/Cover Change (LULCC) from 2000 to 2021.

Objective one was set to determine the extent of LULCC in Kira Municipality between 2000 and 2021; a number of digitized images were processed using the gathered information/data. A Classification System of four LULC types was formulated for the intentions of the research study and identified and drew demarcations of polygonal shapes of the classes. LULC area coverage were as follow: Initially the area covered by built-up land (in 2000) was 13.29% of the total land area of which was the smallest, greatly increased to 36.3% to become the second largest in 2011 and continued to raise to become the largest of all LULC types/classes with 46.8% in 2021. Farmland in 2000 was the largest of all the LULC types with 44.2%, but later in 2011 sharply decreased to 24.2% and slightly increased to 29.9% in 2021. The forest land had initially 16.5%, which steadily increased to 25.9% in 2011 and grossly dropped to 5.3% in 2021 becoming the smallest LULC type, whereas the wetland initially was the second largest in area cover with 25.87%, decreased significantly to 13.3% emerging the smallest LULC type in 2011 and slightly increased to 17.7% in 2021.

In the initial years of 2000 to 2011, the highest LULCC rate was experienced in built-up land at 23.01% followed by forest land at 9.4%. Thirdly in LULCC rate was wetland at -12.57% and lastly was farmland changed at the rate of -20%, whereas between 2011 and 2021 the highest LULCC rate was still experienced in built-up land at 10.5% followed by farmland at 5.7%, third, was wetland at 4.4% and lastly was forest land at -20%.

Statistical analysis from Table 4.2 indicated that the extent of acreage of forest land showed a percentage change of 9.4% from 2000 to 2011 and greatly changed/declined to -20.6% from 2011 to 2021.The unsteady trend in the farmland from -20 % between 2000 and 2011 to 5.7% between 2011 and 2021. Similarly, wetland changed from -12.57% between 2000 and 2011 to 4.4% between 2011 and 2021. The tremendous percentage changes above are attributed to the

continuous raise in the percentage change of the built-up land from 23.01% to 10.5% respectively, which accounts for the loss of wetland, forest land and farmland LULC types. From these findings, it's clearly seen that man's encroachment has significantly impacted on the reduction of the acreage of the Municipal land resource and its natural resources mainly wetland and forests. These human activities have significantly contributed to the transitions in LULC in this Municipality (Tables 4.1- 4.2, 4.5 & 4.6). This is affirmed by the findings quantified from Table 4.1, which showed that Kira Municipality lost her Land Cover of wetland and forest land from 42.37% in 2000 to 23% in 2021 to the great gain of the Land Uses of built-up land and farmland from 57.49% in 2000 to 76.7% in 2021. All these Land Uses of built-up and farmland are human induced activities driven by population pressure indicated in Figures 4.1 A-E, 2020; 4.5. These are solely caused by the expanding settlements and their associated socio-economic developments.

The findings above concur with Ochola (2005) who observed that land/earth resources are largely endangered by deadly imbalances, in environmental unity and productivity as well as experiencing fast change with land resource position lagging behind the sectors of social and economic progress. For example, Lake Victoria basin exhibits both highly spatial and temporal variation in Land Cover which is accounted on Land Use/human activities mainly population growth overtaking land productivity. Similarly, Kira Municipality is experiencing serious industrial, infrastructural, commercial and recreational progress for provision of job opportunities and services to the increasing population. These are highly responsible for the LULCC in this area.

The classified LULC maps revealed a change of LULC over the period of 21 years with a wide gain in the built-up area and a decline in wetland, farmland and forest land (Table 4.1 & Figures 4.2-4.5). The analysis also depicted that the pattern of LULCC in this Municipality is not uniform in spatial distribution. In reference to the analysis of LULCC, there has been a great increase in land degeneration, especially in the South of Kira Municipality, which is a raised land and in the Sloping Central. This has been realized because of the Land Use transitions, tremendously providing good natural resources mainly the vegetative cover. This has been predominately lost to settlements/built-up land and farm/crop land encroaching into the wetland

parts of this Municipality. The continuous growth of trading centres in its wards, has affected the LULC in this area due to the trends caused by urban-rural connections.

Furthermore, the analysis for transitions (Table 4.3-4.4 & Figures 4.6-4.7) showed that the extent of transition from forest land to built-up acreage and farmland was greater from 2011 to 2021 than in 2000 to 2011. This indicates that the level of transition of built-up acreage in particular, is grossly and steadily increasing unlike the rest of the LULC types. These transitions are also clearly justified in Historical Google Earth images (Figure 4.1 A, C & D) which depict a great vegetative cover loss being taken up by the built-up Land Use such as parking lots, mines, dumping sites and others. This is accounted on urban expansion indicating that there is an increase in population in the area. These confirm what Kamukasa and Bintoora (2014) observed that in the past years, much of the issues have been on the increased demolition and alteration of wetlands to different classes of Land Use for instance farming and settlement. Relatedly, Kira Municipal Development Plan (KMDP, 2019) asserts that wetlands have been destroyed or altered through pollution change as in local drainage, conversion to farmland or other uses including human settlement.

The above justify what Lambin (2003) and Chiwa (2012) noted that the Assessment of Land Use Change essentially depends on the relationship between rural and urban settings i.e. rural-urban connections. The rising levels of urban sprawl indicated on the 2021 LULCC maps (Classified maps) and Historical Google Earth images of 2020, raise the demand for land for settlement development. The implication here is that there is increased food and water scarcity in this area as justified by the high cost of living exemplified by the high prices of food stuffs identified in the questionnaire feedback.

Results also confirmed that settlement expansion was the leading rated 51.25% because majority number of respondents asserted that there is high level of urbanization (population explosion) to settle the excess numbers of people, have caused both informal and formal settlements in this Municipality. The reason given here is that 21 years ago, this area was intact especially in the Northern parts from Nakwero to Kijabijo seen in Figures 4.3 and 4.4. Just as it has been documented by other researchers for example, in the neighbouring Lubigi wetland, it was confirmed by Omagor and Barasa (2018) that the leading drivers of this wetland encroachment was population explosion. This confirms these findings that most parts of the South and Central

zones for instance, Kamuli, Naalya, Kyaliwajjala, Kira, Bulindo and Najjera have settlements established in the most parts of the wetlands in this Municipality due to population explosion resulting from urban expansion.

In the initial years 2000-2011, built-up land gained sharply by 23.01% and between 2011 and 2021, averagely gained by 10.5%. This negatively impacted the forest land and farmland (LULC types) because of their unstable trend in area use/cover, but built-up land continuously increased. This justified that some of the built-up land including buildings, road systems, parking lots and recreational grounds took up an average land area of the forested and farming areas/land in the 21years study time. The results further showed that the wetland lost its area/land cover in this area during the 21 years study. For example, from 25.87% in 2000, was the second largest LULC type in Kira Municipality to 13.3% in area cover. This became the smallest of the four LULC types, tremendously reduced by almost half in 2011. This was lost (-12.57) to built-up land because this gained more by 23.01% this same period. Although the wetland gained slightly to 17.7% in 2021, but still lost in general 8.17% to the built-up land just like what happened to the forested and farmland, continued to increase significantly to 46.8% in 2021. This indicates that some of the wetland areas were reclaimed for industrial, commercial, residential, parking lots, recreational and transport systems and services to sustain the increasing settlements in this Municipality.

Infrastructure such as the road network increased in Lubigi wetland because of the extension work of road construction involving Entebbe express high way as well as the Northern Bypass (Mhonda, 2013; Omagor & Barasa, 2018). This same road network was also constructed through the fringes of Nakalere wetland in Namugongo division at Naalya Round About serves (connects) the areas of Upper estate, Naalya, Kiwatule, Banda and Kamuli. There are other road networks of Kitukutwe-Nakwero, Kiwoologoma-Kimwanyi-Gayaza, Najjera-Kira, Kijabijo-Natonko, Kirundambaata-Najjera, Kira-Kasangati, all cross this wetland and greatly have led to its draining and so a change in LULC in Kira Municipality.

The greatest estimated change of Kira Municipality during the years 2000 and 2021 (21 years), is the decrease in the forest land cover area that sharply reduced from its initial extent of 16.5% to 5.3% as well as farmland that greatly dropped from 44.2% to 29.9% and also wetland which

reduced from 25.87% to 17.7%. The result of all those changes, was the continuous increase in built-up land from 13.29% to 46.8%.

4.5.2 The perceived drivers of Land Use/Cover Change (LULCC)

Findings showed that, rising population in Kira Municipality identified by expanding settlements (13%), have imposed significant impact on LULC in the last 21 years (Tables 4.5 & 4.6; Figures 4.8 & 4.9). It was noted that the area (Kira Municipality) had the highest annual population growth rate of 20% from 2002 to 2014 in the entire Country (UBOS, 2014). It was noted by the Government of Uganda, Volume one (GOU Vol. I, 2016) that population pressure/explosion relates with urbanization. It pointed out that urban characters of Kampala City, Mukono and Wakiso Districts clearly demonstrates that land is so valuable, whereby low income earners get evacuated and are compelled to settle in catchment areas like wetlands as the relatively flat lands which are dry, are grabbed for market progress. Similar cause and effect in preserved lands and catchments in and around the City of Kampala was observed (Emerton et al., 2003; Nyakaana et al., 2007; World Bank, 2015; Isunju, 2016). This finding affirms Lambin et al., (2003) and Chiwa (2012) about demographic/population change that also means the transition from low to high levels of death and birth rates, instead of only relating with the transformation of house units and characters of series of stages in life of households. The rising demand for land has accelerated the need for built-up acreage because of the fast growing population in this Municipality. This has in turn contributed to the decline in farmland.

Observations made depict that deforestation is on the increase in this area because of the rapid development of human settlements. This has caused a huge decline in the forested land indicative of 16.5% in the year 2000, reduced to 5.3% in 2021 to the gain of the built-up land area, which increased from 13.29% to 46.8% (Table 4.1 and 4.2). Urban expansion has increased the demand for land for settlement. This has become a dominant factor in LULCC in Kira Municipality which was primarily attributed to fast urbanization of Kampala City with its development control procedures (KMDP, 2019). This has put Kira Municipality and its reserve resources in a trap of the “so called investors/ developers” to rush here to establish infrastructure because it was considered being at the periphery of the 16km radius of Kampala. Although the impact of population growth has been supported by the management of the natural resource (environment) by the concerned bodies, this has pushed people to illegal practices, for example, draining the

wetlands for growing of crops to feed the population, get space for shelter, brick making for housing have resulted to the alteration of the LULC in this area.

The findings also revealed that industry rated 15% as a perceived proximate driver of LULCC underpinned by the perceived drivers of institutional factors (23.75%) and technological factors (14%) was accounted on population explosion with its demands for land for shelter, crop growing to feed the rising population and other socio-economic systems to create employment opportunities for the young growing population. These have consequently exerted pressure on natural resources like wetlands and forests to settle those challenges thus changing the LULC of this Municipality. Similarly, Mercer (1991); Phethi and Gumbo (2019) contend that urban use is identified as the most significant perceived driver or cause of wetland degradation and loss. This is determined by clearing of wetlands for industrial and road construction. This has also been clarified by Nyakaana et al., (2007); Banandda et al., (2009); KCCA (2012); Isunju (2016) that government of Uganda has been draining important apportions of nature reserves and catchment areas such as wetlands to establish road networks, industrial parks and the latest being the programme of converting wetlands into urban parks in the City of Kampala. This was primarily done in abide to draw the attention of investors, create employment opportunities coupled with fighting neediness.

The results further identified infrastructure rated 15%, one of the perceived proximate drivers. These are underpinned by the institutional such as the limited supervision, demographic and technological factors. A number of infrastructural systems have been set up in this Municipality to serve the growing population having been attracted by the expanding urbanization. Therefore, numerous road systems have been established in this area and across it. This has been done purposely to create easy access to the area such as the Northern Bypass, Naalya-Kyaliwajjala which serve the South, Najjera-Kirundambaata, Kira-Najjera and Kasangati-Kira roads serve the Central, while Kitukutwe-Nakwero, Kiwoologoma-Kimwanyi-Gayaza, Kijabijo-Natonko roads serve the Northern part of this Municipality, This is justified by the dominant built-up Land Use in Table 4.1 and 4.2; Figures 4.2, 2011-B and 2021-C.

These developments with their associated facilities such as bridges have altered the LULC of this area. This is acknowledged by WB (2015) and UNRA (2011) that large-scale projects of systems that require draining wetlands/catchments, channelization of wetland water and cutting down of

vegetation in wetlands have reduced the wetlands' health and flood absorption abilities. Encroachment of wetlands for road ways and many other system construction, especially along the Northern Bypass has too, lowered the potential for example, Lubigi catchment to capture, store and dissipate storm water. Similar establishments have been recorded in Nakalere catchment of Kira Municipality causing change in LULC of the same above.

Another observation made showed that LULCC in this area is due to the perceived proximate driver of commerce and recreation (13%). This has been caused by land availability in and around catchment areas of this Municipality to set up market or trading and recreational facilities. This was based on grounds that acquiring land here is easy and cheap because the process involved is short. This leaves no doubt why this Municipality has been changing its LULC over the past 21 years. This confirms what Omagor and Barasa (2018) noted that in areas of urban setting, especially Kampala City area, wetlands (catchments) for example Lubigi are identified as the most inexpensive areas for development of industries, agriculture and settlements thus, transformed into farmlands or else have slowly been overtaken by the slummy or semi-slummy residences and their related uses for instance farming. This is evident in the Southern parts of this Municipality mainly in Kamuli and Kireka sub-wards/cells where Nakalere catchment has been changed into slummy or semi-slummy residences and their related uses including industrialization and farming.

Lack of institutional framework (24%) in this Municipality has made land and its nature resources very vulnerable to change in LULC in the past 21 years, since the concerned bodies have 'paid a deaf ear to their degradation. Pressure for land by the exploding population to settle its excess numbers, conserve farmland for food and trade, industry, commercial and estate land for trade or earning have looming pressure on land and water resources. This clarifies what was observed by Chiwa (2012) that changes in LULC in particular catchment areas are a result of unfavourable policies as well as shortage of institutional implementation. Additionally, population pressure, poor implementation of laws and limited space/land have contributed to land fragmentation. Lambin et al., (2003) also observed that the increasing population within the catchment exerts pressure continuously on the ecosystem such as the vegetation cover and water resources due to shortage of leading developments in the utilization of inputs of natural resources.

Therefore, Water and Land managers have different abilities to take part in and to determine institutions, however, there is a discord sometimes between environmental signals experienced by the micro population/institutions and the macro ones. In this area, institutions are required to relate with international bodies/institutions and national ones, there is need to spot out the micro bridging factors and adaptive mechanisms, considered at different levels. Kira Municipality administration has to therefore cope with these mechanisms suggested by Lambin et al., (2003) to check on the looming perceived institutional driver of LULCC and for the continued maintenance of the ecological habitats.

4.5.3 Impact of Land Use/Cover Change (LULCC) on people's livelihood types

Findings about change in LULC impacting on people's livelihood types in this Municipality were classified into seven and were the perceived people's sources of sustenance or survival that benefit them by providing jobs, income and food though there are little challenges associated with some of them. These range from physical, social, economic, political and cultural in nature. These were recorded from the responses obtained from the socio-economic survey tool – the questionnaire during field survey reflected in Figure 4.10.

The results revealed that the transportation type of livelihood is at the peak in that access roads in and out of this area are established as exemplified in Plate 4.4 and visualized in Figure 4.1 A-E, 2020. These access roads have boosted trade and settlements, manufacturing/industrialization, farming and institutional (supervision) work to be carried out easily and effectively. Therefore, as much as this infrastructure has caused a great change in LULC of this area, they significantly impact on human livelihoods. This implies that some people have got jobs, as drivers, motor cyclists, road constructors, transport administrators, conductors, hoteliers and others have had their earning (income) levels changed or improved, hence better living standards. Generally, the lives of people in this area have been made easy, safe and comfortable due to improved transport and communication systems (good transportation services).

It was noted that LULCC in this Municipality has resulted into the establishment of building and construction sector which sustains numerous livelihoods. This has contributed to improved housing to settle the escalating population in this area, which has been attributed to urban expansion evident in Plate 4.1 and 4.3. This is exemplified by close settlements seen in Figures 4.1 A, C-E, 2020. This area has attracted a large population of migrant labourers from rural areas

and other urban centres to offer building and construction work and services among them include brick laying, carpentry, painting, plumbing, portering and others. This has caused a wide range of infrastructure, industries, commercial and recreational systems to be easily set up here to enhance trade activities and support human settlements. The implication here is that secondary employment for many people is offered by the housing sector. For example, housing estates employ house managers, house mediators/brokers, landlords/ladies and security officers.

Furthermore, the results showed that because of increased urbanization evidenced by improved housing and accessibility in this area, trade has been highly boosted. For example, the crops, fruits, fish and vegetables grown/farmed in this Municipality are locally and expensively sold. According to various responses got when asked about the cost of living. It was confirmed to be high in spite of its increasing population. Respondents confirmed creation of many trading and market centres made up of shops, kiosks, stalls and stores for food, vegetables, drinks and other merchandise. These have been set up mainly in areas of clustered/congested settlements for example the slummy and semi-slummy parts of Kamuli, Kyaliwajjala and Kireka because the demand is high/readily available for the goods sold there. These have created several trade and commerce opportunities for local communities to boost their sustenance.

The above agrees with Malaki (2018) that the communities of the area were capable to realize some positive effects related to change in LULC. The positive impacts originating from declining forest cover include the rise in production of food, empowerment of farmers economically and jobs for local people in horticulture. The readily accessible water is a potential for irrigation, which has too driven numerous settlements here, especially immigrants where majority of them come in for farming purpose. The rising settlements have contributed to the rise in supply of fundamental services connected with the need from rising population for example, educational institutions, health centres together with local trading centres/markets. In Uganda today, these innovations have forced initiatives from diverse institutions plus NGOs concerned with keeping the nation green, National ones such as NEMA and many other multinational ones. These organizations have established plans to recommend for sustainable utilization of resources ready to amend the livelihoods of people at local level. Similar initiatives have led to a significant amendment of people's livelihood types in Kira Municipality.

CHAPTER FIVE

SUMMARY OF RESULTS, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Results

5.1.1 Objectives of the Study and Methodology

In determining the effects of LULC Change on people's livelihoods in Kira Municipality, Central Uganda, these objectives were set for study:

To determine the extent of Land Use/Cover Change in Kira Municipality from 2000 to 2021.

To establish the perceived drivers of Land Use/Cover Change in Kira Municipality.

To assess the impact of Land Use/Cover Change on people's livelihood types in Kira Municipality.

Qualitative and quantitative research techniques were applied in the study. Non-Parametric Tests, Descriptive Numerical, Analysis of Change Detection and Time Series were applied. Remote Sensing (RS), GIS and other equipment were in co-operated in assessing the perceived drivers and impact of LULCC on people's livelihood types provided important information and understanding of the research problem.

5.2 Summary of key findings

Generally, the three LULC types namely: wetland, farmland and forest land decreased during the study period, whereas built-up land continuously increased. The change in LULC in Kira Municipality has been imputed on intensification and expansion of urban development with its affiliated activities including extension of settlements, industry, infrastructure, farming, commerce and recreation to serve the rising population. Landsat images (Classified images) in the study period of 21 years across this Municipality portrayed a tremendous increase in only built-up land by 33.5%, while the rest of the LULC types decreased. For example, Wetland dropped by -8.17%, farmland reduced by -14.3% and also forest land reduced by -11.2%.

The study also showed that the development was caused by demographic factors under the umbrella of urbanization underpinned settlements, grossly contributed to LULCC in this area. Other perceived drivers included institutional factors such as the supervisory work underpinned farming, infrastructure, industry, commerce and recreation; technological factors; climatic

variability as well as soil and land availability factors underpinned all of or some of the identified under institutional factors. These results correspond with what Landsat image analysis discovered and the Historical Google Earth images showed, that the dominant LULC type is the built-up land, especially in the South and Central zones, is exactly what was identified in the questionnaire. This tool too, showed settlement factor as the lead perceived proximate driver, while the demographic factors were the leading perceived underlying driver of LULCC in this area (perceived underlying drivers underpin the perceived proximate drivers).

During the study period, it was found out that LULC Change impacted on livelihoods by influencing human livelihood types which were largely positive because they are the greatest employers of the majority of the population and so sustaining numerous lives in this Municipality. According to the respondents' ideas, perceptions and views given, for example, the leading ones were: transportation, building and construction and trade work/services. These determined the possible recommendations to mitigate the challenges faced by people in this area and for proper planning, utilization and conservation of land resource and its nature resources included modification of drainage systems; proper planning and demarcation of all nature resources; strengthening the institutional framework; sensitization and policing of the neighbouring communities to nature resources and fencing them for their proper conservation and utilization.

5.3 Conclusion

The results showed that the major LULCC in the study period of 21 years in Kira Municipality, were primarily ascribed to the extension of settlements, infrastructure, industry, farming, commerce and recreation which is the built-up land in general. These changes have had majorly positive impact associated with people's livelihood types in this area.

It was discovered that all the livelihood types/sectors have created job opportunities for the largest population in this Municipality. This was supported on grounds that unemployment issue is no longer a big problem because very many building and construction sites, industries, transport and communication, trade and commerce and public service sectors established in Kira Municipality have given jobs to people. This means that many people employed in the socio-economic services/sectors mentioned above, their incomes and standards of living have improved identified by better housing and infrastructure.

The findings clarified that increased infrastructural networks identified by series of access roads, which have been set up in this area connecting to various places near and far, have eased transport and communication here. These include the Northern Bypass linking between Naalya and Kiwatule, Naalya and Banda, Kampala and Jinja High way attachment at Naalya Round About in Namugongo Division among others. All these roads mentioned above and others, are constructed in and cross Kira Municipality in order to serve the urbanizing area and its rapidly growing population. These roads facilitate trade, public work, and industrial and other service activities. The socio-economic infrastructure established in this area therefore boost the social, economic, cultural and political activities/services, which in turn impact positively on people's ways of living directly or indirectly.

The study showed that the changes in LULC brought in livelihood opportunities which resulted into better living standards of many people identified by numerous improved housing facilities and services under building and construction sector to settle the escalating population in this area. This has been attributed to urban expansion evident of a series of large housing estates to accommodate the influx of migrant labourers working in various sectors of this Municipality and the neighbouring urban areas of Kampala and Mukono. This is sustaining a number of livelihoods in this area today.

The study also revealed that there is likelihood of more LULCC to take course as more area acreage is transformed over a period of time, especially forest land to built-up area, wetland to farmland, farmland to built-up area, wetland to built-up area. This endangers the presence of sources of water, especially the prospectus Kira Municipality as was discovered through the Remote Sensing (RS) coupled with Geographical Information System (GIS) techniques. This gives a possibility to Kira Municipal Administration especially Land and Nature resource managers of keeping track of its land uses and their resources (Kira Municipality Land Use and Land Cover) with Remote Sensing.

The findings also revealed that detection and evaluation of the perceived drivers and impact of LULCC contributed to a probable suggestion for a remedy, which is supported by the Geographical Information System. The best alternative to change these rising problems and to properly preserve and utilize land resource, incorporated convergent thinking approach or avenue through recognizing the collection of applicable stake holders for instance from the Ministry of ICT and Security. These should come up with a plan of applying information technology to easily monitor both urban and rural resources from policy/action plan level to the grass root community level, which is a

worthwhile idea for the revival of the degrading land and its nature resources especially wetlands and forest reserves found in the urban areas of Uganda.

Those who have a right in urban planning and development (administration) and any nature resource management for example forests and wetlands, should collaborate and play their role for example communities, government, private sector and others. Higher level decision makers are obliged to reinforce sustainable resource management campaigns by encouraging capacity building drives, implementing policy together with law enactment, improving institutional arrangements. It is right to reevaluate the importance of these resources likewise their neighbouring communities for the progress of the Municipality and the entire country as well as the impact of resource/land degradation.

5.4 Recommendations

Stakeholders and those who live in this Municipality necessitate to be alerted of how to decently and sustainably utilize land and its nature resources. It is necessary to be apprised on the proper utilization and conservation of these resources by sensitizing strongly and policing them in order for them to inhabit comfortably and invulnerable close to or in these resources. Therefore, they end up developing a sense of authority by their preservation rather conservation. Therefore, physical planners in this Municipality should foster vertical housing development instead of spatial development in order to check on the future effect of the rapidly growing population on land resource.

Building of roads campaign has to be given approbate rules and regulations by principal agencies for example the Municipal Planning Authority/Board and UNRA which are in charge of providing development-licenses. These agencies should be able as provide a proper way of building and constructing roads that continue to encourage the flow of water in and out of this Municipality. Housing estates (settlements) should be constructed with plan following urban development plan involving the modernization of drainage channels to avert increased storm water runoff, soil erosion and floods. This will ensure that land and its resources continue to perform their duties to the goodness of the entire surroundings.

In order to rise the accuracy of the classification, finding High Resolution images coupled with the Multi-temporal Ground Truth data should be done by the Municipal Environment Officer and NEMA. This calls for considering other factors including cementing relationships with

stakeholders, supervising land users' relationship as well as the rating of frequent management programmes for land and its nature resources in consideration of the results obtained.

The Municipality land and its resources should be demarcated with borders clearly defined after properly surveying them. This is to help effluent treatment plant operate decently, the papyrus vegetation and other surface cover plants which are very substantial for sewerage treatment. They need to be planted anew in places where some other Land Covers have already taken course. I therefore recommend that NWSC should consider funding papyrus replanting activities to check on their mistreating the people of Lower Naalya mainly with sewerage flooding and its pollution as already had been recommended by Kansiime et al., (2003) and Omagor and Barasa (2018) for Nakivubo and Lubigi wetlands respectively.

Population increase has tremendously led to urbanization (settlement expansion) in Kira Municipality, for instance there is a sharp increase in population in the growing nearby urban centres like Mukono and the expanding Kampala City. Therefore, there is need to increase the vegetation cover, for example, road side trees, demarcation trees, residential shade trees and others in water sheds. The Municipal Planning Authority should work hand in hand with the National Planning Authority such as UBOS, Ministry of Gender and Labour and MOLHUD to lay down strategies to control the escalating human population and its effects on land and its resources (LULC).

Further still, the rapidly increasing emissions in this Municipality, are attributed to heating and cooling of industrial centres, urban residential, moving automobiles and commercial buildings, which need to be checked through rural and urban forestry. The Municipal Environmental Authority should put in consideration educating the entire population about the usefulness of having a green city to avoid future environmental disasters such as drought and floods.

5.5 Future research gaps

Detailed study should be carried out about the human causes and their effects in response to LULCC in this Municipality using high resolution and more detailed satellite images basing on the use of GIS and RS tools.

Due to the rapidly growing population and increased urbanization, some of their negative effects have been realized especially in the south of this Municipality such as storm water runoff, soil

erosion and floods, there is need to carry out a detailed study in this Municipality about the implications of LULCC on biodiversity richness and abundance.

Future research should also focus on developing premises of Land Use to analyze the effects of Change in Land Use. For this case, three theoretical premises to be spotted out in particular urbanization, infrastructural and industrial developments. Various premises can be introduced by providing percentages of Land Cover and so model developed to feign impact response.

There is need to focus on the quantity and quality of water channeled out/abstracted through lawful and unlawful systems which are required to sustain wetlands (catchments) and their ecosystems.

Further studies should apply a model of spatial distribution of hydrology to feign hydrological divisions to identify and differentiate among Land Use types pertaining various spatial land allotment. Additionally, prospectus studies can as well integrate the effects of Land Use Change on the quality of stream water in this Municipality.

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APPENDICES

APPENDIX A: HOUSE HOLD QUESTIONNAIRE

KYAMBOGO UNIVERSITY

FACULTY OF ARTS AND SOCIAL SCIENCES

DEPARTMENT OF GEOGRAPHY AND SOCIAL STUDIES

HOUSE HOLD QUESTIONNAIRE

Dear respondent,

You have been specially chosen to take part in this study about "***Effects of Land use/Cover Change on people's livelihood types in Kira Municipality, Central Uganda".*** Your contribution may be of significance to unsafe local people by giving information that can usher hazard minimization strategies and proper conservation and utilization of land and its resources. This information will further be of much help toward the success of this study and will be treated with the highest level of confidentiality.

BACKGROUND INFORMATION

Respondent Code: Date of Interview:

Initials of Interviewer: Age group: (18-29); (30-39); (40-49);

(50+).Tick appropriately

Parish: Village:

Years/Period of time you have been here: (5-9); 10-14); (15-19); (20+)

Land tenure ship: (Landlord/Landlady); (Tenant). Tick appropriately

001 Land Use/Cover Change (LULCC)

(a) What was the nature of LULC here in 2000 (21 years ago)?

Code	**Variable**	**Attributes Circle appropriately**			
		Opinion on Extent			
Rank	**LULC TYPES**	**Very large**	**Large**	**Relative**	**Small**
1	Built-up land	1	2	3	4
2	Wetland	1	2	3	4
3	Farmland	1	2	3	4
4	Forest	1	2	3	4
5	Others (Specify)……	1	2	3	4

(b)Which was/were the common LULC type(s) in this area by 2011 (11 years ago)?

Rank	**LULC TYPES**	**Priority/Level of measure**			
		Very large	**Large**	**Relative**	**Small**
1	Built-upland	1	2	3	4
2	Wetland	1	2	3	4
3	Farm land	1	2	3	4
4	Forest	1	2	3	4
5	Others (Specify)……	1	2	3	4

(b) What are the dominant categories of LULC in this area today?

Rank	LULC TYPES	Priority/Level of Measure			
		Very large	Large	Relative	Small
1	Built-up land	1	2	3	4
2	Wetland	1	2	3	4
3	Farm land	1	2	3	4
4	Forest	1	2	3	4
5	Others (Specify)……	1	2	3	4

002 Opinion on the perceived drivers

(a) Perceived proximate drivers

(i) What are the perceived proximate drivers of LULCC in this Municipality?

		Priority	
Rank	Perceived driver	Agree	Disagree
1	Infrastructure	1	2
2	Settlement	1	2
3	Industry	1	2
4	Farming	1	2
5	Commerce and recreation	1	2
6	Others (specify) …….	1	2

(ii) Suggest the reason(s)/indicator(s) in support of or against each of the perceived driver identified in (a) (i) above.

1	Infrastructure…..…… ……..……
2	Settlement …… …….....
3	Industry…… …… ……
4	Farming…… ……
5	Commerce and recreation……..... .....
6	Others (specify) ……..…… ……..

(b) The perceived underlying drivers

(i) To what extent has each of the following perceived drivers caused change on LULC in this Municipality?

		Priority	
Rank	**Perceived drivers**	**Agree**	**Disagree**
1	Institutional factors	1	2
2	Climate variability factors	1	2
3	Technological factors	1	2
4	Soil and land factors	1	2
5	Demographic factors	1	2
6	Others (specify) …….	1	2

(ii) Suggest the reason(s)/indicator(s) in support of or against each of the perceived driver identified in (b) (i) above.

1	Institutional factors…….....…….. ……..
2	Climate variability factors……...…….. …….
3	Technological factors ……..... …….
4	Soil and land factors ……..... ……
5	Demographic factors ……..... ……
6	Others (specify) …….

(a) Justifications

(i) To what extent has each of these LULC changed in this area today?

		Indicator	**Priority/Level of measure**		
Rank	**LULC type**	**Evidence**	**Large**	**Relative**	**Small**
1	Wetland	Thick vegetation cover	1	2	3
		Limited wetland vegetation	1	2	3
		Open wetland	1	2	3
		None	1	2	3
2	Farmland	Large scale farms	1	2	3
		Moderate scale farms	1	2	3
		Small scale farms	1	2	3
		None	1	2	3
3	Forest	Large scale forests	1	2	3
		Medium scale forests	1	2	3
		Small scale forests	1	2	3
		None	1	2	3
4	Built-up land	Industrial centres	1	2	3
		Commercial centres	1	2	3
		Residential areas	1	2	3
		Socio-economic infrastructure	1	2	3

003 Impact of Land Use/Cover Change (LULCC) on people's livelihood types

(a) (i) For what reason(s) was/were each of these land uses established here?

			Rating		
Rank	**LULC/LIVELIHOOD ASSETS**	**Purpose(s)/Reason(s)**	**High**	**Medium**	**Low**
1	Infrastructural development	Easy access Employment Others (specify)…… None	1 1 1	2 2 2	3 3 3
2	Settlement/Residential facilities	Population settlement Trade Others (specify)…… None	1 1 1	2 2 2	3 3 3
3	Industry	Employment Market for local products Trade and commerce Others (specify)…… None	1 1 1 1	2 2 2 2	3 3 3 3
4	Agriculture (farming)	Food provision Trade and commerce Employment Others (specify)…… None	1 1 1 1	2 2 2 2	3 3 3 3
5	Commercial and recreational systems	Trade and Commerce Employment Others (specify)…… None	1 1 1	2 2 2	3 3 3

(ii) How has the above LULC changes impacted on people's livelihood types?

		Priority		
Rank	**Livelihood type**	**High**	**Moderate**	**Low**
1	Building and construction	1	2	3
2	Crop farming	1	2	3
3	Trade	1	2	3
4	Automobile sales and maintenance	1	2	3
5	Manufacturing	1	2	3
6	Public work/services	1	2	3
7	Transportation work/services	1	2	3
8	Others (specify)……	1	2	3

(b) What are the benefits associated with people's livelihood types here?

		Priority		
Rank	**Benefits**	**High**	**Moderate**	**Low**
1	Accessibility of food	1	2	3
2	Improved housing	1	2	3
3	Improved market for local goods	1	2	3
4	Increased job opportunities	1	2	3
5	Improved transport and communication	1	2	3
6	Improved security	1	2	3
7	Improved income and SOL	1	2	3
8	Others (specify)……	1	2	3

004 Suggestions/recommendations

(a)Propose/suggest any other reason(s) or example(s) in support or against the positive/negative impact associated with the livelihood type(s) in 003 (a) (ii) above?

(i)……
(ii)……
(iii)……
(iv)…….
(v)…….....

(b) Suggest of what should be done to mitigate the above challenges/problems/what do you recommend to be done?

		Rating People's Responses		
Rank	**Suggestion/idea/policy**	**High**	**Moderate**	**Low**
1	Modify drainage systems	1	2	3
2	Demarcating and fencing nature resources	1	2	3
3	Sensitizing and policing the communities neighbouring nature resources	1	2	3
4	Encouraging vertical development	1	2	3
5	Strengthening the institutional frame work	1	2	3
6	Others (specify)……	1	2	3
7	None	1	2	3

Thanks for your cooperation

APPENDIX B: LETTER OF INTRODUCTION

KYAMBOGO UNIVERSITY

P. O. BOX 1 KYAMBOGO
FACULTY OF ARTS AND SOCIAL SCIENCES
DEPARTMENT OF GEOGRAPHY AND SOCIAL STUDIES

20 July, 2020

TO WHOM IT MAY CONCERN
BUSOLO PAUL
18/U/GMAG/ 19883/PD

This is to introduce to you the above named student who is pursuing a Maslcr of Arts in Geography degree course al Kyambogo University. He is in his second and final year and he is supposed lo conduct a research study entitled **" Effects of land use and land cover change on people's livelihoods in Kira Municipality, Central Uganda".**

Hns research ıs under the supervısion ot Dr. Nadhomi Daniel and Dr. Francis Wasswa Nsubuga.

Any assistance accorded to him will be highly appreciated.

Thank you.

DEPARTMENT OF GEOGRAPHY & SOCIAL STUDIES
20 JUL 2020
KYAMBOGO UNIVERSITY
P.O. BOX 1, KYAMBOGO

PP
Nabbosa Milly (Ms)
RESEARCH COORDINATOR

APPENDIX C: ACCEPTANCE LETTER

OFFICE OF THE TOWN CLERK
P. O. Box 25749,
KAMPALA – UGANDA

01st April 2021

THE REPUBLIC OF UGANDA

Town clerk: 0414696923
IN ANY CORRESPONDENCE ON THIS SUBJECT PLEASE QUOTE
KMC/CR/554/1

KIRA MUNICIPAL COUNCIL
WAKISO DISTRICT

Email: info@kiramunicipality.go.ug / website: www.kiramunicipality.go.ug

To: Members of the community in Kira Division, Kira Municipality

INTRODUCTION TO BUSOLO PAUL OF REG NO. 18/U/GMAG/19883/PD AND NIN. CM75089101GNIC

This is to introduce to you the above named student who is a student pursuing a Masters of Arts inn Geography degree course at Kyambogo University. He is conducting an academic based research entitled **" Effects of land use and land cover change on people's livelihoods in Kira Municipality, Central Uganda."** He is under the supervision of Dr. Nadhomi Daniel and Dr. Francis Wasswa Nsubuga.

Any assistance accorded to him will be highly appreciated.

Thank you.

UNITED FOR DEVELOPMENT
FOR TOWN CLERK
KIRA MUNICIPAL COUNCIL
01 APR 2021
P. O. BOX 25749, KAMPALA
WAKISO DISTRICT
UNITED FOR DEVELOPMENT

Muganga Geoffrey
For: Town Clerk

c.c. Environment Officer - Kira Municipality