Assessing the Determinants Influencing Land Use and Land Cover Change on Land under Maize Cultivation in Likuyani Sub-County, Kakamega County, Kenya

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ABSTRACT

For numerous years, human activities have involved modifying land to sustain basic needs like food which has brought various changes on the Earth's surface. Likuyani Sub County is endowed with good climatic conditions for farming and human settlements. The main cause is rapid population increase, which leads to the division of land into smaller and less profitable units. The objective of the study was; to assess determinants influencing (LULCC) Land use Land cover Change in the maize-cultivating areas of Likuyani Sub County Kakamega County, Kenya from 1997 to 2017. The research employed a descriptive and correlational research design. A study sample size of 286 respondents was used. The data collection tools used were questionnaires and Registry Index Maps which were analyzed using SPSS and ArcGIS 10.3 software respectively. The findings from this study showed that land subdivision, population, market forces and crop diversification affected land use and land cover changes on land used for maize cultivation in Likuyani Sub County from 1997 to 2017. Regression analysis statistical techniques revealed the detrimental impact of land alterations on land under maize cultivation. The study recommends restriction of crop diversification in maize growing areas and minimum land size of one hectare. The study informs policymakers to address gaps in land management and reserve land as a means of sustaining livelihoods. The study concludes that that land use and cover dynamics arose due to dynamicity of human activity.

Keywords: Land Cover Change, Land Sub-Division, Land Use

I. INTRODUCTION

Spatiotemporal usage of land and changing coverage has diverse effects on various land cover types. These changes have a huge impact on ecology, hydrology, agriculture, forestry, and the environment, according to (Food and Agriculture Organization (FAO, 2021). The paper focuses on the agricultural sector particularly land under maize cultivation, maize being the primary staple food crop in Kenya.

The transformation in the use of land and coverage in Likuyani Sub County commenced following transition in land ownership to the Kenyan government after independence and has been progressive over the years, the "Government of Kenya" (GOK, 2020). The changes have mainly been attributed with Increase in Population, Land Subdivision, Market Values and Business Opportunities.

The rise in population within a region often leads to a decrease in land allocated for maize and crop cultivation, as segments of agricultural land are transformed into residential areas. In Likuyani Sub County, some of the factors contributing to population growth have been linked to land purchase and settlement by people from outside the Sub County who are attracted to the fertile land, (Wanyama 2017). Large property holdings in Likuyani Sub-County, spanning from 15 to 100 acres, have drawn people from neighboring highly populated counties such as Vihiga County, resulting in a population growth in Likuyani Sub-County. Some of the new landowners believe that growing other crops would be a better investment than growing maize when they develop and settle on the property.

Another factor which has led to Land use Land Cover Change (LULCC) in Likuyani sub-county include land subdivision. This is the practice. The practice of splitting larger land parcels into smaller pieces for the purpose of selling, inheritance, better managing the smaller component, or using the separate portions for different purposes. Succession and inheritance culture where assets, including land, are divided among heirs one after the other or among a family's sons solely, (Wanyama 2017). This is one of the main reasons for land subdivision. When the land is divided into ever-smaller portions, eventually it becomes unsustainable for any kind of profitable agricultural activity (Peacock, 2014). The area used for maize cultivation is significantly impacted by this change in land use.

Also, the establishment of Kongoni town as a new sub county headquarters since Likuyani Sub County was established, and growth of other urban centers has led to increased demand for housing sub county employees and

company owners. The farms that are closer to these growing municipalities are quickly transitioning from agricultural to populated areas therefore increasing the rates of subdivision of larger parcels into smaller parcels for sale or housing, Wanjala (2016). The primary catalyst behind land use changes in Likuyani Sub-County has been the expansion of cropland, chiefly observed along riparian lands due to their favorable conditions such as water availability for irrigation and suitable environments for farming.

Market values and Business Opportunities equally influence several dynamic land use patterns, which alter biodiversity (Mwangi, 2016). The crops a farmer grows each year depends on market prices. Since maize is farmed in Likuyani Sub County both as a cash crop and a subsistence crop, this directly relates to the farming of maize there. Farmers are deterred from producing the same crop and instead choose to cultivate crops that command higher prices in the market by the declining market prices of maize. A major factor in the change in land use is economic opportunity, (Njiru, 2016).

The study illustrated the interconnected components within this framework, that are key drivers that significantly influence land use land cover change, encompassing population increase, climate change, land subdivision, and alterations in land use patterns. Population growth is closely associated with an augmented demand for land, primarily for construction purposes, (Akgün et al., 2019). However, the availability of land remains fixed. Consequently, with a surge in population, the escalating demand for land for construction purposes inevitably leads to trade-offs, necessitating the sacrifice of other land uses. This dynamic interaction among independent variables such as population increase and land demand represents the dependent variable under scrutiny (Kathumo, 2011). These components form the core structure of the study's framework, outlining the interdependence and influence of various factors on land use transformations.

Existing studies often focus on either biophysical or Socio-economic dimensions of LUCC without looking at the criterion for integrated perspectives. Integrated approaches are crucial in the framing of sound strategies to address the issues of land management with consideration of the social as well as ecological factors as buttressed by Ndegwa et al. (2019). The current study aims to utilize GIS data manipulation on RIMs and SPSS regression techniques to provide more accurate and further research on factors contributing to LULCC on land wherein maize crops are grown in Likuyani Sub-County, Kakamega County, Kenya.

1.2 Research Objective

The overall objective of this study was to assess the determinants influencing LULCC in the maize cultivating areas of Likuyani Sub County from 1997 to 2017

III. METHODOLOGY

3.1 Study Area

The study aimed at identifying factors that affect LULCC of land that was under maize farming in Likuyani Sub County from 1997 to 2017 was done on Likuyani Sub County of Kakamega County, Kenya. This area is approximately located at latitude 0 37”0”N and longitude 34 57”0”E and the geographical coordinates of this area ranges from 0 42”0”N, 34 52”0”E in the northwest and 0 33”0”N, 35 03”O in the southeast. The research domain The Likuyani sub-county, one of Kakamega’s County, spans around 309 square kilometers. Situated between 1300 and 1800 meters above sea level.

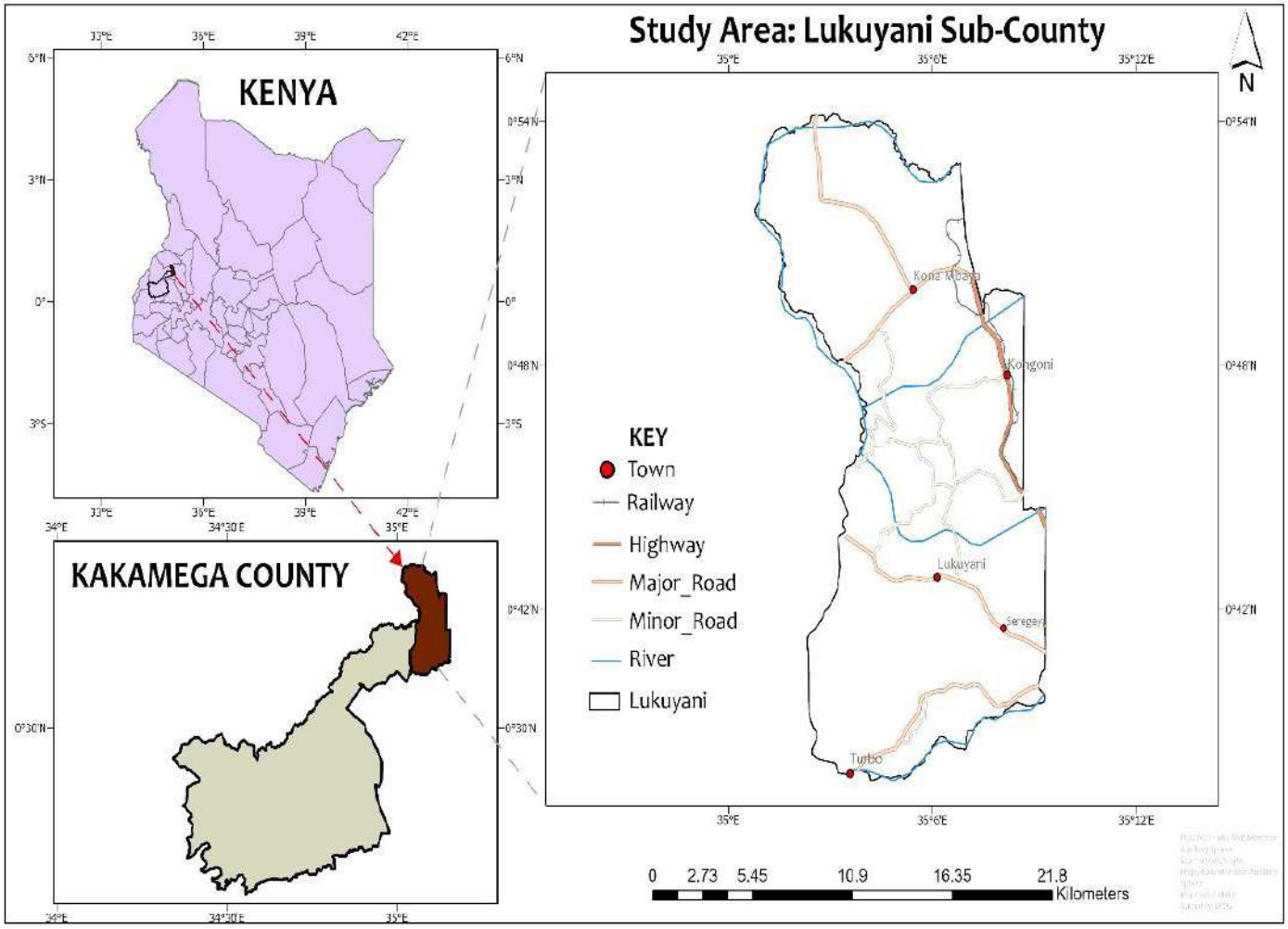

Figure 1
Map of the Study Area
Source: Survey of Kenya Maps

3.2 Research Design

The study used descriptive and cross-sectional research design, and both primary and secondary data was used to provide comprehensive evaluation on the factors that determine the changes in land use and land cover on land used in growing maize in Likuyani Sub-County. Primary data included field observations to directly ascertain ground cover types and questionnaires administered to local respondents to gather qualitative insights on land use practices and socio-economic factors influencing land use change.

Secondary data comprised the analysis of the Land Adjudications Office Records for historical land ownership information, topographic and registry index maps for geographical and land subdivision details, and population data from the Kakamega County Bureau of Statistics to understand demographic impacts on land use. This mixed-method approach ensured a holistic understanding of land use dynamics, integrating accurate, up-to-date observations with historical and demographic data to support sustainable agricultural practices and policy-making in the region (Siedlecki, 2020). The plan employed to carry out this research is described in this section, and it is based on the particular objectives and research designs chosen.

3.3 Sampling Techniques

With regard to the respondents the researcher purposively targeted households for the causes of land use and land cover change data. The study sample population was then arrived at after ground labelling, land use analysis, land cover analysis as well as the degree of land subdivision. This approach aimed to target areas exhibiting substantial instances of land subdivision, ensuring that the sampling focused on locations with notable occurrences of land division.

3.4 Sample Size

The total quantity of the land portions available to the farmers at the onset of the settlement schemes was used to estimate a convenient sample size based on descriptive survey of the Survey of Kenya land settlement scheme data. That is, one land parcel = one respondent. A sample size should be really big enough in a way that it represent the entire population as pointed in Mugenda & Mugenda (2015). The sample size was determined by the researcher using the Krejcie and Morgan (2012) formula shown below;

$$s = \frac{x^2 \mathrm{Np}(1-\mathrm{p})}{p^2(\mathrm{N}-1)+x^2 p(1-p)} \quad (1)$$

Where:

S is the desired sample size

X^2 is the table value of chi-square for one degree of freedom at desired confidence level which is 1.96 x 1.96= 3.8416

N is the population size

P is the population proposition assumed to be 0.05 since this will provide maximum sample Size and is the degree of accuracy expressed as a portion 0.05:

Kothari (2015) contributed that the criterion for an adequate sample size is when it is at least 10% of the targeted

$$\mathbf{S} = \frac{3.8416 \text{ X } 1123\text{X } 0.5\ (1- 0.5)}{0.05^2\ (1123\text{-}1) + 3.8416 \text{ X } 0.5(1- 0.5)} = \mathbf{286} \text{ Respondents}$$

population. The researcher sampled 286 participants (n=286) which is 25.5% of the target population. To get sample distribution for each settlement scheme, the same formula was applied (n) being the number of land parcels representing households. For Sango, n = 540 and applying the formula, the sample size is 225 respondents. Same was applied to the rest of the settlement schemes giving the results in Table 1.

Table 1

Sample Size Distribution per each Settlement Scheme and Area Occupied in Hectares

Settlement scheme	Sample Population %	Area (Hect)
Sango	225	4353.9
Sergoit	13	3705.2
Soy	7	3036.5
Nzoia	41	3448.5
Total	286	11095.6

3.5 Data Collection Methods and Tools

The survey was based on the primary and secondary type of data collection procedures. The secondary data meant Topographic and Registry index maps (RIMs) were collected from Survey of Kenya offices. Data were collected through self-developed structured questionnaires filled by landowners together with direct observations on the ground cross-checked with GPS points. The study benefited from the use of some software tools to process and present the data that were collected including: SPSS and ArcGIS 10.3.

3.6 Data Analysis

This research employed both qualitative and quantitative research studies in diagnosing the effects of land use land cover changes across time and space on the area under maize production in the four settlement schemes within Likuyani Sub County. The qualitative data was analysed through scrutiny of open-ended questions to identify and categorize patterns relevant to the study objectives, following the approach suggested by Mugenda and Mugenda (2015). The patterns were then used to generate linear regression models for the results.

The quantitative data was written down and recorded on the Statistical Package for Social Sciences (SPSS) version 20 for further data analysis. In the analysis of the findings, data was used in tabular form and figures. Imagery data analysis used ArcGIS 10.3 Software and was presented as Choropleth Maps.

3.7 Ethical Considerations

The Research study was approved by NACOSTI and given license number NACOSTI/P/21/11211 after the approval from Masinde Muliro University of Science and Technology. The study involved human adults whose consent was oral agreement. The researcher made sure that the information that respondents submitted would remain private. The study made sure that participants had the right to privacy and were shielded from harm both psychological and

physical. The respondents were given enough information about the study's goal that was both clear and sufficient for them to make an informed decision about whether or not to participate.

IV. FINDINGS & DISCUSSION

4.1 Overview

The study revealed that the main determinants influencing LULCC in maize cultivating areas from 1997 to 2017 are Land Subdivision, Socioeconomic Influence-land hereditary practices, Population Increase, Diversification in type of plants cultivated and Market Forces.

4.1.1 Land Subdivision

The purpose of the study was to evaluate factors affecting LULCC in the districts growing maize in Likuyani Sub County over the period between 1997 and 2017. This which included examining the extent of land subdivision within the area into parcels deemed unsuitable, (less than 50 square meters in size), for sustainable land under maize cultivation, market forces, socio economic influence and diversity in types of plants grown.

Utilizing digitized RIMs of the chosen four settlement schemes, valuable insights were obtained regarding the degree of land subdivision present in the region. Table 2 provided below presents a summary encompassing the sizes and count of land parcels during the schemes inception, the number of subdivided parcels per settlement scheme at the time of RIM acquisition, parcels smaller 50 meters square per settlement scheme, and the percentage of subdivisions per settlement scheme.

Table 2

Settlement Scheme Distribution and Allocation of Land Parcels

Settlement Scheme	Number of Allocated land parcels	Parcels Subdivision After subdivision	No of land Parcels less than half Acre	Percentage Land subdivided
Sango	540	1335	156	247
Sergoit	190	929	63	489
Soy	156	831	113	533
Nzoia	237	412	24	174

Data extracted from Table 2 reveals notable observations regarding land subdivisions in the study area. Sango settlement scheme displayed the highest count of initially allocated parcels at the inception of the scheme. Additionally, it also exhibited the greatest number of subdivided land parcels, particularly those below 50 square meters in size. Sango, characterized by gently sloping plains and situated just 8 km from the nearest access point to the Eldoret-Kitale highway, has drawn considerable interest from potential land buyers. This accessibility has significantly contributed to the rise in land subdivision within this scheme. The digitized land subdivision maps of the four settlement schemes offer a visual representation of the land subdivision patterns observed. Figure 3.1 entails land subdivisions from the initial 540 parcels to 1335 parcels in Sango scheme

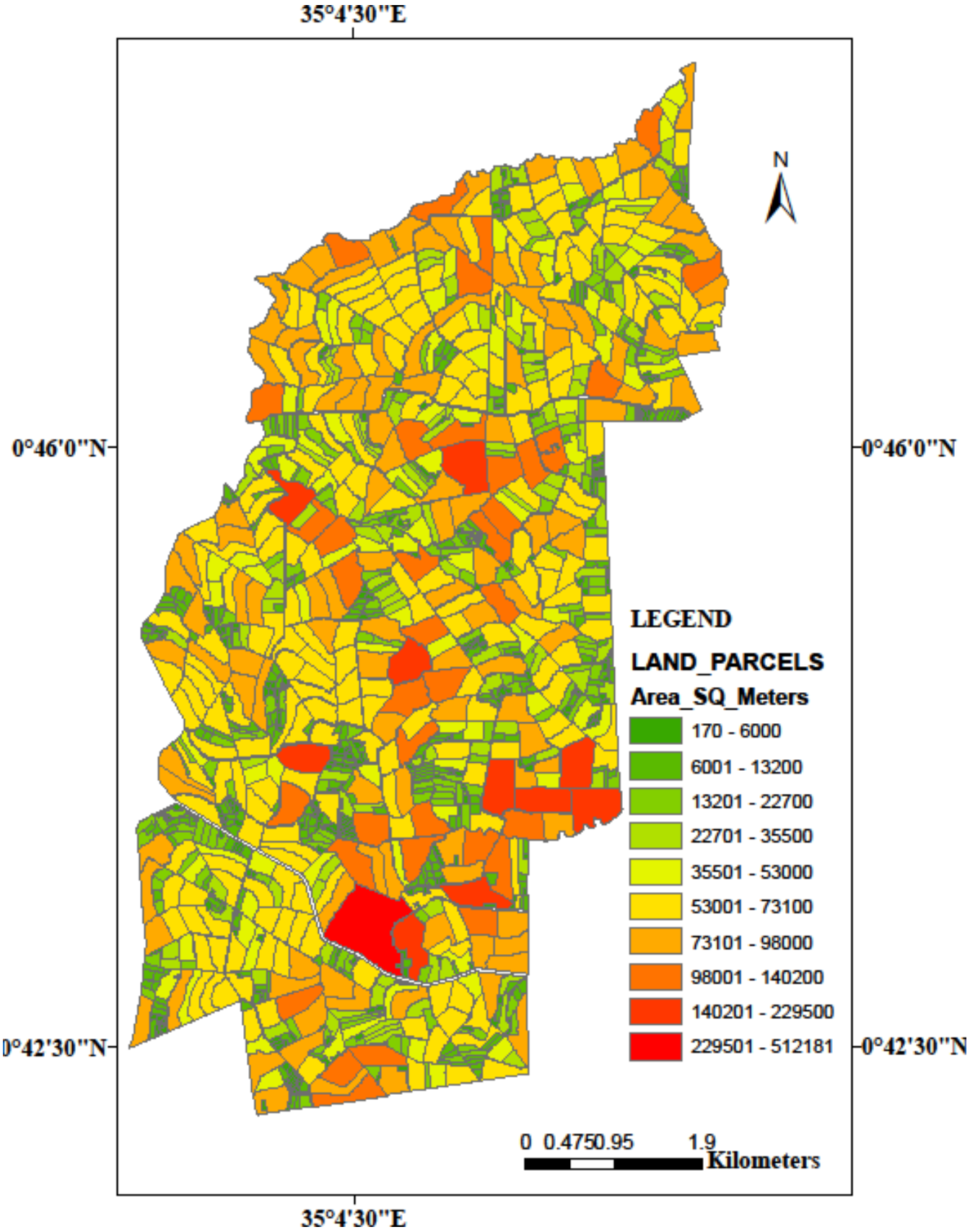

Figure 2
Sango Settlement Scheme Land Subdivision Map
Source: Survey of Kenya RIM Maps 2021

Figure 2 represents the map of Sango settlement scheme land registered subdivisions as per the year 2017 in colour ranking. The colour ranking from green through yellow to red. The colour scheme rates the plots from the smallest

in area to the largest in square meters. The smallest being deep green and the largest deep red. It can be seen the smallest land parcel has an area of 170 square meters and the largest parcel has an area of 512181 square meters. The dominant colour is yellow ranging between 35501 and 53000 square meters. Much of those colored green are located along roads. The least number of land parcels are those in red. This depicts most of the land has undergone subdivision in Sango settlement scheme as per the year 2017. Since land subdivision goes in tandem with population, it can be inferred that the population of Sango did increase within the study period. Figure 3.2 represents the map of Nzoia scheme after land subdivision from the initial 237 parcels to 412 parcels.

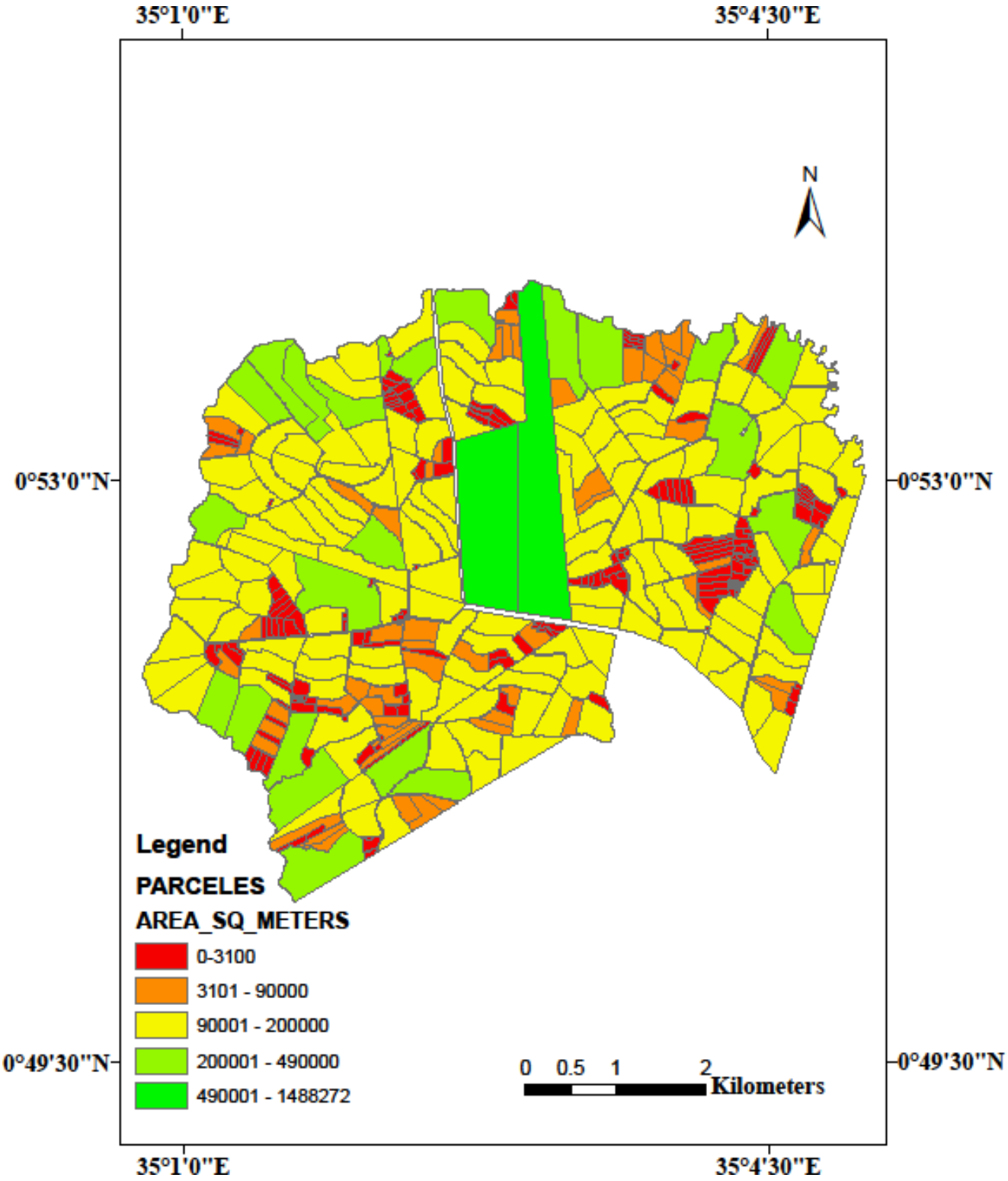

Figure 3
Nzoia Settlement Scheme Land Subdivision Map
Source: Survey of Kenya RIM Maps 2021

Figure 3 represents the map of Nzoia settlement scheme registered land parcels in colour ranking as per the year 2017. The acreages are presented in colour ranking from red through yellow to green. Red representing land parcels with the smallest acreage and green representing land parcels with the largest acreage in the region. The yellow is dominant in Nzoia settlement scheme ranking between 90001 and 200000 square meters. Nzoia settlement scheme had the largest size in land parcels allocations and least land subdivisions. The large land parcels ranked in green are less in number and those ranked in red as the smallest in area are mostly located along main roads.

Figure 4 represents the map of Sergoit settlement scheme after land subdivision from the initial 190 parcels to 926 parcels.

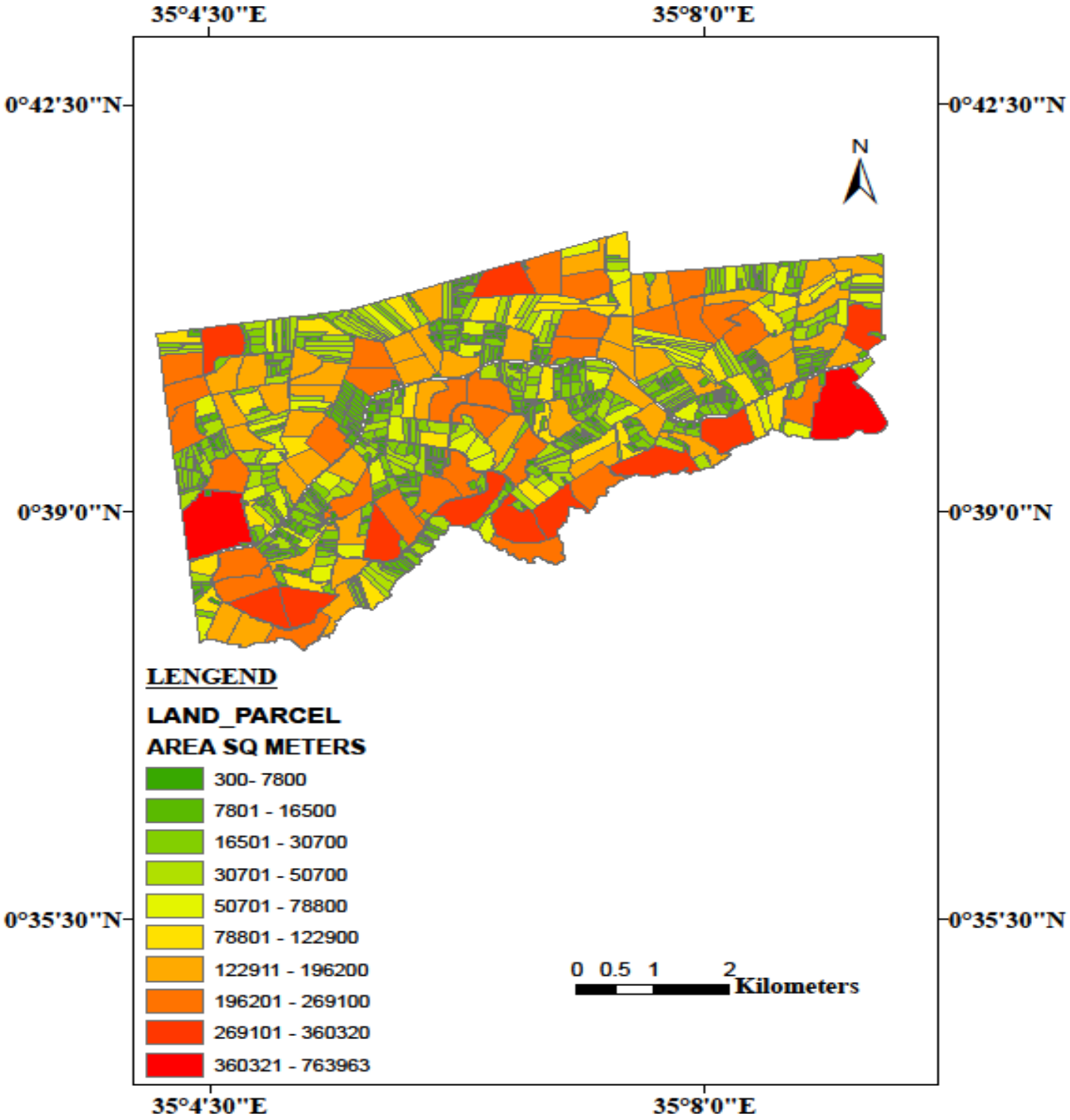

Figure 4
Sergoit Settlement Scheme Land Subdivision Map
Source: Survey of Kenya RIM Maps 2021

Figure 4 represents registered land subdivided parcels of Sergoit settlement scheme with area of the subdivided land parcels ranked in colour from green through yellow, brawn to red. Deep green is ranked smallest in area and the

green colour fades as area increases to yellow. The yellow colour fades in correspondence in increase in area which ends in deep red as highest ranked area. In Sergoit, the colour green is dominant. This indicates the land is highly subdivided in small parcels ranked between 300 and 7800 square meters.
Figure 3.4 presents the map of Soy scheme after land subdivision from the initial 157 parcels to 821 parcels.

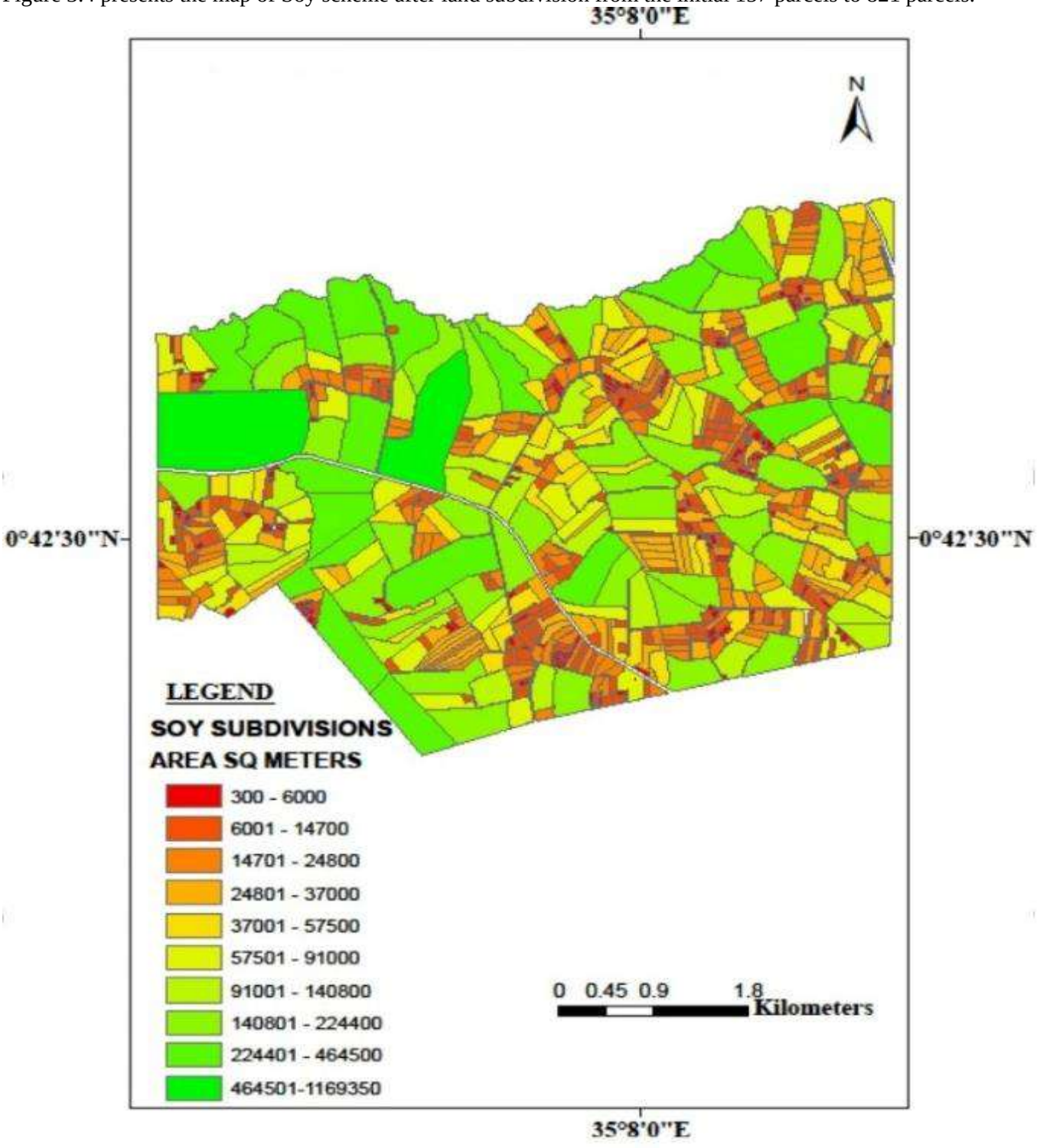

Figure 5
Soy Settlement Scheme Land Subdivision Map
Source: Survey of Kenya RIM Maps 2021

Figure 5 represents the map of Soy settlement scheme land parcels registered as per the year 2017. Land subdivision is dynamic and keeps changing. The land parcel acreages is ranked from red through brawn to green. Deep red represents the smallest parcels in acreage and fades as the area increases to brawn. Brawn also fades with increase in area towards red with deep red standing for the land parcels with largest area in the Soy settlement scheme. Data collected in the field in form of questionnaires and observations confirmed that indeed land subdivision was taking place

at a high scale in the study area. Verbatim with the area chief and agricultural officer affirmed that land subdivision and conversion of land from maize cultivation to expansion of sugar cane plantations had led to reduction in the number of acres of land under maize in the Sub County.

The Soy settlement scheme emerges as the most subdivided, recording a substantial percentage of subdivisions at 53.3%. Situated adjacent to the main Eldoret-Kitale highway and housing Soy town, this region faces significant encroachment from urban expansion. As urbanization encroaches upon agricultural land, particularly in the vicinity of Soy town, land values closer to urban centers increase, leading to a transformation of agricultural land into commercial areas, offices, and shops. Maize land under maize cultivation remains feasible only in the interior farms away from the urbanization influence.

Sergoit settlement scheme closely follows Soy at 48.9%. Situated adjacent to the Soy settlement scheme and bordering the Turbo forest and Eldoret-Malaba highway, Sergoit faces similar environmental challenges as Soy, resulting in considerable land subdivisions. From the land subdivision map of Sango settlement scheme, it is highlighted that what was once a single property between 1970 and 1980 is now divided among multiple households, indicating a significant increase in land subdivisions over time. In the Soy scheme, around 133 land parcels were less than 50 square meters in size, rendering them unsustainable for productive crop cultivation, including maize. Contrarily, Nzoia settlement scheme records the least subdivision rate at 17.4%. Unlike other schemes, Nzoia is situated farthest from main highways and towns, historically lacking easy accessibility due to poor road networks. However, recent improvements in infrastructure, including roads and rural electrification, have led to increased accessibility and improved living standards. These developments have affected land market prices, attracting speculation and potentially influencing land subdivision trends.

Table 3

Response on those who have Subdivided their Land

Response	Frequency	Percentage
Yes	271	94.8
No	15	5.2
Total	**286**	**100**

Table 3 represents number and percentage of respondents on land subdivision. Land subdivision emerged as an important factor in LUCC process and main cause of physical changes in the territory, with 94.8% respondents having subdivided their land for various purposes, including sales or family distribution, while 5.2% had not done so. Land subdivision impacts LUMC negatively in that after land is subdivided, the mew owner sets up residence on part of the land which results in reduction on the land under maize cultivation.

4.1.2 Socioeconomic Influence

Population increase in Likuyani Sub County has contributed to increase in land under structures and consequently reduction in land under maize cultivation. Family heirs shift to settle and build on different parts of the land parcel. Some end up selling part of their land parcel for diverse needs.

Table 4

Response on Purpose for Relocation on Land

Response	No of respondents	Percentage
Heirs	102	35.6
Sold	44	15.4
Heirs and sold	140	49
Total	**286**	**100**

Respondents interviewed on purpose for shifting to different parts of their land parcel, 102 representing 35.6% were heirs shifting to their allocated portion, 44 respondents representing 15.4% were new buyers while 140 were both new buyers and heirs.

4.1.3 Diversification in Type of Plants Cultivated

To this effect the researcher wanted to know the kind of plants the respondents have turned to grow on the same piece of land that may lead to change in area under Maize cultivation. Table 5 represents results from respondents on type of plants cultivated by farmers in Likuyani Sub County.

Table 5
Types of Plants Cultivated

Plants	Frequency	Percentage
Maize	195	67
Eucalptus spp	36	12
Other crops	55	21
Totals	**286**	**100**

Respondents interviewed indicate that a significant majority of the respondents in the study area engage in maize cultivation. Specifically, 195 individuals, constituting 67% of the respondents, confirmed their involvement in maize cultivation. Additionally, 55 respondents apart from maize (21%) cultivate other crops, (Fodder, Coffee, and Horticulture), whereas 36 respondents (12%) have planted *Eucalptus* spp trees and maize. This blue gum tree species typically takes around eight years to mature and finds application in housing construction, fencing, and manufacturing electric poles. Farmers with larger landholdings typically planted these trees on portions of their land or wetlands, while smaller landowners were less inclined toward blue gum tree farming.

4.1.4 Market Forces

Market forces play a pivotal in any given economy. Maize is a main cash crop in Likuyani Sub County. When the market praises are attractive most farmers are encouraged to put much of their land under maize. The opposite will happen when market praises drop. Results from respondents interviewed aided in analyzing how market forces were determining LULCC in Likuyani Sub County in respect to land under maize cultivation. Table 6 represents response on effects of market forces on maize cultivation in Likuyani Sub County.

Table 6
Effect of Market Forces on Maize Cultivation

Response	Frequency	Percentage
Unattractive market prices	157	54.9
Reduced yield	70	24.5
Competitive crops	33	11.5
Government policy	26	9.1

Among the respondents interviewed, 157 (54.9%) gave reason for preferring to shift from maize cultivation to unattractive market prices which was blamed on cheap imports by the government. Reduced yield over the years was reason for 70 (24.5%) respondents preferring to try growing of other crops. 33(11.5%) of the respondents preferred other crops due to perceived higher profit margins. For instance, the cultivation of sugarcane gained popularity as it boasted a ready market with convenient harvesting and direct transportation from the farm. Market forces is a determinant factor as it dictates what is favorable for farmers to grow which comes out as land cover change.

4.2 Discussions

The study analyzed the determinants influencing LULCC in land under maize cultivation from 1977 to 2017. The main factor was land subdivision. Subdivided land encouraged new developments on land under maize cultivation, significant immerging cover being buildings that replace the maize cover. Regression analysis on statistical data, retrieved from the questionnaire indicated, 87.8% Respondents alluded land subdivision as the main cause of LULCC followed by socioeconomic factors, market factors and government policy. According to the study's findings and data assessment in SPSS software, variations in the dependent variable (land under maize cultivation) can account for roughly 83.6% of the variance in the independent variable (determinants of LULCC). This implies that 16.4% of the factors influencing LULCC are not included in this model and instead influence LULCC.

Land subdivision maps of Sango, Soy, Sergoit and Nzoia were analyzed in detail through application of GIS SQL that brought-out very small subdivided land parcels unsustainable for sustainable maize production. From the maps analysed in ArcGIS software, Sango settlement scheme had the highest land parcels subdivision less than halve acre unsustainable for maize production. Soy settlement scheme had the highest percentage land subdivision from 156 parcels to 831. An increase of 533%.This was closely flowed by Sergoit settlement scheme at 489%. These two settlement schemes are located close to two major highways (Eldoret Malaba Rod and Eldoret Kitale Road), a fact that contributed to ease access by prospective buyers,

Market forces played an important role in a determinant influencing LULCC. Respondents interviewed 54.9% agreed Land under maize Cultivation (LUMC) is influenced by market forces. Better prices encouraged putting more land under maize. Reduction in maize yield over the years, introduction of competitive crops with better market prices like sugarcane, horticulture and fodder, influenced reduction in land under maize cultivation. Government interventions

like fertilizer subsidies, cheap maize imports during harvest plays a role in determining maize cultivation. 9.1% of the respondents interviewed agreed that Government policy did influence maize cultivation. Regression analysis on determinants influencing LULCC from SPSS data analysis indicated variations in dependents variable land maize cultivation accounts for roughly 83.6% of the variance variable (determinants influencing LULCC). Moderating term p of 0.07>0.05 implies the hypothesis "There were no significant determinants influencing LULCC on maize-producing areas between the years 1997 to 2017 in *Likuyani* sub-county" does not hold.

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

Findings show that human activity is the primary cause of land use change that impacts area producing maize in the Likuyani sub-count. The study concludes that the main drivers of land use land cover change are: Population growth which comes with urbanization and land subdivision, market forces that bring about diversity in crops grown, socioeconomic influence, Government policy and agricultural practices. However, the study primarily focuses on quantifiable land cover changes but lacks a deeper investigation into the socio-economic drivers behind these changes leaving room for future research to address these gaps.

5.2 Recommendations

The study recommends conducting detailed case studies and interviews with local farmers, policymakers, and other stakeholders will provide insights into the socio-economic, cultural, and environmental factors driving LULC and promoting policies that support sustainable land management practices and incentivizing the cultivation of maize and other essential crops can help balance agricultural productivity with environmental conservation

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