LAND USE LAND COVER CHANGES AND ITS PERCEIVED EFFECTS ON HOUSEHOLDS' LIVELIHOODS IN PERI-URBAN AREAS OF NAKURU CITY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented in this university or any other for the award of a degree

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DEDICATION

This thesis is dedicated to my parents Mr. Joseph Kipsiele Kitur and Mrs Eddah Chepkemoi Kitur for their support during my academic journey.

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ABSTRACT

High rates of population growth in cities is a global phenomenon that leads to notable changes in land use in their peri-urban areas. Nakuru City is not exceptional. It is one of the fastest growing cities in Eastern Africa. The diverse functions of the city attract an influx of people that leads to the growth of Nakuru City, causing notable effects of land use land cover changes in its peri-urban zones. However, the magnitude of these changes is not clear and how they affect households' livelihoods in peri-urban areas of the city. The study sought to: establish the spatio-temporal land use land cover changes in peri-urban areas of Nakuru city since 2003 to 2023; assess the magnitude of the different types of land use land cover changes in peri-urban areas of Nakuru City; and find out the perceived effects of land use land cover changes on households' livelihoods in peri-urban areas of Nakuru city. A cross-sectional research design was employed. Supervised and unsupervised classification techniques were employed to get thematic information from satellite images from Landsat 8. Purposive sampling was used to select three study locations in peri-urban areas of Nakuru city. A structured questionnaire was administered to determine the perceived effects of land use land cover changes. Cross tabulations and calculation of percentages were used to determine the perceived effects of land use land cover changes on households' livelihoods. The results disclosed that land use land cover in peri-urban areas of Nakuru city changed significantly during the past two decades between 2003 and 2023. Farmlands increased by 11.4%, built-up area increased by 8.9%, bare lands increased by 15.6%, forest area increased by 8.1%, shrub land decreased by 25%, grassland decreased by 8.9%, water bodies increased by 9.1% from 2003 to 2023. Forest area and shrub land however depicted a fluctuating trend with an area decrease in 2014 and then an increase in 2023. Area under grasslands constantly decreased. The land use land cover changes have a positive influence on livelihoods as perceived by the households in the peri-urban areas of Nakuru city. The changes made a significant contribution to the development of livelihood opportunities and strategies among households. This in turn influenced positive and beneficial livelihood outcomes. Despite this, land use land cover changes have negative effects on natural resources such as reduced access to water and healthy living environment. This study contributes to the achievement of Kenya's Vision 2030, Agenda 21 of the United Nation and 2063 African Union Agenda that aims at achieving sustainable urban development, characterized by high quality of life for all urban populations. National and County Governments need to take appropriate measures to reduce the rapid change in land use land cover and to integrate environmental conservation with human livelihoods in Nakuru City.

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LIST OF ABREVIATIONS AND ACRONYMS

IGAs : Income generating activities

CDKN : Climate and Development Knowledge Network

ETM+ : Enhanced Thematic Mapper Plus

IDP : Internally Displaced Persons

KNBS : Kenya National Bureau of Statistics

LULCs : Land Use Land cover Changes

NCIDP : Nakuru County Integrated Development Plan

PU : Peri-urban

SUD : Sustainable Urban Development

UPA : Urban and Peri-urban Agriculture

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The global rate of urbanization is high with more than 55 % of the world population living in urban areas in 2018. It is projected that, 60% of the world population will live in urban areas by 2030 and 70% by 2050, with high concentration of the urban population in Asia and Africa (UN, 2018). The rapid pace of urbanization has often brought about rapid land-use change and land cover conversions in Africa and Asia. This has been occasioned by the fact that most parts of Africa and Asia are still predominantly rural as opposed to developed countries.

As urban areas continue to experience unprecedented land use changes, they also experience problems emanating from such changes. For example, inefficient provision of services, food insufficiency, illegal settlement, environmental pollution, waste dumping, forest destruction, reduction in water surfaces and permanent change in land cover (Alsharif et al., 2015). The urban land cover is expected to increase by 1.2 million Km^2 by 2030 (UNDP, 2016).

The land cover categories which experience conversion are: water (Water dams, rivers, lakes), forest which include, deciduous, evergreen, mixed forests; agriculture (Cropland, grassland, orchards) and urban estates which include: residential, industrial, commercial and services, transportation and utilities. As the urban space increases, water surfaces, tree cover grasslands and even agricultural space continue to shrink in peri-urban areas. This entirely changes the land cover of peri-urban areas of a given city or town (Cheruto et al., 2016). Rapid urbanization is noticeable in sub-Saharan Africa where so many countries in the region are urbanized and their fringes are further converted into urban centers (Zasada, 2011).

Land use land cover changes affects household livelihoods. It affects agricultural production, environment, non-timber forest products, forest, economy, culture and tradition in the society .Moreover, the key effects of land conversion on agricultural production are degradation, productivity decrease, insect and disease outbreak, and land limitation (Yuanchun, 2017). Land use patterns is associated with livelihood outcomes, it increases household income especially to households living near major urban centres (Ahammad et al., 2021).

According to Yirsaw et al. (2017), farmlands and wetlands in peri-urban areas of cities have shown a declining trend. Combination of various socioeconomic factors have induced land

use land cover changes (LULC). For instance, in Su-Xi-Chang city, growth of population and built-up environment shows a positive correlation. This implies that increase in population causes an increase in built environment due to increase in demand for settlement. Large parts of agricultural lands are changed into residential areas both in rural and urban areas with the aim to earn increased income by the owners of land.

Land use variation is a major aspect in peri -urban areas and has led to various effects, ranging from economic to social to environmental. A change in livelihoods occur as a result of LULC in the peri-urban areas as people start to engage in other income generating activities. For instance, households work as casual labourers on housing construction, engage in informal trade, or migrate to urban areas in order to obtain their livelihoods as is the case in Accra City of Ghana (Maxwell et al., 2017). Moreover, the existing farmers intensify agricultural activities in urban fringes to be able to cater for the increasing demands of the urban population as witnessed in the peri-urban areas of Kumasi, Ghana (Cobbinah & Amoako, 2012). Further, peri-urban farmers have innovatively responded to the pressure and opportunities attached to their geographical adjacency to urban agglomerations. Peri-urban farming is now characterized by a heterogeneous pattern of holdings with intensive and specialized production, high participation in diversification and lifestyle-oriented farms in the fringes of Nairobi city, Kenya (Thuo, 2013).

Urbanization enhances changes in land use, land transactions and increased rural –urban developments that has given rise to complex rural-urban migration and overall transformation in the peri-urban land. Rapid urbanization in Nairobi city, for example is causing expansion of the city boundaries to the hinterlands of Kiambu, Kajiado and Machakos Counties. As a result, Nairobi – Kiambu, Kajiado and Machakos peri-urban area is strongly emerging as a human-dominated zone, where new human settlements have replaced other LULC types such as forests and grasslands. Conversion of other LULC types into settlements in the peri urban areas is a directional process dictated with economic and social advantages (Wangai et al., 2019).

Areas poorly suited for urban use such as wetlands, steep hillsides, outcrops and rocky shores, estuarine channels, rivers and forest remnants have suffered the effects of intense environmental degradation. This development has occurred in isolation, without taking into account the concept of the ecological balance and how this system is affected (Appiah et al., 2019).Because, rapid urban changes correlate with such effects, a spatial planning framework

must be put in place to prevent the uncontrolled and unplanned urban expansion witnessed in the sprawling development (Dekolo et al., 2015).

Nakuru city planners have also put in place measures to open up the city peripheries in order to enhance transport and communication into and out of the city. This therefore catalyses the development of the city peri-urban areas. This is done through implementation of Nakuru county integrated development plan's objective which aim to provide efficient, affordable and reliable infrastructure for sustainable economic growth and development through construction, modernization, rehabilitation and effective management of all infrastructure facilities (NCIDP, 2017). It is against this background that the study assessed the effects of land use land cover changes on households' livelihoods in peri-urban areas of Nakuru City, Kenya.

1.2 Statement of the Problem

Urbanization process is one of the key factors that have led to global land use land cover changes in the fringes of urban areas. As peri-urban areas continue to experience land use changes they also experience problems emanating from such changes. These include; inefficient provision of services, food insufficiency, illegal settlement, environmental pollution, waste dumping and forest destruction, reduction in water surfaces. This is mainly due to the lack of proactive implementation of policy guidelines in the majority of the areas, particularly in developing countries. Having a proper planning policy is not enough but rather its successful planning, implementation, development control and enforcement is more important. Land use land cover changes present various effects on households' livelihoods in peri-urban areas. Nakuru City has registered rapid population growth rate of 3.4% annually since 2008. This rapid growth is influenced by a number of factors such as migration, increased birthrates and high fertility rates which in turn increases demand for goods and services. This has led to LULC changes in its peri-urban areas. However, there is limited information on, the spatio-temporal LULC changes, the extent and magnitude of the different types of LULC changes in peri- urban areas of Nakuru City and how they affect adoption of livelihood strategies and the livelihood outcomes, issues that this study aimed to investigate. Information generated by the study will be useful to government and other stakeholders involved in planning and development of Nakuru City.

1.3 Research Objectives

1.3.1 Broad Objective

To contribute to the understanding of the perceived effects of land use land cover changes on households' livelihoods in peri-urban areas of Nakuru City, Kenya.

1.3.2 Specific Objectives

i) To establish the spatio-temporal land use land cover changes in the peri-urban areas of Nakuru city since 2003 to 2023.

ii) To assess extent and magnitude of land use land cover changes in peri- urban areas of Nakuru City.

iii) To find out the perceived effects of land use land cover changes on households' livelihoods in peri-urban areas of Nakuru city.

1.4 Research Questions

i) How has land use land cover in peri-urban areas of Nakuru city changed since 2003 to 2023?

ii) What is the magnitude of the different types of land use land cover changes in peri- urban areas of Nakuru City?

iii) What are the perceived effects of land use land cover changes on households' livelihoods in the peri-urban areas of Nakuru City?

1.5 Justification of the Study

Nakuru City has translated into an increased rate of estate developments (GoK, 2018). As a result of this the peri –urban areas of the city are experiencing LULC changes in attempt to meet increased demand for housing facilities, food, security, among others. In order to suggest integration of environmental conservation with human livelihoods, the study generated information which gives a better understanding of LULC changes to assist planners to properly evaluate complex causes and responses in order to better projects, future trends of human activities and LULC changes. It will also contribute towards the UN Sustainable Development Goals, (SDGs) stated in chapters 7 and 8 of Agenda 21 that seek to promote sustainable human settlement development and integrate environment and development in decision-making. Furthermore, it contributes towards chapter 72 of 2063 African Union

Agenda to ensure balanced development of all human settlements while embracing a rural urban continuum and improving the livelihoods of the great percentage of the people working and living in slums and informal settlements. This study also, has a potential to contribute towards the achievement of the Vision 2030 which aims sustainable livelihoods for all through inclusive and participatory stakeholder consultative process involving all Kenyans (GoK, 2007).

1.6 Scope and Limitations of the Study

The study sought to assess the effects of LULC on household's livelihoods in peri-urban areas of Nakuru City, Kenya. This study focused on; the spatio-temporal land use land cover changes, the extent and magnitude of Land use land cover changes in peri-urban areas of Nakuru city and how it affects household livelihoods in the peri-urban areas of Nakuru city. The study area covered Kiamiana, Ngata and Lanet Ummoja locations within the peri-urban areas of Nakuru City. Areas along the major tarmac roads were included for the study because towns develop rapidly along roads. The study included land use land cover changes and how they affect the livelihoods of households in the peri-urban areas of Nakuru City. The effects were limited to livelihood strategies and outcomes. The spatial trends in land use land cover changes were studied from year 2003 to 2023.This is considered adequate time to capture temporal and spatial land use changes (Xian & Homer, 2010). The study was, however, limited by absence of family heads who could be engaged in daily activities during the day. To overcome this, return visits were conducted.

1.7 Assumptions of the Study

i. The continued urbanization of peri-urban areas of Nakuru City was accommodated through increased development densities and land-use conversions in order to provide space for developments.
ii. Developers and investors are driven by the concept of a (rational) economic man who assumes profit maximization as the main motive for the development or investment.
iii. Peri-urban areas located along the roads depict major changes of land use land cover and therefore households located in such areas generated useful information for the study.

1.8 Definition of Terms

Household: A household comprises one or more people who occupy a housing unit or dwelling and have the same cooking arrangements.

Household size: Refers to the total number of household members residing in a dwelling unit.

Livelihood: Livelihood is defined as adequate stock and flow of food and cash to meet basic needs. It comprises people, their capabilities and their means of living including food, income and assets. It is a means of securing the basic necessities of life (Chambers & Conway, 1992). In this study livelihood comprises the capabilities assets (stores, resources, claims, and access) and activities required for a means of living. A livelihood is sustainable and can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities.

Land Use: This relates to the economic functions (utility) associated with a specific piece of land such as agriculture, industrialization, residential, transportation, public purpose, recreation, public utility or educational utility .

Land Cover: This is the biophysical state of the earth's surface and immediate subsurface such as forests, water, agriculture and urban estates of all types. It describes the physical state of the land surface; farmland, bare lands, water bodies, scrubland, forests and built-up area.

Livelihood assets

These are various resources and capabilities that individuals and households possess which enable them to pursue and sustain their livelihoods. In this study they are classified into; human, natural, financial, physical and social capital.

Livelihood strategies: Are the range and combination of activities and choices that people make in order to achieve their livelihood goals.

Livelihood outcomes: These are what households achieve through livelihood strategies such as level of food security, income security, health, wellbeing, asset accumulation and high status in the community.

Land tenure

This is the relationship whether legal or customarily defined among people as individuals or groups with respect to land. It determines who can use land for how long and under what conditions.

Peri-urban: It is a dynamic zone both spatially and structurally. Spatially, it is the transition zone between fully urbanized land in cities and areas in predominantly agricultural use. It is characterized by mixed land uses and indeterminate inner and outer boundaries, and typically is split between a number of administrative areas. The land area which can be characterized as peri-urban shifts over time as cities expand (Feng, 2013). In this study a peri-urban area is one characterized by proximity to a densely populated urban settlement, it will include all the locations bordering the city including Barut, Lanet- Ummoja, Kiamaina, Ngata, Kiamunyi, Viwanda and Mbaruk

Spatial –temporal information: Refers to record of processes of complex phenomena at the interaction between time and space (Peuquet 1994). In this study spatio-temporal information is defined as changes that have been recorded in Nakuru in space over time.

Urbanisation: Urbanization is primarily the outcome of migration from rural to urban areas. It refers to the expansion of urban boundaries and the formation of new urban centres. It is the reclassification of what were previously villages as they grow or develop to meet national urban criteria.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section interrogates relevant literature on three aspects: land use and land cover changes in peri-urban areas, extent and magnitude of peri-urbanisation and the perceived effects of peri-urbanisation on households' livelihoods. The chapter also presents the conceptual framework.

2.2 Land Use Land Cover Changes

Land cover change means a change in the continuous characteristics of land such as vegetation type and soil properties while land use change is the alteration in the way a certain area of land is being managed through human activities. The land cover categories experiencing changes include Water (Water dams, rivers, and lakes), forests such as deciduous, evergreen, mixed forests, agriculture (Cropland, grassland, orchards) and urban estates structures e.g residential, industrial, commercial services, transportation and utilities. Rapid urbanization has been recognized to be in a competition with urban agriculture for space. In this, land cover has changed from natural cover such as water, natural vegetation or bare land to anthropogenic cover such as agriculture and urban estates (Bonye et al., 2020).

Peri-urbanisation is a worldwide phenomenon. In most European countries, peri-urbanization is manifested in different ways, including changes in land use land cover, land management, planning status of an area, socio-economic changes, and environmental changes. While land use changes are often conceptualized as having underlying drivers and leading to one or more impacts, various studies show that peri-urbanization is more complex. The direction or cause of the various processes of urbanization differs across regions. As a result, land use change sometimes precedes socioeconomic changes, while in other areas it follows socioeconomic changes. The multifaceted character of peri-urbanization processes provides particular

challenges for managing peri-urban areas (Shaw et al., 2020). According to Vejre et al. (2010) plans and policies for the peri-urban area around Copenhagen were adjusted to explicitly provide cultural and ecosystem services such as landscape aesthetics and recreational value for urban dwellers. Thus, urban lifestyles add a set of demands for land use in peri-urban areas.

Peri-urbanisation in developing countries in comparison with developed countries is accelerating. The process has been increasing and this problem causes physical expansion without any program in cities to combat harmful effects on the natural environment and agricultural lands in periphery of cities (DESA, 2011). In Iran, expansion of cities takes up agricultural lands and gardens in peripheries of cities. Bojnurd city in North Khorasan province is an example where 2,584 hectares was converted into urban land through continuous growth of cities into peripheral lands (Parsipour et al., 2019).

Wangai et al. (2019) observed that rapid urbanization of Nairobi city is causing expansion of the city boundaries to the hinterlands of Kiambu County. As a result, Nairobi-Kiambu peri-urban area is strongly emerging as a human-dominated zone, where new human settlements are replacing other LULC types such as forests and grasslands. Conversion of other LULC types into settlements in the urban-peri urban-rural gradient is a directional process. The central business district of Nairobi that borders Kiambu in the south acts as an epicenter of spatial expansion of settlements to the suburban and peri-urban area.

2.3 Extent and Magnitude of LULC Changes in Peri-urban Areas

The forces, pressures and dynamics of urban sprawl are certainly diversified. The driving forces and degree of urban sprawl are dependent on its urban properties: socioeconomic, institutional, demographic, market, and technological (Yasin et al., 2020). Economic growth, rate of industrialization at city boundaries and housing demand of people employed on these production areas are listed among the reasons which determine high rates of peri-urban growth (Bhatta, 2012).

Peri-urban areas are viewed by Dutta (2012), as featuring diverse land uses that vary in relation with their urban and rural linkages. It shows a pattern which becomes progressively more agrarian as one recedes from the urban Centre. Thus, agricultural land uses and rural linkages are seen as giving way to urban-oriented activities as distance to the city centre diminishes. These areas are occupied by poor residents from rural areas, being engaged in

multiple income-generating activities. Urban dwellers move to the city fringes in search of advantages in land rent, or to capitalize opportunities for land acquisition and settlement (Dutta, 2012).There is a competition between agricultural land which is close to city and other uses due to intense developments, agricultural lands are allocated for housing, business and transportation uses rather than agricultural uses. This fastens the rate of land use conversions into built-up area (Bhatta, 2012).

European cities have displayed a wide spread urbanization of peri-urban areas. Factors including economic, institutional, sociocultural, biophysical and technological are the major catalysts towards the deep-rooted urban expansion. However, when the above factors are combined, peri-urbanisation occurs to a very large extent. Peri-urbanization also, is not only a land use change process, but rather a multifaceted process that reflects socioeconomic processes in a society (Shaw et al., 2020).

Different processes in peri-urban areas are also reported in case studies from other parts of the world. As an example, a review of studies for the Mekong region also found broad variation in patterns of changing urban growth and socioeconomic contexts, differentiated by local and national policies. In China, different spatiotemporal growth patterns are reported alongside socioeconomic changes such as access to education, clean water, urban green space and mobile phone use. This suggests that the multifaceted process of peri-urbanization is not a strictly European process, instead a more generic phenomenon that manifests itself in multiple world regions (Shaw et al., 2020).

Santiago is also a city which experience peri-urban expansion, real estate factor is one of parameters with high influence. A second factor influencing peri-urban expansion is enhanced transportation system of infrastructure, which promotes decentralization of urban centers of Santiago (Puertas, 2014).

Furthermore, Freetown of Sierra Leone, experiences conversion of forest land cover into agricultural use which suggests a linkage between urbanization, agriculture and deforestation. The conversion of grassland in 1986 to agricultural in 2000 is further proof that urban farmers are losing out on lands in urban Freetown and are now shifting to forests and grasslands in order to maintain and increase their farm production. Major conversions occurred between agricultural lands, grasslands, evergreen forest, built-up areas and barren land. Built-up areas increased by at least 40% between 1974 and 2000, suggesting a high urbanization rate. About 882 ha (27%) of agricultural lands in 1986 were converted to

residential purposes in 2000, especially at the urban fringes, as a result of an increase in population. Some 14% of evergreen forest was found to have been converted to agricultural land. These major conversions suggest a strong linkage between urbanization, agriculture and deforestation (Forkuor & Cofie, 2011).

Such conversions have also been experienced in Makueni county of Kenya. A study by Cheruto et al. (2018), shows land cover changes where bare-lands were converted to other classes such as 54% of the barelands were converted into grasslands 45% into farmlands, 36% into built up areas. Up to 50% of bush-lands were converted to evergreen trees while 36% was converted to both water bodies and built-up area from 2005 to 2016 all in attempt to increase income.

Non-agriculture workers and existing regional services are the most important factors leading to urbanization process in peri-urban areas of Cairo in Egypt. Other major factors include housing and land markets, planning decisions, ownership patterns, land use characteristics, infrastructure and transportation structure and roles of actors within these processes (Salem, 2015). Forest cover and grazing lands decline rapidly, in comparison with settlement and cultivated land which increase at higher rates of greater than 10%, population pressure and associated demand are the main causes behind LULC changes in North Eastern Ethiopia (Abebe et al., 2021).

It is evident in Tanzania that urbanization in regions with high poverty levels catalyzes changes in land use. This is depicted by land transactions, increased rural–urban immigration and the overall transformation of land use in the peri-urban areas. Unregulated peri-urban land development has given rise to complex organic urban structures which predominantly expanding horizontally. The emerging land use pattern, indicate a mismatch with the widely cherished planning norms and standards and land value theories. Such theories support urban land use planning such as zoning and density distribution and principles like equitable provision of basic services and complementarity in urban land developments (Briggs &Mwamfupe, 2014).

2.4 Effects of Land Use Land Cover Changes on Livelihoods in Peri-Urban Areas

Changes in land use land cover have serious environmental, economic and social impacts on rural livelihoods in many parts of the sub-Saharan African region (Maitima et al., 2010).

2.4.1 Environmental Effects

The increasing dependence on the resources may aggravate the pressure on these resources leading to over-exploitation and subsequently deforestation and land degradation (Kalaba et al., 2010). Land-use changes and urban development have led to the expansion of paved surfaces and encroachment into riparian reserves. The immediate effect of such encroachments has posed flood risks to such areas and disrupted ecosystem services of such riparian reserves (Orewole et al., 2015).

Consequently, water shortages have been a growing concern throughout the world .With ongoing droughts, water rationing, climate change, and global warming being the main environmental constrains which occur as a result of urbanization and the high rate of land-use changes that exert pressure on already limited existing natural resources (Tamara et al., 2016).Land use land cover changes result in environmental degradations including: erosion, habitat and biodiversity loss and groundwater depletion (Díaz-Caravantes & Sánchez-Flores, 2018). Deforestation, cultivation on slopy area, and land fragmentation are lead to increased land degradation (CDKN, 2021).

Deforestation in Wadi Ziqlab catchment is considered the main cause of land degradation. During the last two decades, less than 60 thousand forest trees were removed and replaced with fruit trees, houses, or buildings. Such activities have thus led to the reduction of farm land area and wetlands (Cahya et al., 2018). Moreover, LULC changes interferes with peri-urban microclimate. Ecosystems help mediate temperature changes and filter air pollutants. Replacing green spaces with built infrastructure can give rise to ‘heat islands’, which reduces the adaptive capacity of a population (CDKN, 2021).

2.4.2 Social Effects

A result of conversion of agricultural land into built up environment challenges on food shortages have occurred, for example in the case of Northern Delta in Canada where agricultural land has continued to diminish due to urban growth (Shaheen et al., 2018). Peri-urban agriculture can improve food security for local population as well as in the urban areas, making food systems more resilient. Further, locally-grown food can reduce pollution and greenhouse gas emissions and aid mitigation efforts, since the distances covered to deliver the produce to the city is reduced (Svetislav et al., 2019). In the city of Gorakhpur of India, land market due to changing land-use patterns led to agricultural lands have been replaced by

housing infrastructure which in turn affect the overall food resilience of the city (CDKN, 2021).

Land use change in peri-urban areas is associated with social traits such as age, gender of household, family size, size of households, educational status (Wilson, 2013). Pressure on the existing infrastructure has emerged as another major effect of urban sprawl. The road networks, supply of water and electricity are becoming inadequate and experiencing more pressure due to increased demand from the upcoming areas. Infrastructure and services should be provided before development takes place. However, in most areas this is not the case. Provision of services and infrastructure is done in retrospect without improving capacity of the old infrastructure (Owusu & Chigbu, 2020). Fragmentation is also considered as a major problem, which prevents land development. Multiple ownership of single plot is also dominant and hinders proper farming. Thus, the land is left unused and exposed to degradation (Wilson, 2013).

Floods caused by land-use changes/urban developments have led to the destruction of property and loss of life and if not controlled the situation can worsen with the increased level of land-use conversions. This has caused flash floods in urban and peri-urban areas. Floods are enhanced by the impervious surfaces as a result of urban developments which does not allow a substantial amount of surface runoff water to percolate into the ground. The surface runoff is also obstructed by non-biodegradable materials which often clog the drainage systems .These end up into sewerage drainage and water supply systems leading to spillovers, pollution, and contaminations endangering the life of people and the ecosystem. The impacts of such floods are experienced on roads especially where the drainages are not maintained or do not have adequate capacity to contain storm water making roads impassable (Mukherjee et al., 2016).

2.4.3 Economic Effects

The use of natural resource is vital in people's livelihoods. The drivers of land use land cover change are agricultural expansion, population increase and illegal logging in forests (Alsharif et al., 2015). Livelihood coping strategies include entrepreneurship, farming, employment and wild food. Unfavorable land tenure system cause farmers to lose their lands to competing uses (Svetislav et al., 2019). Urbanization of PU areas leads to increased and diverse sources of households' livelihoods. This fastens urbanisation in such areas (Alsharif et al., 2015). Bangladesh of South Asia has suffered quick LULC due to speedy population growth and urbanization that resulted from severe contractions in agricultural land (Hasan et al., 2021).

The effect of LULC changes on sources of livelihoods is shown by increase of income per capita and increase in the number of workers which lead to increase in demand for residential houses due to rapid urban population growth. Industrialization and housing demand in cities are listed among the reasons which magnify the peri-urban growth. All with the profit-making objectives of the investors and land owners in peri-urban areas of cities (Parsipour, 2019). These investors take advantage of availability of new unexploited lands in the peri-urban areas. Numerous fertile agricultural land and forest land in Turkey disappear all in attempt to obtain better livelihoods by the ever-rising urban population. Low land prices in urban fringes cause heavy demand of sectors such as industry, trade and construction. Since these sectors are more preferable to agriculture, LULC occur together with inefficient use of resources due to non-agricultural use of land (Bhatta, 2012). In Nairobi, agricultural transformations in the peri-urban areas of the city are widespread. Famers in peri-urban areas are taking advantage of the prevailing situations and put land under high value crops and practice zero grazing. This is enhanced by available market offered by increased population (Thuo, 2013).

Growth of Bojnurd vicinity, has caused major changes in livelihood structure and body of villages that have direct or indirect influences on land use. Results of many studies on rural infrastructural development plans show that closer villages to physical domain of the city have less occupants in agriculture and this is the main reason for increase of occupants in industry and service parts in Bojnurd (Svetislav et al., 2019).

It is in agreement therefore with the land rent theory of Von Thunen, which states that the land prices of places which are close to settlement units (urban centres) are higher. This is of a high economic value to the owner of land. Also, the lands are cultivated more intensively to increase net income of agricultural land. He further pointed that transformation of agricultural land are also effective in development of urban peripheries all in pursuit of increased income. Increase in land values and housing cost brings higher returns to the real estate investors/ landowners. For instance, once a farm has changed user into residential user, the value would go up and the investor would earn more from his investment. Similarly, if the farm is developed, the resultant housing cost/rentals would be higher to enable the investor cover the higher value of the land and increase profit margins (Owusu & Chigbu, 2020).

Also, employment opportunities are developed and more resources are exploited (particularly agricultural resources); More recreational and leisure activities could be pursued and

provided. The environments are expected to receive many important infrastructural developments (e.g. transportation infrastructure), or local important industry, particularly in the processing of agricultural products (Živanović-Miljković et al., 2012).

In most developed countries urban development is controlled in order to retain the agricultural lands in the peri-urban areas. This is visible in countries such as Denmark, north-western Germany, the Netherlands and Belgium where the land is mainly used for agriculture while also containing an above average share of peri-urban areas. This is also the case in large parts of Poland, the Atlantic coast of France, eastern Italy, parts of Hungary and the south of the United Kingdom. Some are run in a highly intensive manner, often with horticultural production and high economic productivity (Shaw et al., 2020).

Urban and peri-urban agriculture (UPA) is a major source of livelihood for many people and can be used to reduce the high levels of poverty and food insecurities in most cities especially in developing countries. Free town of Sierra Leon is an example of a city where UPA is carried out by very many people. Urban dwellers cultivate open spaces to subsidize their income and sustain their livelihoods. However, lands used for UPA are becoming increasingly scarce due to high competition from other land uses and the rapid population growth being experienced in many cities of the developing world (Forkuor & Cofie, 2011).

However, while LULC is pushing some determined farmers farther into the hinterlands, their livelihood systems are also greatly affected. Rapid urban growth, shrinking peri-urban farmlands and growing urban poverty raises concerns, particularly about Ghana's urban live is characterized by high levels of poverty (Appiah et al., 2019).

Solutions have been sought towards shortage of land for UPA. Recent land-use development in Dar es Salaam's peri-urban areas, have been characterized by infill rather than further linear expansion along route ways, densification of existing linear settlement and by limited spatial growth to the south of the city in order to sustain both development and agricultural production in the peri-urban zones (Briggs & Mwamfupe, 2014).

2.5 Summary of Knowledge Gaps

It is evident from the studies done that urban sprawl in the world cities is unavoidable. In this essence, the land cover is basically converted from natural biophysical state to human dominated environment. The agricultural land within the urban fringes will continue to shrink and come with its effects on human livelihoods. This means that providing food to the ever-

rising population will thus be unending struggle and in this, the natural resources continue to be strained or exhausted if not diminished in value. Land use land cover changes lead to development and accessibility of remote areas and increased income to people living in the peri-urban areas while at the same time promoting social cultural benefits. However, unsustainable LULC changes have negative implications on rural livelihoods and natural-resource management.

Most studies have identified indicators of LULC changes such as reduction of forest cover and increase in built-up environment. However, the knowledge on spatial mapping of LULC changes in peri-urban areas of Nakuru city is limited.

The extent in which LULC changes occur is dependent of the rising population in cities which increases the demand for natural resources and has been witnessed in urban fringes of towns and cities. The high demands fasten the extent in which the peri-urbanisation occurs. However, knowledge on the extent in which LULC changes have occurred in peri-urban areas of Nakuru city is lacking.

Perceived effects of LULC changes on households' livelihoods include the social, economic, and environmental effects. Development of peri-urban areas lead to increased income and diverse sources of livelihoods. However, knowledge on how LULC changes in peri-urban areas of Nakuru City and how it affects households' livelihood is lacking. Further, information on the resulting environmental degradation as a result of LULC changes in the peri-urban areas of Nakuru City, such as overexploitation of natural resources and urban development lead to degradation of natural resources such as land, air and water, occurrence of poverty, conflicts and food shortages, is lacking.

2.6 Theoretical Framework

Various theories have been used to illustrate the development of peri-urban areas. They include: Doughlass' model on the rural-urban linkages, Von Thunen's model of agricultural land uses, the growth pole theory, core-periphery model and theory of concentric zones. However, this study is informed by the Doughlass' model on the rural-urban linkages, and the core-periphery model.

Douglass' model on the rural-urban linkages.

This theory posits that different flows can follow different trajectories, configuring either positive (virtuous) or negative cycles of development. Douglass' template includes linkages

and flows suggesting that: rural structural change and development are linked to urban functions and roles through a set of flows between rural and urban areas (Douglass, 1998). The five types of flows identified by Douglass are people, production, commodities, capital and information, each having multiple components and impacts. They also feature different spatial linkage patterns and variable benefits to rural and urban areas. (Douglass, 1998). This theory is applicable to this study because the presence of the city motivates households in the study areas to diversify livelihood strategies in order to obtain better livelihoods. The maximization of these benefits is achieved through peri-urban development. Rural households earn higher incomes from the production of agricultural goods for non-local markets and increase their demand for consumer goods. This leads to the creation of non-farm jobs and employment diversification, especially in small towns close to agricultural production areas (the peri-urban areas).

Core-periphery model

States that core areas/cities are the heart of economic activities, whereas periphery/rural areas deliver resources in the form of labor and goods. This theory depicts that the core dominates, whereas the periphery is dependent. This dependence is structured through the relations of exchange between core and periphery. The model includes the spatial dimension by stressing proximity to cities in providing income opportunities and services. The concept of the urban ecological footprint suggests that cities need a larger area than their actual size on which their inhabitants depend for food and natural resources. This dependence on food and other natural resources is primarily fulfilled by the rural area and hence demonstrate rural–urban linkages. This theory indicate that rural and urban areas are intrinsically linked. The dominant features is the flow of people production, commodities, capital and information to and out of the cores/cities.

This theory is applicable to the study in this way; the linkage between Nakuru city and the peripheries are the peri-urban areas where the city finds space to expand. The peri-urban areas are spaces where new livelihood strategies are applied to meet the demands which originate from the expansion of the city/central place, which dominates while the peri-urban areas are dependent.

2.7 Conceptual Framework

Figure 2.1 shows the conceptual framework of the study and describes the variables livelihood strategies and livelihood outcomes which occur as a result of LULC changes in peri-urban areas of Nakuru city. The dependent variables are the LULC changes and the livelihood strategies amid LULC changes while the dependent variables are the livelihood outcomes as perceived by the households of peri-urban areas of Nakuru city. New technologies and innovations, government policies on national housing, agriculture, education, health, transport and industrial development are extraneous variables which influence households' livelihoods in peri-urban areas of Nakuru city.

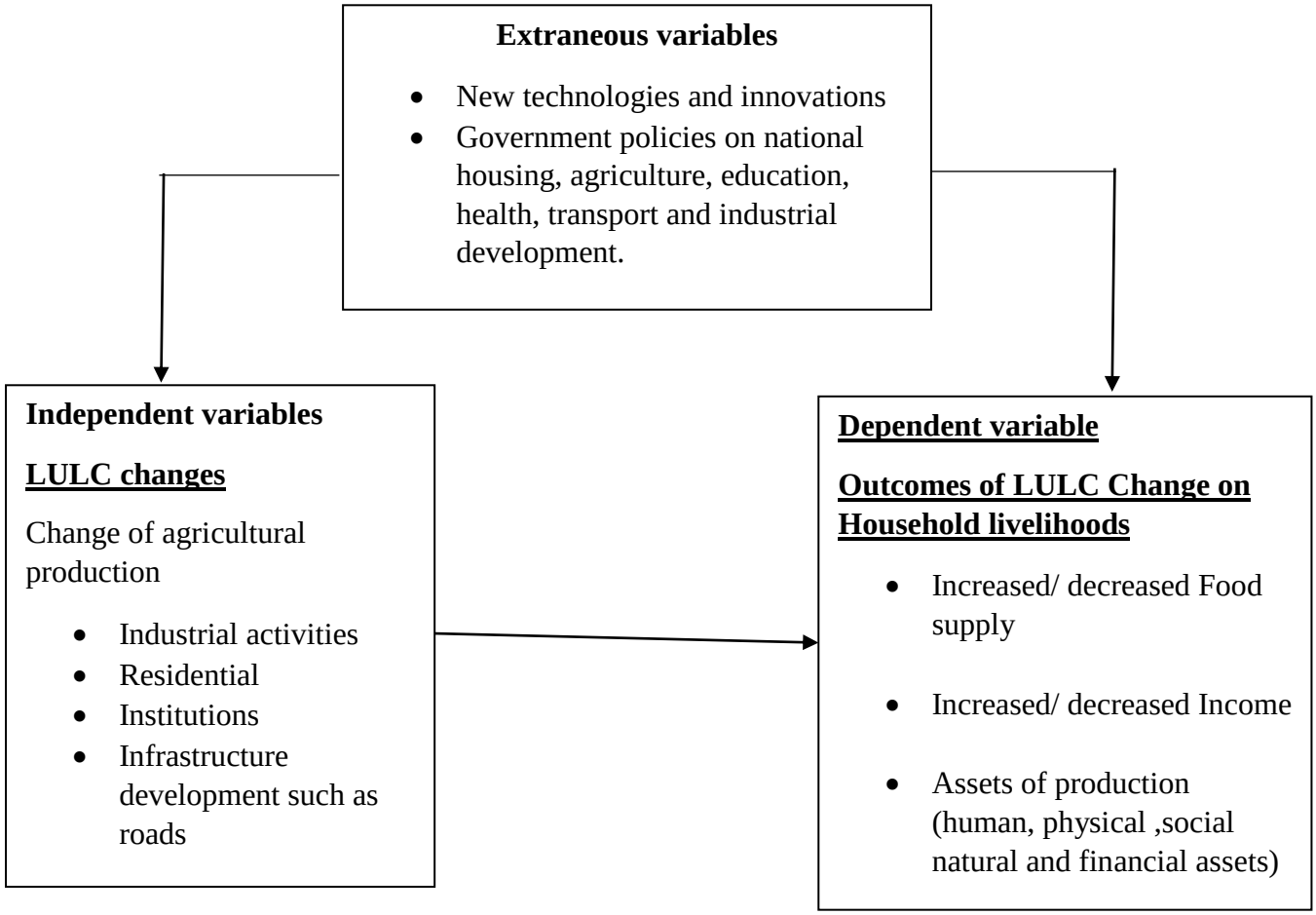


Figure: 2.1 Conceptual Framework showing the Interaction between Dependent and Independent variables

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the study area, research design, study population, sample size and sampling design, methods of data collection and tools of data analysis.

3.2 Study Area

3.2.1 Location of the Study Area

The study area comprised of the peri-urban areas of Nakuru City (0^o 12 ^{1}S 360^{o}E, 0^0 12^1 S 36^012^1E) (Figure 3.1). Nakuru is Kenya's 4th largest city with a population of 570,674 (GoK, 2019) and headquarter of Nakuru County. The peri-urban areas of Nakuru city include: Barut, Lanet Umoja, Kiamaina, Viwanda, Ngata and Mbaruk sub-locations.

3.2.2 Physical Characteristics of the Study Area

Relief

Nakuru city has an altitude of 1850m above sea level. It is however characterized by both gentle slopes. The city and its environments is characterized by physical features such as mountain slopes, rift valley, lakes and rivers.

Climate

The climate of Nakuru City and its adjacent areas is strongly influenced by its altitude which is about 1850m above sea level, and physical features such as mountains, rift valley and lakes and rivers. It receives rainfall throughout the year with seasonal variation in monthly amount. The temperatures rang from 54^{o}F to 74^{o}F. However, these temperatures are greatly modified by the activities carried out in the city and Lake Nakuru (GOK, 2013).

Vegetation and Soil

The forests neighbouring Nakuru City, are Menengai Crater, Mbogoini, Mau, Bahati, and Dundori. The forest and the high altitude also influence climate condition in the county resulting to wet conditions suitable for agro-based economic activities. The climatic conditions are also favourable for micro-organisms that catalyze the decomposition of organic matter thereby enriching the soil that support agricultural activities especially dairy and crop farming (GOK, 2013).

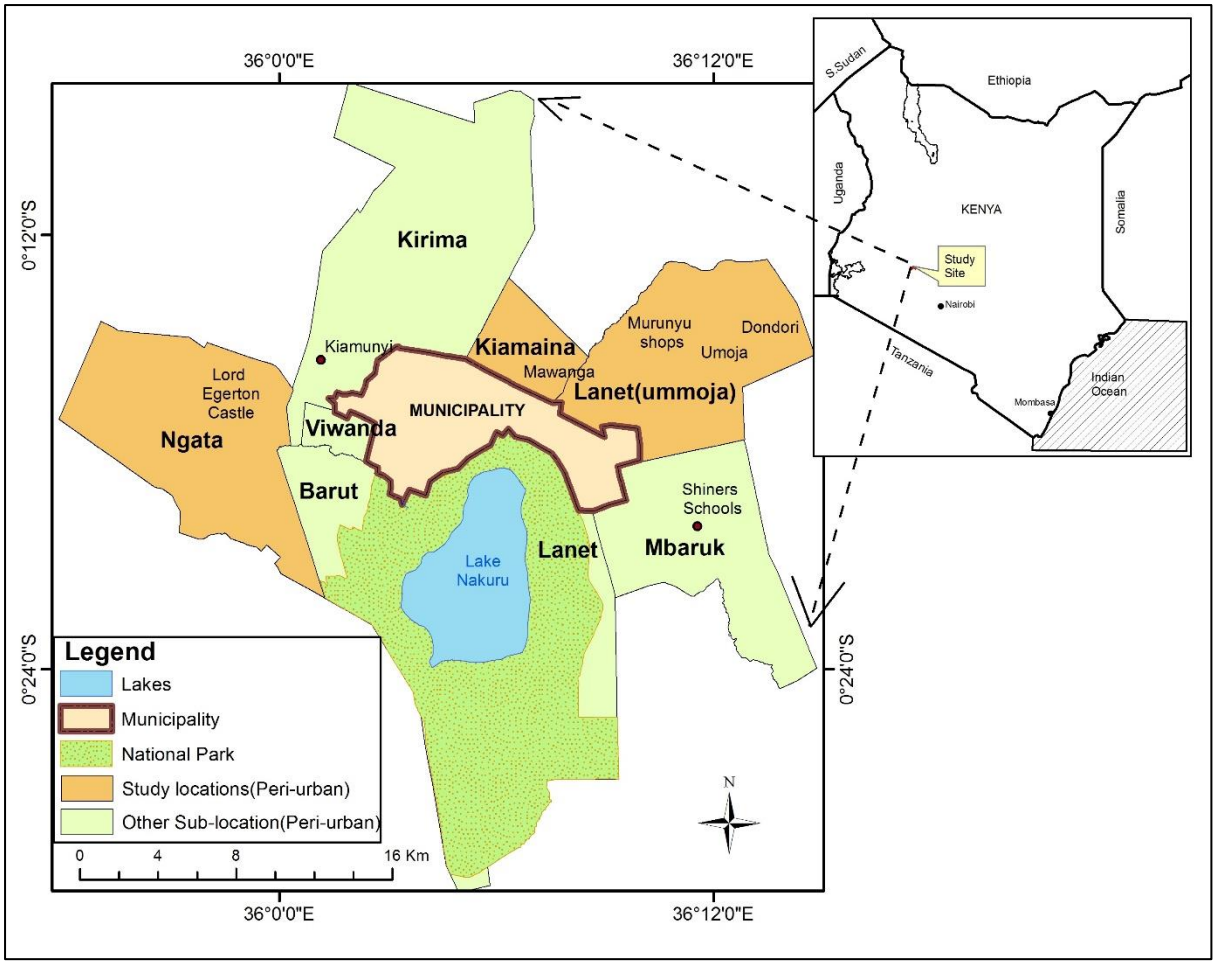


Figure 3. 1 A Map of the study area showing study sites

Source: Survey of Kenya (2022)

3.2.3 Socio-Economic Characteristics of the Study Area

Agriculture, manufacturing and tourism are the main activities of the economy of Nakuru city. The areas surrounding the city are known for its agricultural uses, with numerous small farms and large agricultural enterprises. The main crops grown around Nakuru include coffee, wheat, barley, maize, beans and potatoes. The crops provide the primary raw materials for agro-manufacturing industries in Nakuru and Nairobi, such as flour milling and grain ginneries. Dairy farming is a key economic activity in Nakuru and provides the inputs for various milk processing plants around the city (GOK, 2013).

3.2.4 Demographic Characteristics of the Study Area

The city's population according to the 2019 National Population and Housing Census was 408000.The continuously rising population in Nakuru city is as a result of emigration and natural increase (GOK, 2017).

An estimated 33 percent of the population is aged at 18-35 which is a predominantly youthful population. About 68.9 percent of the population is below 30 years of age. This population is estimated to increase by 13.9 percent by the year 2022. The aged population comprises a smaller percentage in Nakuru City. Young population aged below 45 years of age comprises the larger percentage of the population of the city population. This age bracket (18-45) consists majorly of young school-going and working people. Generally, there are more male than female living in Nakuru City. Nakuru urban centres have the highest population density due to rural-urban migration as a result of well-developed infrastructure and availability of employment opportunities (GOK, 2018).

3.2.5 Infrastructure of the Study Area

The road network in Nakuru city is well developed and it connects various parts within the city and its peri-urban areas. Lanet airstrip is also undergoing constant upgrading to enhance transport of people, goods and services. In general, Nakuru is endowed with various industries; primary, secondary and service, of which a bigger percentage is concentrated within the city. This makes the city a preferred destination for job seekers. Other infrastructures include piped water, sewerage, market, electricity and housing facilities. The infrastructure is continuously strained due to the ever-rising city population.

3.3 Research Design

The study adopted a cross-sectional research design. The design allows comparison of different types of data (Cochran, 1963), that is, data on spatial-temporal LULC changes and household survey data on perceived effects of LULC changes on household's livelihoods.

3.4 Target Population

The target population of the study are all 20,000 households in peri-urban areas of Nakuru City (KNBS, 2019) and Landsat images between 2003 and 2023. The study also targets 27 seven key informants working in Nakuru City. .

3.5 Sampling Procedure and Sample Size

To determine the sample size, the formula by Cochran (1963) was applied.

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

Where:

n_o= the desired sample size for target population greater than 10000

z= standard normal deviate at the required confidence level (1.96)

p = estimated proportion of the population.

q =1-p

e =accepted level of confidence.

$$n_{o=} \frac{(1.96)2x\ 0.5x0.5}{0.05^2} = 385$$

Table 3.1 Distribution of Sampled Households

Location	Sampled Households.	Sampled Key informants
Kiamaina	148	4
Ngata	92	2
Lanet Ummoja	133	3
Total	**373**	**9**

Out of the seven locations surrounding Nakuru City: Barut, Lanet Umoja, Kiamaina, Ngata, Kiamunyi, Viwanda and Mbaruk, three locations were purposely selected for study. These include: Kiamaina, Ngata and Lanet-Umoja. The selection of these 3 locations was based on their location along the major tarmac roads. Areas along these major roads depict significant changes in land use land cover because roads facilitate flow of people, goods and services into and out of a locality because many socio-economic activities gravitate alongside the roads and the regions surrounding them (Evans, 1992). Within the selected locations, households were randomly selected for the study.

Nine out of twenty-seven key informants were also interviewed using the schedule in Appendix 2.this formed a third of the whole. The key informants, who had relevant

information concerning the themes under investigation, comprised: Chiefs and Assistant Chiefs (6); and Nakuru County Chief Officers in the Departments of Public Health (6), Education (6), Agriculture (3), Security (3) and Environment (3).

3.6 Data Collection

Data for this study was collected differently. Objective one and two relied on geographic information system (GIS) and remote sensing (RS) techniques which were used to carry out processing and analysis of the obtained remotely sensed data to meet the objectives of the study. The study utilized remote-sensing data (medium resolution satellite images) for the 2003, 2014, and 2023 periods. Objective three relied on household questionnaire (Appendix 1) to establish the perceived effect of land use land cover changes on households' livelihoods in the study areas.

3.6.1 Data on Perceived effects of LULC on Households' Livelihoods

Primary data was obtained by administering a questionnaire (Appendix I) in the months of July and August, 2023. A total of 385 household heads were interviewed in selected peri-urban areas (Kiamaina, Ngata and Lanet Ummoja locations) of Nakuru city. The number of households which took part in the study was in the ratio of the number of households per location. Kiamaina =7836 households, Ngata location = 4886 households and Lanet Umoja location =7002 households (KNBS, 2019). Key informant interviews were also conducted to supplement household survey. The key informants interviewed include: Chiefs and Assistant Chiefs, Nakuru County Chief Officers in the Departments of Public Health, Education, Agriculture, Security and Environment.

3.6.2 Data on Land Use Land Cover Change

The study area polygon was used to select cloud free images and appropriate off-nadir angle of inclination and date of acquisition from the United States Geological Surveys (USGS) glovis website (https://glovis.usgs.gov/). The LANDSAT imagery was used to cover a period of 10-year intervals starting in 2003 and ending in 2023 for the dry seasons. The satellite images described in Table 3.1 were utilized in the study. They included Landsat Thematic Mapper (TM) at 30-meter resolution, Landsat Enhanced Thematic Mapper (ETM+) at 30-meter plus and the 15-meter panchromatic band, Operation Land Imager (OLI) at 15-meter resolution and the Sentinel images at 10-meter resolution.

Table 3.2 Enhanced Thematic Mapper plus sensor and Operation Land Imager and Sentinel.

Satellite Sensor	Acquisition Dates	Resolution (meters)	Website search ID
ETM+	Feb 2003	30m	LE07_L1TP_169060_20030204_20200916
OLi	Jan 2014	15m	LC08_L1TP_169060_20140125_20200912
OLi	Feb2023	15m	LC08_L1TP_169060_20230203_20230209

Source: Survey of Kenya (2023)

Image Processing

Image processing included Preprocessing, transformation, correction, and classification. Pre-processing techniques for satellite images involve; false color compositing of multispectral bands to be used to discern the unique features to carry out classification using Idrisi remote sensing software. Concatenation was done to delimit the area of interest from the satellite images. Image color stretching and enhancement was also done to improve the contrast and color sharpness in the images.

Image Classification

The images were subjected to both supervised and unsupervised classification for spectral signature of features in order to distinguish various classes such as closed forest, open forest and highly degraded areas and shrub land. Ground-truthing to validate information gathered from satellite images was carried out. The classified raster and vector data was exported to the Geographical Information System (GIS) software Arcgis10.7 for analysis and map design. GIS images were produced to show the change in land cover area for the period from 2003 to 2023.

Table 3.3 Land cover classification scheme used in the study

Cover class	Description
Forests Area (FA)	The continuous stand of trees, many of which may attain a height of 50 m including natural forest, mangrove and plantation forest.
Shrubland (SL)	This class includes true shrubs, young trees in an early successional stage or trees stunted
Grassland (GL)	This class contains cultivated lawns typical of residential neighborhoods, parks, cemeteries, golf courses, turf farms, and other maintained grassy areas
Farmland (FL)	Areas that are under agricultural uses such as crop production and/or active pasture
Bare area (BA)	Mostly non-agricultural areas free from vegetation, such as sand, sand and gravel operations, bare exposed rock, mines, and quarries
Water body (WB)	Open water bodies and watercourses with relatively deep water.

3.7 Validity and Reliability

Tools of data collection were tested to weigh its content, face and construct validity. Face validity was done to determine if the format of the instruments was appropriate and meet all the typology requirements. Content validity determines whether the contents of the instruments are adequate enough to represent the study area and hence worth to be used in drawing general conclusions. Construct validity determined the characteristics measured by the instruments. Peers and my academic supervisors in the Department of Geography at Egerton University reviewed the instrument to check their suitability. Corrections made were implemented to improve the quality of the instrument. Five percent of the study sample was selected for piloting to refine instrument. Twenty households, selected from Menengai Location, were randomly selected for pilot study in order to determine the reliability of the questionnaire. Menengai location possess a demographic composition such as income level, education and family size which mirror the broader target population. This ensures that the pilot study identifies trends that may arise during the main study. According to Kothari, 2004, a small sample should be taken for piloting to minimize chances of pre-emptying the study.

3.8 Data Analysis

To establish the spatial temporal land use land cover changes in peri-urban areas of Nakuru city, the independent variables were time and space while the dependent variables were the land use and land cover. These variables were tested by obtaining Landsat images and processing them to show changes in various classes of land cover. A comparison of area coverage was done in order to rate the extent in which land use land cover changes had occurred from 2003 to 2023 in the study areas.

To determine the extent of LULC changes in the peri-urban areas of Nakuru City, independent variables identified were time and space while the dependent variables were: population increase; demand for housing, basic infrastructure, goods, services and technological factors. Percentage change detection was used to determine the magnitude in which LULC changes occurred in the two episodes. The percentage of area covered by a land cover was individually calculated in regard to the total area in study location. This presented the trend in magnitude of land use land cover changes in the study locations.

To find out the perceived effects of LULC changes on households' livelihoods in peri-urban areas of Nakuru city, high demand for goods and services which occur as a result of the rising population in the city formed the independent variables while the dependent variables included the livelihood strategies and livelihood outcomes. The variables were analysed using descriptive analysis involving calculation of percentages. Cross tabulations were employed to determine whether LULC changes affect households' livelihoods and the kind of relationship between the rising city population and LULC changes in the peri-urban areas of Nakuru City. Descriptive analysis was used to describe the effects of LULC changes on households' livelihoods in the study areas.

3. 9 Ethical Considerations

An introduction letter to National Commission of Science, Technology and Innovation NACOSTI was sought from Egerton University Graduate School. Research permit was obtained from NACOSTI. Respondents were informed on the purpose and the research objectives and their consent sought before data collection exercise. The respondents were assured of their right for voluntary participation while the utmost confidentiality was upheld for the information collected.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents results and discussion on the assessment of the perceived effects of land use land cover changes on households' livelihoods in peri-urban areas of Nakuru City, Kenya. The chapter has five sections with each focusing on a specific subject matter. The first section discusses the response rate of the data collection instruments, while the second section presents the demographic characteristics of the respondents. The remaining three sections discusses the findings of the study in the context of the three specific objectives.

4.2 Response Rate of the Research Instruments

The study targeted a sample of 385 respondents from three peri-urban areas of Nakuru town, namely: Kiamaina, Ngata and Lanet Umoja. The study obtained 292 valid responses out of the 385 semi-structured questionnaires which were administered. This represents a response rate of 75.84%. According to Mugenda and Mugenda (2003) a response rate above 70.0% is considered adequate for data analysis. In addition, the study successfully interviewed nine key informants. The above response rate was considered as sufficient for making inferences from the results. However, the 24.16% non-response rate provided incomplete information, which was not included in the analysis and discussion of the findings.

4.3 Socio-economic Characteristics of the Household Head

This section described the selected demographic characteristics of the sample respondents. The description provided a profile of the respondents and the foundational details for the discussion of the subsequent results. The selected characteristics included age, gender, and highest level of education, household size, employment status and main occupation. These characteristics influenced and determined the land use land cover changes experienced in the study areas.

4.3.1 Age of the Household Head

Age is an important socio-economic factor for conferring status differences in society and determining the roles, responsibilities, and decision-making power at the individual, household, and community levels. This is especially with respect to decision making power at the household level, with regard to issues concerning land use activities. The study established that the respondents had a mean age of 49.29 years with a minimum of 26 years

and a maximum of 80 years. In addition, the respondents had lived in the project sites for an average of 13.13years. The mean age and years lived in the three study areas suggests that the respondents had lived in the areas long enough and thus expected to have gained sufficient knowledge and experiences about the land use land cover changes.

4.3.2 Gender of the Household Head

Gender is an important universal dimension on which society bases and confers status differences. Women and men differ in their needs, challenges, opportunities, and potentials in a settlement, which influences their expected roles, responsibility, and decision-making power. Table 4.1 summarizes the gender distribution of the sample respondents.

Results in Table 4.1 show that 58.2% of the respondents were male, while 41.8% were female. This suggests that more male residents participated in the study compared to their female counterparts. The study attributed the variation in the gender distribution to the dominance of men in decision making concerning land and its utilization.

Table 4 1: Gender Distribution of the Household Head

	Frequency	**Number of respondents (%)**
Male	170	58.2
Female	122	41.8
Total	**292**	**100.0**

4.3.3 Marital Status of the Household Head

The marital status of a respondent influences the social and economic status of a household and the magnitude of the challenges that one faces in the settlement. The economic stability of a household is largely influenced by the marital status of its members. Married couples share household responsibilities. This in turn suggests that such households have diverse ways of attaining food security compared to those made up of widowed and divorced/separated couples.

Results in Table 4.2 show that, 81.5% of the sampled respondents were married, 5.1% had separated, 3.1% were divorced, 1.7% were divorcees and 8.6% were single. With majority of the respondents married, there is a possibility that both the wife and husband actively participate in making decision concerning land use land cover change. The married respondents reported that they had settled in the study areas with their families in order to

obtain a better source of livelihood. Such respondents were concerned about their land use activities.

Table 4.2: Marital Status of the Household Head

	Frequency	Number of respondents (%)
Married	238	81.5
Separated	15	5.1
Widow	9	3.1
Never married	25	8.6
Divorced	5	1.7
Total	**292**	**100.0**

4.3.4 Household Size

Related to the marital status, the respondents were asked about their household size. The study established that the mean household size was 4.52 with a minimum of 1 and a maximum of 8 persons. This was considered important in influencing the socio- economic burden of a household. The findings suggest moderate household sizes given the high cost of living in the study areas.

4.3.5 Level of Education of the Household Head

The level of education influences the perception of people about availability and access to opportunities, participation in decision-making, and the general well-being of an individual. Results in Table 4.3 show that 97.9% of the respondents had attained post-primary school level of education, while the remaining 2.1% had primary school level of education. This level of education was considered adequate in influencing decision making and land use activities undertaken at the household level. This suggests a population that is dynamic and receptive to new ideas, employable, and capable of adopting productive land use activities for high food production and/or incomes.

Table 4.3: Highest Level of Education of the Household Head

	Frequency	Number of respondents (%)
Primary	6	2.1
Secondary	109	37.3
Tertiary college	83	28.4
University	94	32.2
Total	**292**	**100.0**

4.3.6 Employment Status of the Household Head

The level of education of a person strongly determines the kind of occupation one can undertake and even the amount of income to be earned. The main occupation, in turn, influences the level of access to food in a household. Households involved in non-farm activities were expected to have higher incomes while those involved in farm activities have high food production. Therefore, the employment status influences their livelihood strategies, livelihood outcomes, and levels of well-being. The employment status of the sample respondents is summarized in Table 4. 4.

Results in Table 4.4 indicate that 61.0% of the sampled respondents were self-employed, 37.3% had salary employment and 1.7% were unemployed. This suggest that majority of the respondents had a source of income, which could enable them invest in productive land use activities and influence positive livelihoods.

Table 4.4: Employment Status of the Household Head

	Frequency	Number of Respondents (%)
Salary employment	109	37.3
Self-employment	178	61.0
Unemployed	5	1.7
Total	**292**	**100.0**

4.4 Spatio-Temporal LULC Changes in Peri Urban Areas of Nakuru City

Results in Figure 4.1 (a), 4.1 (b), and 4.1(c) shows that classified Landsat images depict various land use land cover changes in the study areas for 2003, 2014 and 2023 respectively. Seven land use land cover categories were classified. The overall classification accuracy was 87.0%. The study area was defined to have seven land use land cover categories namely forests, shrub land, grassland, farmland, built-up areas, bare area and water bodies.

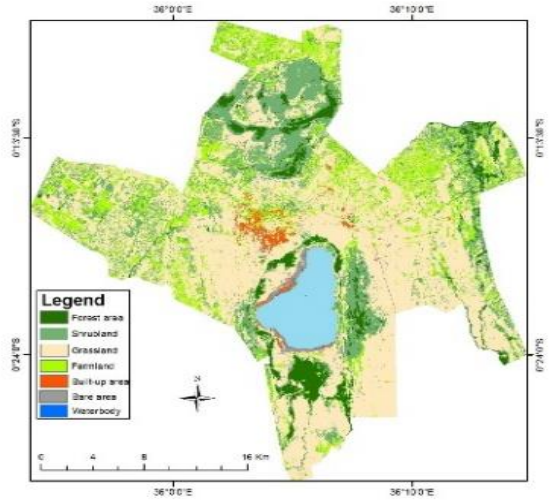


Figure 4.1 (a): 2003

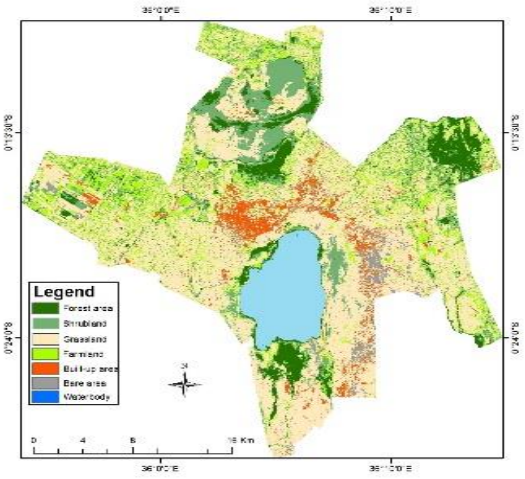


Figure 4.1 (b): 2014

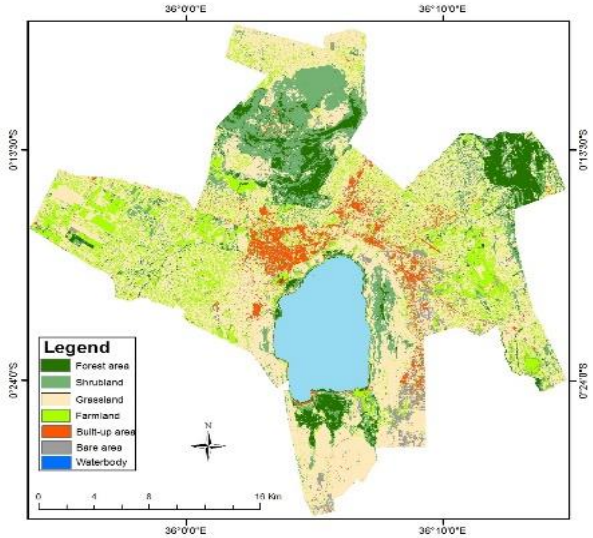


Figure 4.1(c): 2023

Figure4.1: Spatio-Temporal LULC of Peri-urban Areas of Nakuru City

Source: Survey of Kenya (2023)

4.5 Extent and Magnitude of LULC Changes in the Peri-Urban Areas of Nakuru City

This sub-section is divided into three sections: change detection between 2003 and 2014, change detection between 2014 and 2023, land use land cover change analysis. The evidence depicted by the Landsat images and peri-urban household interview results confirmed that land use land cover changes have been ongoing during the study period, but reached a noticeable peak in 2003-2014 period where most areas of land were converted into built-up area and farmlands. This is attributed to the 2007 post-election violence, where majority of the people displaced from other regions migrated and settled in Nakuru town and its environment as revealed by the respondents in a ground truthing exercise.

4.5.1 Land Use Land Cover Change Detection between 2003 and 2014

Results in Table 4.5 show that 6.65%, 20.33%, 50.28%, 15.21%, 1.56% 1.2% and 4.77% of land was under forests, shrub land, grassland, farmland, built-up areas, bare area and water bodies respectively in 2003. In 2014 there were significant conversions from one land use to the other where 7.85%, 14.85%,49.77%, 13.33%, 3.72%,2.774% and 7.7% was covered by forests, shrubs, grassland, farmland, built-up areas, bare area and water bodies respectively. This depicts the highest increase in built-up area by 27.12% and highest decrease in shrub land by 26.94%. There were also significant conversions from one land cover category to another within the same period. There were significant conversions of 2.1% of farmlands to built-up area and 5.4% of shrub land to bare area. Some patches of bare land were converted into forest area. Most areas covered by grass in 2003 had been converted into farmlands and bare lands in 2014 (Table 4.5). This is attributed to the increase in socio-economic opportunities which encouraged people to move from rural areas to Nakuru town in search of formal employment and education. In return, the population pressure and high demand for farm produce from the city catalyzed the rate of conversion of grassland and bare areas into farmlands.

4.5.2 Land Use Land Cover Change Detection between 2014 and 2023

The second comparison was made between 2014 and 2023. 7.85%, 14.85%, 49.77%, 13.33% 3.72%, 2.77%, and 7.7% was covered by forests, shrubs, grassland, farmland, built-up areas, bare area and water bodies respectively. All the land cover categories in the study area were converted to various uses between 2014 and 2023 such that 7.18 %, 15.24%, 45.81%, 15.35%, 4.22%, 3.08%, and 9.10% were covered by forests, shrubs, grassland, farmland, built-up areas, bare area and water bodies respectively. Some area under shrub land

were converted to farmlands and built- up areas. There was also the conversion of shrub-lands, grasslands and farmlands to forests. Bare-lands and shrub- lands were also converted to farmlands and built-up areas. Grasslands and farmlands were significantly converted to bare-lands in 2023 (Table 4.5).

This study showed that generally farmlands, built-up area, bare lands and water bodies increased from 2003 to 2023.Forest area and shrub land however depicted a fluctuating trend with an area decrease in 2014 and then an increase in 2023. Area under grasslands constantly decreased (Table 4.5). The changes in LULC are attributed to population growth which lead to the increasing demands for housing and business premises, these have been increasing at the expense of natural vegetation and agricultural lands from 2003 to 2023. The results are in agreement with the findings of Kamwi and Chirwa et al. (2015) who found out that the drivers of land use land cover change in Zambezi region of Namibia are agricultural expansion, population increase and illegal logging in attempt to obtain livelihoods.

	2003 (Area Ha)	**2014 (Area Ha)**	**2023 (Area Ha)**
Forest area	4633	5473	5008
Shrub land	14171	10354	10622
Grassland	35048	34689	31933
Farmland	9603	9294	10703
Built-up area	2087	2594	2945
Bare area	838	1934	2149
Water bodies	3325	5367	6345
Total area	**69705**	**69705**	**69705**

Table 4.5: Land Use Land Cover Change Analysis per Hectare

4.6 Land Use Land Cover Change and Livelihoods

Objective three assessed the perceived effects of land use land cover change on households' livelihoods in peri-urban areas of Nakuru city. Land is a resource useful in obtaining livelihoods. Any change in its usage has an influence on both livelihood strategies and outcomes. The study sought to investigate: land characteristics, land use land cover changes and the perceived effects of land use land cover change on livelihoods. The study assessed the perception of the sample respondents about the effects of land use land cover changes on

their livelihoods from two perspectives, namely: livelihood strategies and livelihood outcomes discussed in the subsequent subsections

4.6.1 Land Characteristics

The findings of the study indicate that the sampled respondents had lived in the study areas for 13.13 years. The study considered this duration as sufficient for the respondents to have gained adequate knowledge and experiences about the land use land cover changes in their study areas over time. The study established that only 6.8% of the respondents were born in the study areas while the remaining 93.2% migrated to the areas. However, the 93.2% respondents who migrated varied in their places of origin (Table 4.6).

Results in Table 4.6 show that 47.1% of the respondents migrated to Nakuru town, 40.4% came from other towns and 12.5% from rural areas into the study areas located in the peri-urban areas of the town.

Table 4.6: Place of Origin of the Migrants

	Frequency	**Number of respondents (%)**
Nakuru town	128	47.1
Other towns	110	40.4
Rural areas	34	12.5
Total	**272**	**100.0**

4.6.2 Reasons for Migration into Study Areas

Results in Table 4.7 indicate that 41.5% of the respondents migrated to the three study areas in search from better and affordable housing to settle their families. The respondents reported that the high population and rent charges in Nakuru town influenced their movement into the surrounding peri-urban areas in search of better and affordable houses. The respondents bought land in the three study areas where they constructed their family homes. Another 6.3% of the respondents reported that they settled in the three peri-urban areas after retirement from active employment. They preferred the peri-urban areas since they were less crowded and provided cool atmosphere for retirement life.

Table 4.7: Reasons for Migration into the Study Areas

	Frequency	Number of respondents (%)
Better and affordable housing (settlement)	113	41.5
Employment	79	29.0
Marriage	26	9.6
Farming	24	8.8
Retirement	17	6.3
Political violence	13	4.8
Total	**272**	**100.0**

In addition, 29.0% of the respondents moved and settled into the study areas because of availability of employment opportunities outside Nakuru Central Business District. In connection with availability of employment opportunities, 8.8% of the respondents reported that they settled in these peri-urban areas to practice farming because of the huge market in Nakuru town and the surrounding. The respondents engaged in crop and dairy farming, which had ready market within the area and the town centre. The study also established that 9.6% of the respondents lived in the study areas by virtue of marriage and family. The areas were ideal for a family setup, especially for people preferring more privacy and space.

Lastly, 4.8% of the respondents reported that for a long time, Rift Valley region experienced recurrent violent political and ethnic conflicts before, during and after the general political election in the country since the early 1990s. The situation became worse during the 2007 post-election violence, where majority of the people were displaced in the region migrated and settled in Nakuru town and its environs as Internally Displaced Persons. This is also the case in other parts of the world for example, civil war in Thapangthong District, Savannakhet Province, in China which caused reduction of forests and displacement of people (Douangphachanh, 2016).

4.6.3 Land Ownership

After establishing reasons for settlement in the study areas, the respondents were then asked about their land ownership and size.

Results in Table 4.8 show that 73.3% of the respondents owned land with title deeds, 16.4% had leased their land, while 10.3% had rented their land. Therefore, majority of the respondents operated on privately owned land with registered title deeds and full user-rights. The respondents observed that this gave them legal security of tenure and thus state protection against eviction threats. This was an inducement for the respondents to invest more in farm management, renovate, improve, and upgrade their land. Notably, 10.3% of the respondent who had rented land reported that this provided them with opportunities to practice commercial crop farming targeting the ready market in the neighbourhoods and Nakuru town. Crop farming entailed short-term horticultural crops that included assorted vegetables. The remaining 16.4% of the respondents operated on leased land. This was a legal agreement of tenure conferring full user-rights but with no transfer rights over the property (land or house) within a certain fixed period and under specific conditions.

Table 4.8: Land Ownership

	Frequency	**Number of respondents (%)**
Owned with title deed	214	73.3
Leased	48	16.4
Rented	30	10.3
Total	**292**	**100.0**

The land size owned by respondents varied in size. In the study area, the respondents had a mean of 1.95077 acres with a minimum of 0.125 acre and a maximum of 8.0 acres. It was observed that 50.3% of the respondents operated on lands of up to 1.0 acres. The relatively small land sizes were attributed to the high demand and increasing population density, which reinforced fragmentation and intensive utilization of the land in the area. This is line with Zambezi region of Namibia where increase in the population growth rate has led to land fragmentation and thus characterized by small scale farming which form sources of livelihoods (Kamwi and Chirwa et al., 2015).

4.6.4 Changes in Land Size

The researcher asked respondents whether the land size has ever changed since acquisition and summarized their responses in Table 4.9. Results in Table 4.9 indicate that 47.9% of the respondents had not witnessed any change in their land size, 24.0% had observed a decrease

while 28.1% reported an increase. The study established that changes in land size is an individual endeavor, which varied across the respondents. The 24.0% of the respondents reported that the high level of poverty had forced them to sell part of their land to meet other domestic needs. The study established that the high returns from investment in commercial residential homes and/or farming activities had motivated 28.1% of the respondents to buy and expand their land. The remaining 47.9% were comfortable with their land sizes and thus witnessed no change.

Table 4.9: Change in Land Size

	Frequency	Number of respondents (%)
Increased	82	28.1
Decreased	70	24.0
No change	140	47.9
Total	**292**	**100.0**

4.6.5 Land Use Land Cover Change

After establishing the land characteristics, the study went further to interrogate the land use land cover changes among the respondents. The respondents were asked about the main land use activities in the area at the time of migration. Results in Table 4.10 indicate that 40.1% observed open land, 37.3% had farming, and 15.4% had quarrying activities and 7.2% saw residential housing. Majority of the respondents from Kiamaina and Lanet Umoja reported that the two areas were previously open lands with quarrying activities taking place in some pockets of Kiamaina. In Ngata, respondents reported farming since the area was previously an Agricultural Development Corporation farm. However, there are scattered residential housing across the three study areas.

The respondents varied in terms of whether there were changes in land use activities over the years. Accordingly, 76.7% of the respondents reported changes in land use in the study areas over the years while 23.3% had not observed any such changes. The respondents reported that they had experienced farming and open land losing to residential activities over time.

Table 4.10 Main Land Use Activities at the Time of Migration

	Frequency	Number of Respondents (%)
Open land	117	40.1
Farming	109	37.3
Quarrying	45	15.4
Residential housing	21	7.2
Total	**292**	**100.0**

4.6.6 Drivers of Land Use changes

Results in Table 4.11 indicate that the main causes of changes in land use activities included population increase (49.1%), high demand for housing (22.8%), availability of business opportunities (18.3%) and climate change (9.8%). The respondents observed that over the years, the population of Nakuru town has been increasing leading to outward expansion of the town into the surrounding peri-urban areas where the study areas are located. In addition, the population within the three study areas has also been increasing putting a lot of pressure on land and the available land use activities. Over time, the previous open lands and large farmlands had been subdivided into small parcels and change in land use activities. These findings confirm observations of previous studies that land cover change is influenced by both the increase and decrease in given population (Lambin et al., 2003). For example, in Ethiopia, population growth has been a dominant cause of land use land cover changes than other forces (Sage, 1994).

Table 4.11: Main Causes of Changes in Land Use Activities

	Frequency	Number of respondents (%)
Population increase	110	49.1
High demand for housing	51	22.8
Availability of business opportunities	41	18.3
Climate change	22	9.8
Total	**224**	**100.0**

Meyer and Turnner (1994) add that there is a significant statistical correlation between population growth and land cover conversion in most of the African, Asian, and Latin American countries. Population growth leads to the increasing demands of food production, expanding agricultural lands at the expense of natural vegetation and grassland (Lambin et al., 2003).

The respondents also observed that the high demand for housing in Nakuru town and its peri-urban areas had also seen farm and open lands converted into commercial and residential functions to maximize on profits. The high demand for food products in Nakuru town had also led to intensive farming in the peri-urban areas including the study areas. In addition, increased business opportunities in the town and study areas had contributed to the increased quarrying activities to provide building materials. Lastly, the respondents reported that as a result of climate change, there has been increased drilling of water boreholes to supply water in the three study areas and Nakuru city. This is also true to Bufebo and Elias (2020), who in their study mentioned climate change, biodiversity loss, scarcity of basic forest products, habitat alteration leading to human-wildlife conflicts, decline in quality and availability of water, reduction in crop yield as a result of accelerated runoff, and soil degeneration to be the major consequences of land use land cover change in Shenkolla watershed in South Central Ethiopia.

In addition to the study area in general, the study also sought to establish the land use activities among the sample respondents. The respondents were asked about the main land use activity on their land at the time of acquisition and the responses captured in Table 4.12. Results in Table 4.12 show that the main land use activity on the land of the respondents at the time of acquisition were open land (46.9%), farming (41.8%), residential housing (7.9%) and quarrying (3.4%).

The respondents reported that the peri-urban areas of Nakuru town were either government Agricultural Development Corporation land or open lands with limited activities at the time of acquisition of their land. In general, the study areas were ideal for land buying companies who bought large parcels of land, subdivided and sold it to individuals including the respondents in this study. Only a few of the respondents had quarrying and residential housing on the land at the time of acquisition. All the respondents reported that there were changes in the land use activities on their individual lands since acquisition. They had

individually changed the land use activities in accordance with the intended purpose of acquisition.

Table 4.12: Main Land Use Activity at the Time of Land Acquisition

	Frequency	Number of respondents (%)
Open land	137	46.9
Farming	122	41.8
Residential housing	23	7.9
Quarrying	10	3.4
Total	**292**	**100.0**

Results in Table 4.13 show that the respondents were currently using their land for family residence (45.9%), farming (32.5%) and commercial/rental building (21.6%). However, the respondents varied in their reasons for changing the land use activities since acquisition (Table 4.14).

Table 4.13: Land Use Activities on the Land in 2023

	Frequency	Number of respondents (%)
Family residence	134	45.9
Farming	95	32.5
Commercial/rental building	63	21.6
Total	**292**	**100.0**

Results in Table 4.14 indicate that the main reasons for changes in land use activities included need for better and spacious housing (45.9%), need to generate income (34.2%) and availability of market and high demand for farm produce (19.9%). The respondents reported that overcrowding and high rental charges were among the reasons for migration to and settling in the study areas. They preferred to move to construct better and spacious houses for their households. This was reflected by the dominance of single housing units in the three study areas. The respondents added that some of them constructed commercial/rent housing and/or engaged in urban farming to generate additional income by taking advantage of the available market and high demand for farm produce in the town and the surrounding Bustch

(2020), describes peri-urban areas as a multifunctional and complex region, where land uses comprise low density settlement, functional agriculture, open green space, agro-business, and industrial areas. This area also has an abundant supply of relatively cheap land and good road network, which attracts investment and development.

Table 4.14: Causes of Changes in Land Use Activities since Acquisition

	Frequency	**Number of respondents (%)**
Need for better and spacious housing	134	45.9
Need to generate income	100	34.2
Availability of market and high demand for farm produce	58	19.9
Total	**292**	**100.0**

4.7 Perceived Effects of Land Use and Land Cover Changes on Livelihoods

The objective assessed the perception of the respondents about the effects of land use land cover changes on households' livelihoods in peri-urban areas of Nakuru city. Previous studies indicate that land use land cover changes impact on the livelihood strategies and livelihood outcomes of the respective respondents. Land use land cover changes are the most important factor that influences the livelihood since majority of people depend on land and its natural resources for their livelihood. Changes in land use land cover have serious environmental, economic and social impacts on livelihoods. The study assessed the perception of the effects of land use land cover changes on the livelihoods from two perspectives namely the adopted livelihood strategies and associated livelihood outcomes discussed in the subsequent subsections.

4.7.1 Effects of the Land Use Land Cover Changes on the Livelihood Strategies

The sample respondents were asked whether their current land use land cover changes in any way influenced their livelihood strategies at the household level. Results in Table 4.15 indicate that 71.6% of the sample respondents pursued livelihood strategies directly related to the current land use land cover changes in the study areas. The respondents observed that their land use land cover changes created enabling environment that influence their current adopted livelihood strategies. The settlement in the three study areas and the associated opportunities created a conducive environment for their livelihoods. The remaining 28.4% of the respondents observed that their livelihoods have not changed regardless of the changes in

land use land cover changes in the study areas. The 209 respondents enumerated the specific livelihood strategies attributed to the land use land cover changes as summarized in Table 4.15.

Table 4.15: Effect of Land Use Land Cover Change on Current Livelihood Strategies

	Frequency	Number of Respondents (%)
Yes	209	71.6
No	83	28.4
Total	**292**	**100.0**

Results in Table 4.16 indicate that the land use land cover changes contributed to the diversification of income generation opportunities (30.1%), crop farming (27.3%), creation of free time and financial freedom to invest (24.4%), horticultural farming (12.9%), and dairy farming (5.3%). Thus, the land use land cover changes made a significant contribution to the development of livelihood opportunities and strategies among the sample respondents.

Table 4.16: Livelihood Strategies Influenced by the Land Use Land Cover Changes

	Frequency	Number of Respondents (%)
Diversified income generating activities	63	30.1
Crop farming	57	27.3
Creation of free time and financial freedom to invest	51	24.4
Horticultural farming	27	12.9
Dairy farming	11	5.3
Total	**209**	**100.0**

The land use land cover changes diversified the economic opportunities of 30.1% of the respondents in the three study areas. The respondents observed that the main objective was to promote income generating activities as a strategy to improve incomes. The current land use land cover change created an enabling environment, which provided diverse income-generating opportunities and improved local economies. The majority of the respondents

benefited from more than one economic activity thereby expanding their income sources. For example, some of the respondents reported using their plots of land to construct rental houses, while others engaged in commercial farming.

From field observations, majority of the households were engaged in small business activities, which diversified the sources of income among the respondents. In summary, diversification of income generation opportunities provided multiple income sources, minimized vulnerability, and stabilized incomes among the respondents.

Similarly, 24.4% of the respondents reported that their current land use land cover changes enabled them to create free time and financial freedom to invest. Living in their own homes enabled the respondents to save on the amount rent that they previously used to pay property owners in town. This is in agreement with the Von Thunen's model of agriculture land uses which suggests that land rent and transportation cost define the economic activity in the hinterland of a city (Christaller, 1933). The respondents used the saved rental charges to invest and engage in income generating activities within and outside their residence.

Results in Table 4.16 reveal that land use land cover changes enabled 45.5% of the respondents to engage in farming activities including 27.3% in crop farming, 12.9% in horticultural farming and 5.3% in dairy farming. Some of the respondents engaged in farming activities within their compounds while others used their improved incomes to rent land for farming within the study areas. The respondents observed that this was necessitated by the readily available market in the nearby Nakuru town and the surrounding. They engaged in commercial crop and horticultural farming in addition to poultry and dairy farming. From field observations, several respondents had kitchen gardens in their residential plots to boost food availability and generate incomes through the sale of the produce.

The respondents reported that they engage in various types of farming enterprises including crop farming, livestock keeping, and mixed farming. The common food crops grown included assorted types of vegetables (such as kales - *sukuma wiki*, cabbage, spinach, onions, tomatoes, etc.), maize, bananas, sugar cane, beans, and potatoes. The common livestock kept were poultry, goats, sheep, pigs, rabbits, and cattle. This matches the findings of a study on Dynamics of Land Use Changes on the Livelihood of Local Communities in Baringo County where land use changes increased livelihood assets productivity in highlands. The increase in

livelihood assets productivity in highlands of Baringo is associated with security of land tenure under registered private land use (Kateiya et al., 2021).

4.8 Effects of Land Use Land Cover Change on Livelihood Outcomes

From literature review, positive livelihood strategies significantly influence positive and beneficial livelihood outcomes. Changes in land use land cover have serious environmental, economic and social impacts on livelihoods. Therefore, from the conceptualization of the literature review, the study identified eight basic livelihood outcomes including household vulnerability, income, food security, well-being, access to credit, security of tenure, access to quality water and soil fertility. The study asked the 71.6% of the sample respondents who pursued livelihood strategies directly related to the current land use land cover changes to rate their perceived effects on the above eight basic selected livelihood outcomes.

The respondents based their rating on a comparison of the conditions of each of the above selected livelihood outcome at the time of acquisition of land in the area and current status. The rating was done on a five-point Likert scale ranging from 0 to 4. The scale represented a continuum from no effect to very high impact, where 0 indicated negative effect (NE), 1 indicated low positive effect (LPE), 2 indicated average positive effect (APE), 3 was high positive effect (HPE) and 4 indicated very high positive effect (VHE). The higher the score, the more positive effect on a specific livelihood outcome, and vice versa. The respondents also provided a justification of their rating of each selected livelihood outcome. Table 4.17 summarizes the rating of the effect of land use land cover changes on selected livelihood outcomes by the respondents.

Table 4. 17: Rating of the Perceived Impacts of the LULC on Livelihood Outcomes

	Response (%)					**Mean**	**St Dev.**
	NE	**LPE**	**APE**	**HPE**	**VHE**		
Household security of land tenure	2.4	2.9	3.9	13.9	77.5	**3.61**	0.876
Household food security	6.2	6.7	13.4	46.9	26.8	**2.81**	1.096
Household access to credit	9.6	10.5	14.8	20.6	44.5	**2.80**	1.358
Household income	8.1	1.0	23.0	45.9	22.0	**2.73**	1.073
Household vulnerability	23.4	40.7	15.8	11.5	8.6	**2.59**	1.210
Soil fertility	41.6	8.1	0.0	2.4	47.8	**2.07**	1.923

Household well-being – quality of life in terms of health and socio-economic status	36.4	7.7	0.0	32.5	23.4	**1.99**	1.676
Household access to quality water	78.9	3.8	1.9	4.8	10.5	**0.64**	1.352

Results in Table 4.17 indicate that the sample respondents varied in their perceptions of the effects of land use land cover change across the eight selected livelihood outcomes. All the livelihood outcomes had a mean score above 0.000 suggesting some positive effect of land use land cover change on the eight-selected livelihood outcomes. In order of magnitude of the effect, the respondents rated the livelihood outcomes as follows; improved security of tenure, food security, access to credit, income, soil fertility, well-being – quality of life, vulnerability, and access to quality water.

Table 4.17 shows that improved security of land tenure had a mean score of 3.61. Respondents reported that by settling in the study areas, the current land use land cover change encouraged them to pursue and process title deeds for their land. This had witnessed reduced cases of forced eviction and/or demolition of structures, which were previously pervasive in the study areas. Some of the respondents used their land and/or house as collateral to secure credit. Increased security of tenure triggered private investment in housing improvement, wealth production, and property development.

Moreover, the respondents rated improved food security with a mean score of 2.81. The respondents reported improved food security in terms of quality, quantity, access, and availability. They observed that before moving and settling in the study area, they were vulnerable to changes in food availability and prices in Nakuru town. However, their settlement in the study areas and current land use land cover changes had enabled them to engage in farming thereby improving food production and incomes. Some of the respondents used their plots of land for farming, which produced food for domestic consumption and generated income.

Results in Table 4.17 further indicate that improved household access to credit had a mean score of 2.80. The respondents observed that the settlement in the study areas and the associated saving of previous rental expenditure encouraged a saving culture through the formation of saving groups and social networks where residents pooled their meagre financial resources together for investment and provision of affordable credit. In addition, the saving

groups strengthened the bond between members, which in turn strengthened social capital in the study areas.

The land use land cover changes improved household income with a mean score of 2.73. Respondents reported that the main goal of settling in the study areas was to use the saved income to diverse income-generating opportunities, which improved local economic activities and disposable incomes. In addition, the sample respondents rated reduced vulnerability with a mean score of 2.58. Respondents reported that the land use land cover changes enabled them to diversify their income-generating opportunities, which improved incomes and enhanced their purchasing power. In addition, improved access to better and quality housing minimized the threat of eviction, reduced incidences of diseases, and ensured improved well-being. There was increased access to improved water and sanitation, which reduced incidences of water-borne and communicable diseases among the respondents. Thus, diversified income generating activities, access to low-cost housing, and increased access to improved water and sanitation significantly reduced the level of vulnerability among the respondents.

The respondents rated improved soil fertility with a mean of 2.07. They observed that increased farming activities and construction of houses had assisted in better retention of water, reduced soil erosion and improved soil fertility. The respondents also rated improved household well-being and underscored change in quality of life in terms of better health and socio-economic status with a mean score of 1.99. The respondents reported that the current land use land cover changes had a significant positive change in the quality of their lives resulting from improved socio-economic conditions in terms of increased income, food security, access to credit and access to basic services. They reported that there was increased access to improved water and sanitation, which in turn contributed to better health and socio-economic well-being by reducing incidences of water-borne and communicable diseases. Increased access to water enabled respondents to reallocate the time saved and engaged in other IGAs. In addition, the construction of adequate and quality housing had reduced the susceptibility to diseases and illnesses. Some respondents observed that improved security of tenure reduced the threats of eviction and increased access to basic municipal services.

However, according to key informants and sampled respondents, the increased land use land cover changes in the study areas had increased population in the area leading to over-abstraction of ground water through the use of boreholes, degeneration of soil, increased

waste production, reduced forest products, increased volume of surface runoff, and excessive use of agrochemicals. The respondents witnessed a compromise of the access to quality water in the study areas (0.64). This is in agreement with the results of a study on Local Perception of Drivers of Land-Use and Land-Cover Change Dynamics across Dedza District, Central Malawi Region which concluded that LULC changes have a negative effect on availability of natural resources (Munthali et al., 2019). The key informants directly associated challenges such as inefficient provision of services, food insufficiency, illegal settlement, environmental pollution, waste dumping, forest destruction, reduction in water surfaces land dereliction and the overall damage of the scenic beauty to the rapid population growth in the city and land use land cover changes in the peri-urban areas of Nakuru City. This also, is in agreement with a study on Environmental planning and management of the peri-urban interface. The study emphasized that the high dependence on natural resources such as land, forests, and water put pressure on these resources, leading to overexploitation, forest degradation, and deforestation (Allen, 2003).

From results in Table 4.18, the study aggregated the individual scores of the perceived effects on all the selected eight livelihood outcomes into a composite index score known as a livelihood outcome index score. The higher the index score, the higher was the perceived level of impact of the land use and land cover change on the livelihood outcomes among the sample respondents, and vice versa. The index score ranged from a value of 0 indicating negative to 32, indicating very high positive effect. The index score had a reliability coefficient of α = 0.683 with a mean of 19.24. The study transformed the index score into four ordinal categories namely a score of 0 (negative effect), a score of 1-11 (low positive effect), a score of 12-21 (average positive effect), and a score of 22-32 (high positive effect). Table 4.18 summarizes the overall perceived level of effect of the land use and land cover changes on the livelihood outcomes.

Results in Table 4.18 indicate that the sample respondents varied in their overall perception of the effects of land use and land cover changes on the livelihood outcomes in the study areas. On the overall, 52.6% of the respondents rated the land use and land cover change to have a high positive effect on their livelihoods, followed by 35.4% who reported average positive effect and 12.0% with low positive effect. Being beneficiaries of their movement and settlement in the study areas and associated land use land cover changes, the respondents perceived their actions to have a positive effect on their livelihood. The findings are in consonant with previous studies such as Lambin et al. (2003) who observed that land use land

cover changes are associated with positive influences in terms of increases in food production, resources use efficiency wealth, livelihood security, welfare and human well-being.

Table 4.18: Perceived Effect on Livelihood Outcomes

	Frequency	**Number of Respondents (%)**
Low positive	25	12.0
Average positive	74	35.4
High positive	110	52.6
Total	**209**	**100.0**

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter present summary of the findings, conclusions and recommendations of the study.

5.2 Summary of Findings

5.2.1 Spatio-Temporal Land Use Land Cover Changes

Objective one of the study sought to determine the spatio-temporal land use land cover changes in the peri-uban areas of Nakuru City. The results indicate that land use land cover changes are evident in peri-urban areas of Nakuru city. This is seen in variation of area under various land uses from the year 2003 to 2023. The Landsat images and peri-urban household interview results confirmed that land use land cover changes have been ongoing during the study period, but reached a noticeable peak, particularly the expansion of built-up areas and farmlands in the period 2003-2014.

5.2.2 The Extent and Magnitude of Land Use Land Cover Changes

The observed changes varied from one LULC category to another with highest increase in built-up area by 38.64% and highest decrease in area covered by shrubs by 26.94% in the two analysis periods (2003-2014 and 2014-2023). Area covered by some classes such as farmlands and scrublands underwent decrease in the first period and an increase in the second period while other categories such as forest area increased in the first period of study and decreased in the second period. Built-up and bare areas however, maintained an increasing trend while area of land under classes such as shrub land and grassland decreased from2003 to 2023. There is also much of inter-class conversions from 2014 to 2023. Farmlands were converted into built-up areas and forests while grasslands and farmlands were converted into bare-lands.

5.2.3 The Effect of Land Use Land Cover Changes on Households' Livelihoods

Land use land cover changes in the peri-urban areas of Nakuru City is caused by high population pressure in the city. The respondents migrated to the peri-urban areas in search of affordable housing, employment and as internally displaced persons from other towns in the country. The respondents owned land with title deeds, leased and others rented. The land owned varied in sizes. Land use land cover changes, as reported by the households of peri-urban areas of Nakuru city, affect households' livelihoods through diversification of economic opportunities of the respondents who reported that it promoted their income generating activities. The respondents pursued livelihood strategies directly related to land use land cover changes. Such strategies improved the respondents' livelihood outcomes. This includes: increases in food production, resources use efficiency, wealth accumulation, livelihood security, welfare and human well-being. This forms a strong influence towards development of peri-urban areas into an urban environment. However, some of the livelihood benefits from land use land cover changes are short term because they cause environmental degradation in peri-urban areas such as increase in waste and reduction in the quality and quantity of water sources, environmental pollution, waste dumping, forest destruction, reduction in water surfaces land dereliction and damage of scenic beauty.

5.3 Conclusions

Spatio-temporal analysis show that land use land cover changes have occurred over time in the peri-urban areas of Nakuru city.

The area under the different land use categories varies from 2003 to 2014 to 2023. There is no area which maintained same cover in the entire study period. The observed changes varied from one LULC category to another with some maintaining a constant change (increase or decrease) over the two analysis periods (2003-2014 and 2014-2023). This is attributed to population growth which lead to the increasing demands for housing and business premises, these have been increasing at the expense of natural vegetation and agricultural lands from the year 2003 to 2023.

The findings indicate that land use land cover changes have impacted on households' livelihoods. The land use land cover changes diversify the economic opportunities of households in peri-urban areas of a city. This forms a strong influence towards development of peri-urban areas into an urban environment. It is advantageous in that land use land cover changes are associated with positive influences in terms of increases in food production,

resources use efficiency, wealth, livelihood security, welfare and human well-being. However, such advantages do not last long because they cause environmental degradation in peri-urban areas such as increase in waste and reduction in the quality and quantity of water sources.

5.4 Recommendations

This study recommends the following:

i. In order to relieve pressure from large urban agglomeration of developing countries and in this case Nakuru City, national policies and strategies should be implemented towards development of intermediate cities that create employment opportunities for unemployed labour in the rural areas and support rural-based economic activities.
ii. The National and County Governments, as well as, different NGOs should take steps to provide training to all residents about the impact of LULC changes in peri-urban areas of cities. This will help residents undertake appropriate development decisions in the peri-urban areas of Nakuru City.
iii. Alternative sources of livelihood should be adopted to match with the land use land cover changes to reduce natural resources degradation beyond strengthening household income sources.

5.5 Recommendations for Further Research

i. Assessment of land use land cover changes and climate change resilience among households in peri –urban areas of Nakuru city
ii. Assessment of impacts of land use land cover changes on environmental degradation in peri-urban areas of Nakuru City.

REFERENCES

Abebe, G., Getachew, D., & Ewunetu, A. (2022). Analysing land use/land cover changes and its dynamics using remote sensing and GIS in Gubalafito district, Northeastern Ethiopia. *SN Applied Sciences, 4*(1),30. https://doi.org/10.1007/s42452-022-04879-9

Allen, A. (2003). Environmental planning and management of the peri-urban interface: Perspectives on an emerging field. *Environment and Urbanization, 15*(1), 135–147. https://doi.org/10.1177/095624780301500103

Alsharif, A. A., Pradhan, B., Mansor, S., & Shafri, H. Z. M. (2015). Urban expansion assessment by using remotely sensed data and the relative Shannon entropy model in GIS: A case study of Tripoli, Libya. *Theoretical and Empirical Researches in Urban Management, 10*(1), 55–71.

Appiah, D. O., Asante, F., & Nketiah, B. (2019). Perspectives on agricultural land use conversion and food security in rural Ghana. *Sci, 1*(1), 14. https://doi.org/10.3390/sci1010014

Bender, D. R. (1967). A refinement of the concept of household: Families, co-residence, and domestic functions. *American Anthropologist, 69*(5), 493–504. https://doi.org/10.1525/aa.1967.69.5.02a00040

Bhatta, B. (2012). *Urban growth analysis and remote sensing: A case study of Kolkata, India 1980–2010*. Springer Science & Business Media. https://doi.org/10.1007/978-94-007-2169-4

Bonye, S. Z., Aasoglenang, T. A., & Yiridomoh, G. Y. (2021). Urbanization, agricultural land use change and livelihood adaptation strategies in peri-urban Wa, Ghana. *SN Social Sciences, 1*(1), 1–23. https://doi.org/10.1007/s43545-021-00014-0

Briggs, J., & Mwamfupe, D. (2014). Peri-urban development in an era of structural adjustment in Africa: The city of Dar es Salaam, Tanzania. *Urban Studies, 37*(4), 797–809. https://doi.org/10.1080/00420980050004052

Bufebo, B., & Elias, E. (2020). Effects of land use/land cover changes on selected soil physical and chemical properties in Shenkolla watershed, south Central Ethiopia. *Advances in Agriculture, 2020*, 1–8. https://doi.org/10.1155/2020/7108573

Chambers, R., & Conway, G. (1992). *Sustainable rural livelihoods: Practical concepts for the 21st century*. Institute of Development Studies. https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/775

Cheruto, M. C., Kauti, M. K., Kisangau, D. P., & Kariuki, P. C. (2016). Assessment of land use and land cover change using GIS and remote sensing techniques: A case study of Makueni County, Kenya. *Journal of Remote Sensing & GIS, 5*(4), 1–8. https://doi.org/10.4172/2469-4134.1000175

Cho, H. J., Kirui, P., & Natarajan, H. (2008). Test of multi-spectral vegetation index for floating and canopy-forming submerged vegetation. *International Journal of Environmental Research and Public Health, 5*(5), 477–483. https://doi.org/10.3390/ijerph5050477

Christaller, W. (1933). *Central places in Southern Germany* (C. W. Baskin, Ed.). Prentice-Hall.

Cobbinah, P. B., & Amoako, C. (2012). Urban sprawl and the loss of peri-urban land in Kumasi, Ghana. *International Journal of Social and Human Sciences, 6*, 388–397.

Cochran, W. G. (1963). *Sampling techniques* (2nd ed.). John Wiley & Sons.

Dekolo, S., Oduwaye, L., & Nwokoro, I. (2015). Urban sprawl and loss of agricultural land in peri-urban areas of Lagos. *Regional Statistics, 5*(2), 20–33. https://doi.org/10.15196/RS05202

Díaz-Caravantes, R. E., & Sánchez-Flores, E. (2011). Water transfer effects on peri-urban land use/land cover: A case study in a semi-arid region of Mexico. *Applied Geography*, *31*(2), 413–425. https://doi.org/10.1016/j.apgeog.2010.10.010

Douglass, M. (2018). A regional network strategy for reciprocal rural–urban linkages: An agenda for policy research with reference to Indonesia. In *The Earthscan reader in rural–urban linkages* (pp. 124–154). Routledge. https://doi.org/10.4324/9781315188283

Dupar, M. (2021). *Gender in climate action training pack: A resource for practitioners*. https://www.weadapt.org/knowledge-base/gender-in-climate-change/gender-in-climate-action-training-pack

Dutta, V. (2012). Land use dynamics and peri-urban growth characteristics: Reflections on master plan and urban suitability from a sprawling North Indian city. *Environment and Urbanization Asia, 3*(2), 277–301. https://doi.org/10.1177/0975425312473226

Elena Huzui, A., Abdelkader, A., & Patru-Stupariu, I. (2013). Analysing urban dynamics using multi-temporal satellite images in the case of a mountain area, Sinaia (Romania). *International Journal of Digital Earth, 6*(6), 563–579. https://doi.org/10.1080/17538947.2012.678845

Evans, H. E. (1992). A virtuous circle model of rural-urban development: Evidence from a Kenyan small town and its hinterland. *Journal of Development Studies, 28*(4), 640–667. https://doi.org/10.1080/00220389208422237

Feng, Y. (2013). University of Nottingham Ningbo China and Xi'an Jiaotong-Liverpool University: Globalization of higher education in China. *Higher Education, 65*(4), 471–485. https://doi.org/10.1007/s10734-012-9558-8

Forkuor, G., & Cofie, O. (2011). Dynamics of land-use and land-cover change in Freetown, Sierra Leone and its effects on urban and peri-urban agriculture–A remote sensing approach. *International Journal of Remote Sensing, 32*(4), 1017–1037. https://doi.org/10.1080/01431160903586712

Friedmann, J. R. P. (1966). *Regional development policy: A case study of Venezuela* (2nd ed.). M.I.T. Press.

Hasan, M. M., Sharma, A., Johnson, F., Mariethoz, G., & Seed, A. (2016). Merging radar and in situ rainfall measurements: An assessment of different combination algorithms. *Water Resources Research, 52*(10), 8384-8398. https://doi.org/10.1002/2016WR019067

Hudalah, D., Winarso, H., & Woltjer, J. (2012). Peri-urbanisation in East Asia: A new challenge for planning? *International Development Planning Review, 29*(4), 503-520. https://doi.org/10.3828/idpr.2007.29.4.7

Ingram, G. K. (1998). Patterns of metropolitan development: What have we learned? *Urban Studies, 35*(7), 1019-1035. https://doi.org/10.1080/0042098984572

Kalaba, K. F., Chirwa, P., Syampungani, S., & Ajayi, C. O. (2010). Contribution of agroforestry to biodiversity and livelihoods improvement in rural communities of Southern African regions. In *Tropical rainforests and agroforests under global change: Ecological and socio-economic valuations* (pp. 461–476). Springer. https://doi.org/10.1007/978-3-642-00493-3_24

Kamwi, J. M., Chirwa, P. W., Manda, S. O., Graz, P. F., & Kätsch, C. (2015). Livelihoods, land use and land cover change in the Zambezi Region, Namibia. *Population and Environment, 37*(2), 207-230. https://doi.org/10.1007/s11111-015-0246-8

Kateiya, E. L. O., Thuo, A. D. M., & Ombok, M. O. (2021). Dynamics of land use changes on the livelihoods of the local communities in Baringo County: Understanding the drivers. *Open Journal of Social Sciences, 9*(4), 186-201. https://doi.org/10.4236/jss.2021.94014

Knapp, G. (2010). The Andes: Personal reflections on cultural change, 1977–2010. *Journal of Cultural Geography, 27*(3), 307-316. https://doi.org/10.1080/08873631.2010.528754

Kombe, W. J. (2005). Land use dynamics in peri-urban areas and their implications on the urban growth and form: The case of Dar es Salaam, Tanzania. *Habitat International, 29*(1), 113-135. https://doi.org/10.1016/j.habitatint.2003.12.002

Kothari, C. R. (2004). *Research methodology: Methods and techniques* (2nd ed.). New Age International.

Kuusaana, E. D., & Eledi, J. A. (2015). Customary land allocation, urbanization and land use planning in Ghana: Implications for food systems in the Wa Municipality. *Land Use Policy, 48*, 454-466. https://doi.org/10.1016/j.landusepol.2015.06.030

Lambin, E. F., Geist, H. J., & Lepers, E. (2003). Dynamics of land-use and land-cover change in tropical regions. *Annual Review of Environment and Resources, 28*(1), 205-241. https://doi.org/10.1146/annurev.energy.28.050302.105459

Leisz, S. J., Rounds, E., The An, N., Thi Bich Yen, N., Nguyen Bang, T., Douangphachanh, S., & Ninchaleune, B. (2016). Telecouplings in the east–west economic corridor within borders and across. *Remote Sensing, 8*(12), 1012. https://doi.org/10.3390/rs8121012

Maitima, J. M., Olson, J. M., Mugatha, S. M., Mugisha, S., & Mutie, I. T. (2010). Land use changes, impacts and options for sustaining productivity and livelihoods in the basin of Lake Victoria. *Journal of Sustainable Development in Africa, 12*(3), 189-216.

Maxwell, D., Larbi, W. O., Lamptey, G. M., Zakariah, S., & Armar-Klemesu, M. (1998). Farming in the shadow of the city: Changes in land rights and livelihoods in peri-urban Accra. *Cities Feeding People Series; Rept. 23*. International Development Research Centre.

McGregor, S. L. T. (2016). Conceptualizing home and household: Toward a home economics-centric theory. *Kappa Omicron Nu FORUM*, 19(1), 19-1

Mugwedi, L. F., Ray-Mukherjee, J., Roy, K. E., Egoh, B. N., Pouzols, F. M., Douwes, E., ... & Rouget, M. (2018). Restoration planning for climate change mitigation and adaptation in the city of Durban, South Africa. *International Journal of Biodiversity Science, Ecosystem Services & Management, 14*(1), 132-144. https://doi.org/10.1080/21513732.2018.1423354

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

change dynamics across Dedza District, Central Malawi Region. *Sustainability*, *11*(3), 832. https://doi.org/10.3390/su11030832

Narain, V., & Nischal, S. (2007). The peri-urban interface in Shahpur Khurd and Karnera, India. *Environment and Urbanization, 19*(1), 261-273. https://doi.org/10.1177/0956247807076905

Nengroo, Z. A., Shah, A. H., & Bhat, M. S. (2017). Dynamics of land use change in rural-urban fringe: A case study of Srinagar city. *Environmental Science: An Indian Journal, 13*(4), 142-147.

Orewole, M. O., Alaigba, D. B., & Oviasu, O. U. (2015). Riparian corridors encroachment and flood risk assessment in Ile-Ife: A GIS perspective. *Open Transactions on Geosciences*, 2372-6458.

Owusu Ansah, B., & Chigbu, U. E. (2020). The nexus between peri-urban transformation and customary land rights disputes: Effects on peri-urban development in Trede, Ghana. *Land, 9*(6). https://doi.org/10.3390/land9060187

Parsipour, H., Popović, S. G., Behzadfar, M., Skataric, G., & Spalevic, V. (2019). Cities expansion and land use changes of agricultural and garden lands in peri-urban villages: A case study of Bojnurd. *Agriculture & Forestry/Poljoprivreda i Sumarstvo, 65*(3), 193-206. https://doi.org/10.17707/AgricultForest.65.3.16

Perroux, F. (1955). Note sur la notion de pole de croissance? *Économie Appliquée, 8*, 307-320.

Peuquet, D. J., & Duan, N. (1995). An event-based spatiotemporal data model (ESTDM) for temporal analysis of geographical data. *International Journal of Geographical Information Systems, 9*(1), 7-24. https://doi.org/10.1080/02693799508902027

Puertas, O. L., Henríquez, C., & Meza, F. J. (2014). Assessing spatial dynamics of urban growth using an integrated land use model: Application in Santiago Metropolitan Area, 2010–2045. *Land Use Policy, 38*, 415-425. https://doi.org/10.1016/j.landusepol.2013.11.024

Rukwaro, S. K. (2018). *Strategic planning and implementation of constituency development funded projects in Njoro Constituency, Nakuru County, Kenya* (Doctoral dissertation, Kenyatta University). Kenyatta University. Salem, M. (2015). Peri-urban dynamics and land-use planning for the Greater Cairo Region in Egypt. *World Academy of Science, Engineering and Technology, International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering, 9*(5), 494-504.

Shaheen, S. M., Ali, R. A., Abowaly, M. E., Rabie, A. E. M. A., El Abbasy, N. E., & Rinklebe, J. (2018). Assessing the mobilization of As, Cr, Mo, and Se in Egyptian lacustrine and calcareous soils using sequential extraction and biogeochemical microcosm techniques. *Journal of Geochemical Exploration, 191*, 28-42. https://doi.org/10.1016/j.gexplo.2018.04.005

Shaw, B. J., van Vliet, J., & Verburg, P. H. (2020). VU Research Portal. *Landscape and Urban Planning, 196*, 103733. https://doi.org/10.1016/j.landurbplan.2020.103733

Stevenson, A. (Ed.). (2010). *Oxford dictionary of English* (3rd ed.). Oxford University Press.

Strategy, U. S. U. (2016). *UNDP's support to sustainable, inclusive and resilient cities in developing world.* New York: United Nations Development Programme.

Tacoli, C., & Mabala, R. (2010). Exploring mobility and migration in the context of rural-urban linkages: Why gender and generation matter. *Environment and Urbanization, 22*(2), 389–395. https://doi.org/10.1177/0956247810379935

Thuo, A. D. M. (2013). Impacts of urbanization on land use planning, livelihood and environment in the Nairobi rural-urban fringe, Kenya. *International Journal of Scientific and Research Publications, 3*(11), 1-11.

United Nations Department of Economic and Social Affairs/Population Division. (2018). *World urbanization prospects: The 2018 revision*. Working Paper No. ESA/P/WP.252. New York: United Nations. https://doi.org/10.18356/b9e995fe-en

United Nations Economic Commission for Africa. (2008). *The state of African cities 2008: A framework for addressing urban challenges in Africa*. UN-HABITAT.

United Nations Human Settlements Programme. (2018). *The state of African cities 2018: The geography of African investment*. United Nations Human Settlements Programme.

United Nations, Department of Economic and Social Affairs. (2011). *World Urbanization Prospects: The 2018 revision*. https://population.un.org/wup/

Wangai, P. W., Burkhard, B., & Müller, F. (2019). Quantifying and mapping land use changes and regulating ecosystem service potentials in a data-scarce peri-urban region in Kenya. *Ecosystems and People, 15*(1), 11-32. https://doi.org/10.1080/26395916.2018.1562365

Wilson, G. A. (2013). Community resilience: Path dependency, lock-in effects and transitional ruptures. *Journal of Environmental Planning and Management, 56*(1), 1-23. https://doi.org/10.1080/09640568.2012.741519

Xian, G., & Homer, C. (2010). Updating the 2001 National Land Cover Database impervious surface products to 2006 using Landsat imagery change detection methods. *Remote Sensing of Environment, 114*(8), 1676-1686. https://doi.org/10.1016/j.rse.2010.02.018

Yasin, M. Y., Yusoff, M. M., Abdullah, J., Noor, N. M., & Noor, N. M. (2021). Urban sprawl literature review: Definition and driving force. *Geografia, 17*(2), 58-76.

Yirsaw, E., Wu, W., Temesgen, H., & Bekele, B. (2017). Socioeconomic drivers of spatio-temporal land use/land cover changes in a rapidly urbanizing area of China, the Su-Xi-Chang Region. *Applied Ecology and Environmental Research, 15*(4), 809-827. https://doi.org/10.15666/aeer/1504_809827

Zasada, I. (2011). Multifunctional peri-urban agriculture—A review of societal demands and the provision of goods and services by farming. *Land Use Policy, 28*(4), 639-648. https://doi.org/10.1016/j.landusepol.2011.01.008

Živanović-Miljković, J., Crnčević, T., & Marić, I. (2012). Land use planning for sustainable development of peri-urban zones. *Spatium, (28),* 15-22. https://doi.org/10.2298/SPAT1228015Z

APPENDICES

Appendix A: A Household Questionnaire for Peri-Urban Areas of Nakuru City

The purpose of this questionnaire is to collect data which will be used to evaluate the effects of land use land cover changes on households' livelihoods in peri-urban areas of Nakuru City. The information provided will be used exclusively for academic purposes and will be held confidential. Your cooperation and assistance are highly appreciated.

Personal Details

1) Age (in complete years) _____
2) Gender: Male □ Female □
3) Marital status:
   Married □ Never married □
   Separated □ Divorced □
   Widow/widower □
4) Highest level of education
   No formal education □ Primary □
   Secondary □ Tertiary college □
   University □
5) Head of household Male □ Female □ Relatives of the head of household □
6) Household size: _____
7) Residential area Ngata □ Kiamaina □ Lanet Umoja □
8) Employment status
   Salary employment □ Self-employment □ Unemployed □
9) If employed (including self-employment), what is your main occupation? ***Choose only one that applies***
   Farming □ specify _____
   Business □ specify _____
   Public civil servant □ specify _____
   Private sector employment □ specify _____

Land Characteristics

1. How long have you lived in this area? (years) _____
2. If less than 20 years in Qn 1, where did you live before

Rural area □ Nakuru town □ Other towns □

3. What was the reason for migration into this area?

Marriage □ Employment □ Retirement □

Farming □ Others (specify) _____

4. Your land ownership

Own with Title Deed □ Leased □ Rented □ Communal □

5. Your current land size (in acres) _____

6. Has there been any changes in land size since acquisition:

Increased □ Decreased □ No change □

Land use and land cover change

1. What were the main land use activities on this area at the time that you were migrating here? _____

_____

_____

2. Has there been any changes in land use activities since over time?

Yes □ No □

3. If yes, what are the main land use activities currently in this area? _____

_____

_____

4. If yes, what are the main causes of changes in the above land use activities since over time? _____

_____

_____

5. In reference to your land, what was the main land use activity on it at the time of acquisition? _____

_____

_____

6. Has there been any changes in the above land use activities on your land since acquisition? Yes □ No □
7. If yes, what is the main land use activity currently on your land? _____

_____

_____

8. What necessitated the change in the land use activities on your land since acquisition?

_____

_____

_____

Impact of the land use land cover change on Livelihoods

1) In your opinion, has the land use land cover change influenced your current livelihood strategies adopted by your household? Yes □ No □
2) If yes, what are your specific current livelihood strategies directly linked to the land use land cover change? *Identify and explain* _____

_____

_____

_____

3) On a scale of 0 to 4, where 0 = negative effect (NE), 1 = neutral (N), 2 = low positive effect (LPE), 3 = average positive effect (APE), 4 = high positive effect (HPE), rate the level of effect of land use and land cover change on the following livelihood outcomes:

	NE	N	LPE	APE	HPE	Explain
Household vulnerability						
Household income						
Household food security						
Household wellbeing – quality of life (health and socio-economic)						
Household access to credit						
Household security of tenure						
Household access to quality water						
Soil fertility						

Appendix B: Interview Schedule for Key Informants

1. (a)Are there changes in quantity and quality of agricultural production amid land use land cover changes 2003-2023?

   (b) What are the reasons leading to such changes?

2. (a)Are there changes in the number of learning institutions in your area of jurisdiction 2003-2023?

   (b)What led to changes in the number of learning institution?

3. (a)Are there changes in the number of health facilities in your area of jurisdiction 2003-2023?

   (b) What led to changes in the number of health facilities?

4. (a) What is the trend of housing and urban development in your area of Jurisdiction from 2003-2023?

   (b) What are the possible factors towards such variations?

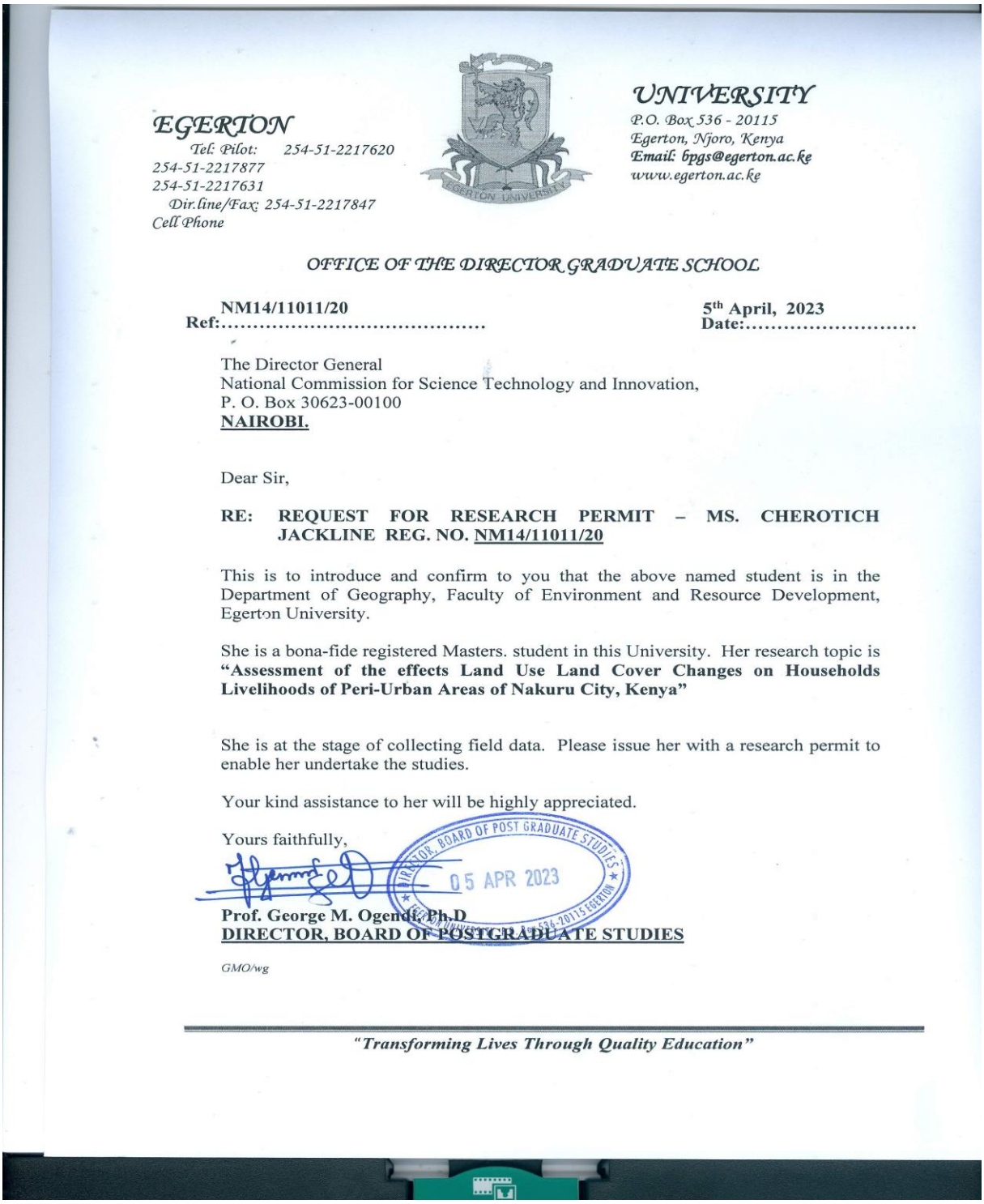
   (c) Are there challenges which have come as a result off the changes above?

5(a) Which environmental trends have occurred as a result of land use land cover changes in your area of jurisdiction?

   (b) Which methods are employed to mitigate challenges?

   (c) Are there difficulties in implementation of strategies?

Appendix C: Introduction Letter



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OFFICE OF THE DIRECTOR GRADUATE SCHOOL

Ref: NM14/11011/20 Date: 5th April, 2023

The Director General
National Commission for Science Technology and Innovation,
P. O. Box 30623-00100
NAIROBI.

Dear Sir,

RE: REQUEST FOR RESEARCH PERMIT – MS. CHEROTICH JACKLINE REG. NO. NM14/11011/20

This is to introduce and confirm to you that the above named student is in the Department of Geography, Faculty of Environment and Resource Development, Egerton University.

She is a bona-fide registered Masters. student in this University. Her research topic is **"Assessment of the effects Land Use Land Cover Changes on Households Livelihoods of Peri-Urban Areas of Nakuru City, Kenya"**

She is at the stage of collecting field data. Please issue her with a research permit to enable her undertake the studies.

Your kind assistance to her will be highly appreciated.

Yours faithfully,

DIRECTOR, BOARD OF POST GRADUATE STUDIES
05 APR 2023
P.O. Box 536-20115 EGERTON

Prof. George M. Ogendi, Ph.D
DIRECTOR, BOARD OF POSTGRADUATE STUDIES

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Appendix D: Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **440883**

Date of Issue: **29/April/2023**

RESEARCH LICENSE

This is to Certify that Miss.. CHEROTICH JACKLINE KITUR of Egerton University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Nakuru on the topic: Assessment of the effects of land use land cover changes on households' livelihoods in peri-urban areas of Nakuru city, Kenya for the period ending : 29/April/2024.

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Appendix E: Publications

Perceived Effects of Land Use Changes on Household Livelihoods in Peri-Urban Areas of Nakuru City, Kenya

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https://doi.org/10.62049/jkncu.v4i2.120

Abstract

High rates of population growth in cities is a global phenomenon. Nakuru City is one of the fastest growing cities in Eastern Africa. The city, performs administrative, educational, tourist, industrial, commercial, medical and transport functions. These diverse functions of the city attract an influx of people that impacts on the growth of Nakuru City, causing notable changes on land use patterns in its peri-urban zones. It in turn affect households' livelihoods. The study sought to find out the perceived effects of land use changes on households' livelihoods in peri-urban areas of Nakuru city. A household survey research was conducted where three hundred and eighty five households were selected for study. Purposive sampling was used to select 3 study locations, Kiamaina, Lanet Umoja and Ngata out of seven locations, Barut, Lanet- Ummoja, Kiamaina, Ngata, Kiamunyi, Viwanda and Mbaruk which surround the city council of Nakuru. Random sampling was used to select three hundred and eighty five households from the study areas. Cross tabulations and calculation of percentages were used to determine the perceived effects of land use changes on households' livelihoods. The results disclosed that the expansion of built-up area and agricultural land has a positive influence on livelihoods as perceived by the households of peri-urban areas of Nakuru city. However, it also has negative effects on natural resources such as reduced access to water and healthy living environment. This study contributes towards achievement of the Kenya's vision 2030 which aims at providing high quality life, clean and secure environment to all through inclusive and participatory stakeholder consultative process involving all Kenyans. Appropriate measures need to be employed to reduce the rapid change in land use and to integrate environmental conservation with human livelihoods.

Keywords: Peri-Urban, Livelihood, Land Use