The Trend of Peri-Urban Land Use Change in Small and Medium Sized Urban Areas. A Case of Kimilili Town, Bungoma County, Kenya

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ABSTRACT

The purpose of this study was to determine patterns in land use change in Kimilili peri-urban areas between 1990 and 2020. We got Landsat data for the years 1990, 2000, 2010, and 2020 from the USGS website. Arc GIS version 10 and ERDAS Imagine version 2018 were used for digital image processing and GIS analysis. Imageries for the following land use groups were obtained using supervised classification using the Maximum Likelihood classification algorithm: built-up area, agricultural land, dense vegetation, and bare terrain. Ground truthing was done in order to get the required reference information. An accuracy assessment was conducted using Google maps at various periods of the year for the LULC maps from 1990, 2000, 2010, and 2020. Change detection analysis was used to carry out land use conversions between the research intervals. The land use types were categorized based on their respective areas, measured in hectares. Over a 30-year period, a notable 16.6% growth in built-up area was seen overall. Additional findings revealed a 16.7% decrease in agricultural land. According to the study, there were notable changes in land usage between 1990 and 2020. Enforcing management standards is necessary in order to maintain control over urban expansion.

Key words: GIS, Kimilili Town, Land Use Change, Peri-Urban, Remote Sensing

I. INTRODUCTION

Several studies have been conducted to ascertain land use changes in small and medium urban centers in Kenya. For example, in Nyahururu town, Kenya, Mandere et al. (2010) looked into periurban development, livelihood shift, and household income. In Lower Kiandani, Machakos Municipality, Mutua (2013) investigated the impact of periurban development on the means of subsistence for indigenous households. These studies used questionnaires as the primary research tool. Questionnaires capture the perceptions of people about how they use their land. The present study, however, departs from the previous studies in terms of data sources and methodology. Given the dearth of information on the impact of spatial expansion of urban settlements on periurban land use, this study employed GIS and remote sensing to show how urban growth is occurring in small to medium-sized urban centers like Kimilili Town. In light of this, the current study used remote sensing data from 1990, 2000, 2010, and 2020 to assess the impact of Kimilili Town's spatial expansion on periurban land usage.

Given that over half of the world's population already resides in urban areas, urbanization is an inevitable socioeconomic phenomenon that is happening everywhere (United Nations, 2018). Population dynamics are strongly linked to this rapid expansion, and it is firmly expected that this trend will continue over the next few decades on a global scale (Araya and Cabral, 2010; United Nations, Department of Economic and Social Affairs, Population Division [UNDESA], 2018). World population increased from 3.3 billion in 1965 to 7.7 billion in 2019. It is projected that by 2030, there will be 8.5 billion in the globe, a figure that is expected to reach 9.7 billion by 2050. At the moment, 55% of people on the planet reside in cities. By 2030, sixty percent of the world's population is predicted to live in cities. If current trends continue, it is predicted that 68% of people on Earth will live in cities by 2050 (UNDESA, 2018).

Africa is undoubtedly one of the Global South's most urbanizing regions, despite the continent still being primarily rural (UNDESA, 2018). Just 14% of the continent's population was expected to reside in towns in the 1950s. Nonetheless, the percentage of people living in cities rose to 43% by 2018 and is predicted to reach 50% by 2030 and 59% by 2050 (UNDESA, 2018). Migration is expected to be less noteworthy than the rise in urban populations in several African countries (Pott, 2012).

Like most of Africa, Kenya is characterized by rapid urbanization and sprawl. The country's urban population is predicted to grow significantly during the coming years. Only 8% of people lived in cities in 1963, and by 2018, that number had risen to 27%. The UN predicts that this percentage will reach 33.4% by 2030. Given the most recent worldwide population trends, it is predicted that this percentage will reach 58% in 2050 (UNDESA, 2018). Kimilili is not an isolated town. The population of the town increased from 13,929 in 2009 (Kenya National Bureau of Statistics [KNBS], 2009) to 17,939 in 2019 (KNBS, 2019), an increase of 2.9 percent per year.

The inevitable consequence of the growing metropolitan population is the spatial expansion of urban regions beyond their boundaries into their hinterlands. According to Seto et al. (2011) and Angel et al. (2011), metropolitan areas increase twice as quickly as urban communities globally on average. Additionally, a number of studies have demonstrated that in recent decades, the average household volume has gradually declined (Haase et al., 2013). Thus, the majority of cities in the global North experienced a rise in the amount of space occupied per inhabitant, which was unquestionably one of the several elements that significantly impacted the spatial growth of the cities. It is anticipated that in the years to come, land resources will be under increasing pressure due to changes in land usage in urban areas worldwide (UNDESA, 2018).

The peri-urban area is the primary area directly impacted by city expansion. Land-use periurban areas are in a transitional state. The community is made up of diverse groups as a result of the variety of land uses; these include the indigenous population, growers, migrants, leisure travellers, industrial users, users of natural resources, developers, builders, and investors (Thuo, 2010). Consequently, the peri-urban areas experience intense, ongoing, and uncontrolled physical expansion. This increases the demand for land resources, leading to a rise in the conversion of valuable agricultural land to commercial and residential uses (Amoateng et al., 2013).

Over fifty years ago, the importance of peri-urban areas increased as a result of the flaws in the rural-urban dichotomy. Metropolitan neighbourhoods, suburban areas, urban peripheries, and peri-city areas are other classifications for peri-city communities. In literary works and policy discussions, the term "peri-urban" is often used (Kamau., 2015). Sites of conflict or rivalry between new (urban) and traditional (rural) uses of the land are the unifying elements or characteristics that are taken from the literature about defining urban areas. Secondly, the external boundaries of peri-urban areas are differentiated with regular maximum commuting distances in CBDs from the urban areas, as posited by the European Conference of Ministers responsible for Spatial/Regional Planning [European Conference of Ministers responsible for Spatial/Regional Planning/Conférence Européenne des Minister Responsables de L'aménagement du Territoire] (CEMAT, 2007).

The main issue facing the town is the unrestrained extension of urban centers to adjacent arable land. According to the County Integrated Development Plan Bungoma 2013–2017 (Government of Kenya [GOK], 2013), fragile ecosystems and prime agricultural land are being transformed into commercial and residential development. Finding the trend of peri-urban land use change in small and medium-sized urban areas—with a particular focus on Kimilili town in Bungoma County, Kenya—was the primary goal of the study.

II. LITERATURE REVIEW

The population growth resulting from natural growth, migration, and the conversion of rural communities into cities is linked to the development of urban land space beyond legal bounds into the hinterland (Fox, 2014). Global population growth trends suggest that the world is becoming more urbanized. In 1950, just 30% of people on Earth were urban dwellers; by 2018, that number had risen to 55%. According to UN-Habitat (2012), if the current trend continues, the percentage of people living in cities worldwide is expected to reach 60% by 2030 and 68% in 2050. Africa is undoubtedly one of the Global South's most urbanizing regions, despite the continent still being primarily rural (UNDESA, 2018). In the 1950s, just 14 percent of the population of the continent was projected to live in towns. However, by 2018, the urban population had increased to 43%, a figure that is expected to rise to 50% by 2030 and 59% by 2050 (UNDESA, 2018).

Like most of Africa, Kenya has experienced rapid urbanization and development. Kenya's population in 1969 reached 10.9 million inhabitants, up from 38.6 million in 2009 and 47.6 million in 2019, an annual increase of 2.3 percent per year. It is estimated that Kenya’s population will exceed 60 million people by 2030 and 77 million by 2050 (Hope, 2012). In 2018, an estimated 27 percent of the total population in Kenya was urban. This is projected to hit 33% by 2030 and 50% by 2050. Kimilili is currently experiencing rapid urbanization as one of Kenya's small and medium-sized urban centres. According to the 1989 population census, Kimilili Town recorded a population of 5483 people. The population reached 7734 people in 1999, 13,929 people in 2009, and 16,833 inhabitants in 2019, with a projected growth to 22,578 inhabitants by 2030.

Previous studies (Mandere, 2010, Thuo, 2010, and Oyugi et al., 2017) suggested that the growth of built-up regions, which may be linked to an increase in population, is the primary driver of a shift in the types of land uses that occur on the outskirts of towns. A high birth rate, internal migration from the countryside, and external migration from outside the country all contribute to the growth of cities. In order to accommodate the continuously rising urban population, the expansion of urban settlements into the hinterland becomes inevitable.

According to Oyugi et al. (2017), there is an increasing demand for homes, enterprises, factories, and institutional buildings due to the world's rapid population expansion. Rapid changes in land use follow, leading to the growth of informal settlements and urban sprawl. The mass of periurban land is reduced to areas that are not suitable for agricultural production as a result of these changes in periurban land use. Because of this, people living in periurban areas have stopped cultivating (Abbas & Afua., 2013; Mandere et al., 2010). For example, in a 2013 study, Abbas and Afua noted that the proportion of farming households in Periurban Kumasi, Ghana, decreased from over 89% in 1986 to 40% in 2013. However, a survey conducted in 2010 by Mandere et al. in peri-urban Nyahururu found that 49% of households no longer depended on farming as their primary source of income, as compared to 90% in 1960.

According to the studies mentioned above, although agriculture is still a significant economic sector in periurban areas, the number of households making farming their primary source of income is declining, which significantly reduces the agricultural sector's economic value. Land uses that overlap, such as industry, transportation, public usage, residential, commercial, and recreational, may be the cause of this (Abbas & Afua, 2013).

In order to tackle the problems caused by the exponential expansion of small and medium-sized towns in Kenya, a spatially feasible planning framework that recognizes and foresees changes in urban land use and the consequences that follow is needed. According to Mubea and Menz (2012), remote sensing and GIS techniques therefore form an integral component in the mapping of urban land use patterns and the provision of real-time data needed for policy formulation and intervention planning.

III. METHODOLOGY

3.1 Research Design

The effects of Kimilili Town's spatial development on the use of periurban land were examined using a descriptive research design in this study. To ascertain land use differences over time in the study area throughout the preceding three decades, remote sensing and GIS analysis were employed for the period 1990-2020. The research area is shown in Appendix 1.

3.2 Methods of Data collection

3.2.1 Key Informant Interviews

Data from the Lands Office, the Department of Survey, the Department of Physical Planning, and the Municipal Manager were gathered through key informant interviews.

3.2.2 Remote Sensing Images

Over the course of three decades, from 1990 to 2020, the extent of land use changes in Kimilili peri urban areas was ascertained using a collection of remote sensed data. This was accomplished by determining alterations in periurban land use over a thirty-year span. From the USGS website, landsat data for the years 1990, 2000, 2010, and 2020 was downloaded. Since Landsat data is freely accessible, it was chosen. Table 1 below lists the land satellite pictures that were utilized for the research.

Table 1

Landsat Images used in the Study

Data	Year	Band	Spatial Resolution
Landsat 4	7.02.1990	TM	30m
Landsat 7	14.09.2000	Enhanced TM	30m
Landsat 5	21.01.2010	TM	30m
Landsat 8	13.09.2020	OLI	30m

Source: USGS Explorer

3.2.3 Methods of Data Processing and Analysis

Spatial data was processed and analyzed using ARC GIS version 10 and ERDAS envision version 2018. The World Geodetic System (WGS) 1984 UTM Zone 36N was used as the datum for all satellite photos that were downloaded from the USGS website. This allowed for accuracy in all of the photographs.

In order to extract photographs of the specified study area, data analysis was performed by clipping areas that encompassed the study periods of 1990, 2000, 2010, and 2020, utilizing the boundaries of Kimilili ward and Kibingei ward. Using the Maximum Likelihood approach, supervised classification in ERDAS Imagine was used to produce the following land use classes for the previously indicated study period: developed region, farmland, heavily forested area, and bare land. Every year's percentage change for every land use category was calculated. Tables were utilized to calculate the trend of land use change over the study period, expressed in hectares.

IV. FINDINGS & DISCUSSIONS

4.1 Land Use Classification

Four primary land use types were identified following supervised classification: built-up area, agricultural land, dense vegetation, and barren terrain. Land use maps showing changes over time were created from the 1990, 2000, 2010 and 2020 classification data (Figure 2). Table 2 displays the findings of the pattern of land use change in the research region between 1990 and 2020.

Table 2

The Trend of Land use Change in the Study Area between 1990 *and* 2020

	1990		2000		2010		2020		1990-2020 Percentage change
Land use type	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**	**%**
Agricultural land	2876	59.5	2742	56.8	2536	52.5	2067	42.8	- 16.7%
Bare land	526	10.9	56	11.6	1010	20.9	1591	33.0	22.1%
Built up area	54	1.1	287	5.9	378	7.8	856	17.7	16.6%
Dense vegetation	1474	28.5	1241	25.7	906	18.8	317	6.5	- 22.0%
TOTAL	**4830**	**100.0**	**4830**	**100.0**	**4830**	**100.0**	**4830**	**100.0**	

Source: *Researcher's Analysis* (2021)

Each year, the area of land cover and utilization was computed by deducting the area from the previous year's area. The variation shows how land use is changing in terms of the region it affects spatially as well as the direction it is moving in. The percentage increase or decrease of each land use was then determined by computing the percentage change of each land use, as shown in Table 2 above.

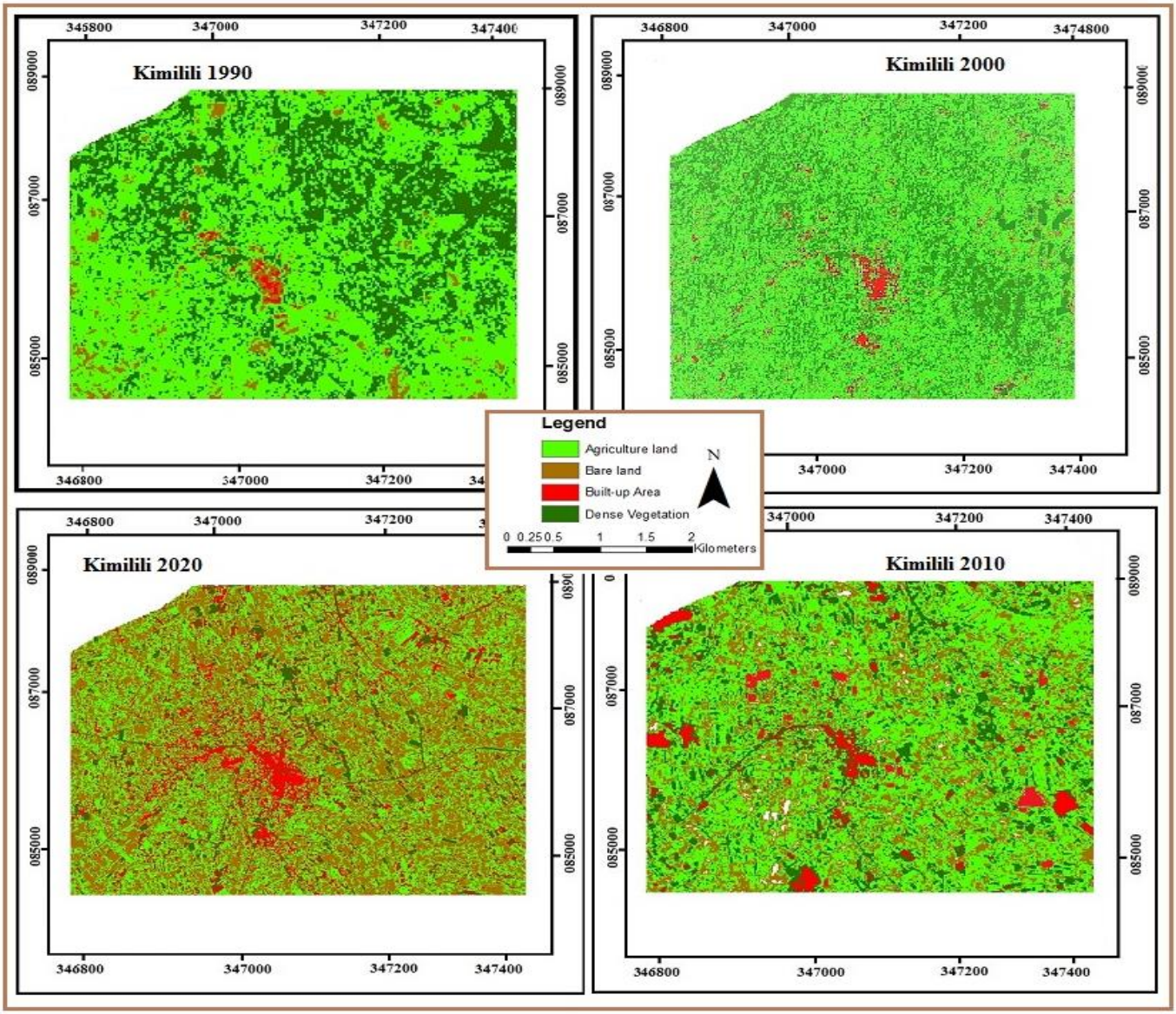

Figure 1
Land use and Land Cover Maps for the Study Area
Source: *Researchers analysis in Erdas Imagine* V.2018 (2021)

As demonstrated in Table 2 and Figure 1, in a 30-year period, built-up area increased significantly from 1.1% in 1990 to 17.7% by 2020, accounting for 16% of the change. The area under agriculture, on the other hand, showed a continuous decline from 59.5% in 1990 to 42.8% in 2020, representing a 16.7% decrease over a period of 30 years. The results revealed a negative relationship between built area and agricultural land, implying that an increase in built area results in a corresponding decrease in agricultural land. This may indicate increased land conversions in the study area, primarily from agricultural to non-agricultural use. The results further revealed an increase in bare land during the period under study. This may be attributed to the increased subdivision of land for sale in the study area.

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

The aim of this study was to establish the trend of peri-urban land use change in small and medium-sized urban areas, with a specific focus on Kimilili town in Bungoma County, Kenya. The built-up area of the studied region rose exponentially from 1.1% in 1990 to 17.7% in 2020, according to spatial-temporal analyses conducted in the area.

The data also show that, during the same time period, the percentage of land used for agriculture fell from 59.5% in 1990 to 42.8% in 2020. The built-up area and agricultural land use are the two areas that have changed the most, with the former increasing and the latter declining. The loss of agricultural land has led to a decrease in agricultural output. For periurban households that rely on agriculture for their daily livelihood, this presents a threat. Due to agricultural disruption, there is a greater food shortage, which has led to high food prices, challenging economic conditions, and poverty.

5.2 Recommendations

Households deploy three different coping mechanisms to deal with these changes: the utilization of non-farm (formal and informal work) or both farm and non-farm (intensification and diversification) techniques. According to Thuo (2010), these adaptation techniques provide households with a substitute source of income. There is an urgent need to implement management measures to guarantee that urban expansion is controlled in order to protect peri-urban livelihoods.

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APPENDIX 1: MAP OF RESEARCH AREA