Influence of Population Size on the Trend in Rural Land Use Change in Rongo Sub-County, Kenya

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Received: 27/05/2024 **Revised: 29/05/2024** **Accepted: 31/05/2024**

Trends in rural land use change are significant for the economic viability of any country as it contributes to the general health of any bionetwork by promoting conservation. The information on the aspects of population size that influence the trends in land use change is thus crucial for the formulation of policies that can guide common rural land uses such as settlements and agriculture. This paper examines the influence of population size on the trend in rural land use change trends in Rongo Sub-County. The study used a descriptive research design and collected primary data through questionnaires, observations, interviews, focus group discussions, and satellite imagery. A total of 384 respondents were selected using cluster random sampling. A review of relevant literature was adopted to acquire secondary data. The study used descriptive statistics in analysing the quantitative data, while qualitative data was analysed thematically. Findings which were presented in tables and charts show that the study area's population has increased by 45.5% over the study period (2002-2022) and that there is an increased number of households. Consequently, there is an expansion of farmlands for the production of food and a continuous increase of the area under settlements. The study recommends the development and implementation of policies that can influence the aspects associated with rural land use change transition tendencies.

Keywords: Demography, Demographic change, Land, Land use, Land use change

https://dx.doi.org/10.4314/etsj.v15i1.18

INTRODUCTION

Human beings for a long time in the World have lived in relative harmony with the available resources by adjusting the environment and enriching the resources it offers (Livi-Bacci, 2017). However, the mechanism of the human species to balance and re-establish the balance between population numbers and resources is of varying efficiency from population to population and from one age to another (Park et al., 2022). Demographic change such as the alteration in the size of a population is the principal element of human influence on Land Use (LU) (Hersperger & Bürgi, 2009). The effects of the changes in population size are not specific as they overlap with economic trends, climatic change, scarcity of resources, and policy objectives institutions; these impacts may cancel or make worse the demographic change influences (Hoffmann, 2020).

Population growth, and household food consumption diversity have been shown as the chief drivers of land use change in most parts of the world (Doelman, 2018; Hassan *et al*., 2016; Msofe *et al*., 2019). Similarly, in Africa, land use is relentlessly changing, particularly in the suburban areas and major watersheds due to the changing population structure (Kamwi *et al*., 2015; Kato *et al*., 2014; Munthali *et al*., 2019; Omuruli, 2022;). Human population and anthropogenic activities have equally been shown as the chief drivers of LUC in most parts of Kenya, mostly in built-up and peri-urban areas (Opiyo *et al*., 2022; Muhati *et al*., 2018; Muriithi, 2016; Nkedienye *et al*., 2009).

Despite most parts of the developing countries being rural areas, they are presently experiencing uncontrolled development in most sections of their land (Ochola, 2019; Owuor *et al*., 2019). Large areas of the land initially occupied by agricultural plantations like sugarcane, food crops, shrubs, and trees, are now being turned into settlement areas and mining areas. Consequently, there is a decline in food security, loss of crucial ecosystems with profound consequences for biodiversity and climate regulation, and improper waste management.

Significant negative impacts on the environment are worsening due to unsustainable land use practices (Sadeh *et al*., 2020). Comprehension of the aspects of influence by the population size on the trends in land use change will assist in guiding the policy intercessions to regulate rural land use. Therefore, the study examined the influence of population size on the trends in land use change to facilitate decision-making on sustainable rural land uses in Rongo Sub-County, Kenya, and the world.

LITERATURE REVIEW

The world population will reach 8 billion people by 2025, and Africa will experience a growth rate of 2.5% (United Nations [UN], 2019). The UN (2019) equally pointed out that Africa will bear the greatest impact of population pressure due to the high demand placed on land resources. The population of Kenya has increased from 28.7 million people to 47.6 million people in the year 2019. The population of Migori County where Rongo Sub-County is located has equally increased

from 666,784 in 1999 to 1,116,436 in 2019 (Kenya National Bureau of Statistics [KNBS], 1999, 2019). The rising population has continued to pose immense pressure on land resources thus resulting in the decline in forest lands (Onyango *et al*., 2021).

The increase in population size has placed intense pressure on natural resources such as land as most people move in to acquire land for cultivation and settlement (Omuruli, 2022). According to Marchant *et al*. (2018), increased population size and movement of people is the principal cause of influence on LU. In Africa, LU is relentlessly changing, particularly in the suburban areas' major watersheds, due to the changing population structure (Kato *et al*., 2014). Land holding is reducing due to the high population that forces continuous land sub-division (Omuruli, 2022).

Land resources in Kenya have been impacted by the growing population size which has seen farmlands change to settlement (Ogola, 2018; Owuor *et al*., 2019). Agricultural land which is the dominant land use in Migori County where Rongo Sub-County is located experienced marginal changes from 1979 to 2009. However, a significant change was realized between 1999 and 2009 with a drop-in area of 3,392.5 Ha. Forest lands also experienced a reduction in area coverage during the same years as the population continued to grow (Ogola, 2018; Yaser & Saba 2016).

Population growth influences the demand for settlement and associated amenities which in turn impact the forest land to create space for housing and infrastructural development (Kamwi *et al*., 2015; Munthali *et al*., 2019). As the population increases and the household size changes, there is a need for more food production and consequently the need for more land for farming activities (Kanda *et al*., 2022; Mekuria, 2014; Owuor *et al*., 2019). A study conducted in the Lake Victoria basin in Kenya by Onyango *et al*. (2021) also reported that LUC is caused by population pressure, which influences the food demand leading to the expansion of agriculture and increased logging and fuel wood use. However, in a contrary finding, in a study by Juniyanti *et al*. (2021), LUC is caused by political and institutional drivers as opposed to population growth.

In most developing countries, the fertility rate has remained below the replacement level (2.1 births per woman) for a few decades. The declining fertility in the context of demographic transition in most countries of the world can be attributed to modernization (Gu et al., 2021). Population growth or decline is influenced by fertility rates (Vander Borght & Wyns, 2018). Nevertheless, the momentum of population growth will still drive the growth in population despite the decline in fertility levels thus the basis of the projected increase of 1.9 billion in the world's population from 2020 to 2050 (Gu *et al*., 2021).

There are varying degrees and intensities in population growth within a fairly large strategic space that can lead to rapid expansion or extinction when the rates of growth are high or on the decline (Livi-Bacci, 2017). The upper limit of the space is determined by fertility and the biological characteristics of the human species. The age of the female partner is a factor influencing the spontaneous probability of conception (Vander Borght & Wyns, 2018). Consequently, the development of the available resources and population growth grow side by side with population growth, ultimately imposing a greater limit on the available resources that are not static and expand in response to persistent human development (Livi-Bacci, 2017).

Population growth, and household food consumption diversity have also been shown as the chief drivers of LUC (Doelman, 2018; Hassan *et al*., 2016; Msofe *et al*., 2019). Similarly, household composition in terms of gender and age impacts land use change, it impacts production decisions, and hence LUC (Hettig *et al*., 2016). In the same way, the elderly population and women population impact LU as they tend to contribute to the fragmentation of land and land abandonment due to lack of labor (Tang *et al*., 2022).

Gender specificity does not influence decisions in land use change (Villamor *et al*., 2014a). The change in LU patterns is influencing the shift of farmland responsibilities to women thus resulting in certain consequences associated with decision-making and gender division of labour (Villamor *et al*., 2015). The inability to resist development proposals makes the involvement of women in land use decisions impossible, as this is likely to aggravate and accelerate the rate of LUC, thus leading to the intensification of carbon emissions and forest degradation (Villamor *et al*., 2014b). However, a study by Kieran *et al*. (2015) showed that women are not always allowed to own land thus limiting their ability to partake in land use decisions.

Immigration influences population growth consequently leading to high population densities which are associated with LUC (Msofe *et al*., 2019; Soby, 2017). Similarly, investments and development projects in rural areas done by immigrants expand agricultural landholdings (Soby, 2017). Migrants may not contribute to land use change more than the natives (Jones *et al*., 2018).

STUDY AREA

Rongo Sub County is bound by the coordinates 00 39'12" S; 34^0 35'.40" E and 00 59'16" S; 34^0 37'21" E (Mudereri *et al*., 2020), with an area of 213.4 square kilometres (KNBS,2019). It is located at an altitude of 1470m to 1600m above sea level and borders Rangwe and Homabay town Sub-Counties to the North, Ndhiwa, and Awendo Sub-Counties to the West, South

Mugirango Sub-County to the East, and Kilgoris Sub-County to the South. It has an average annual temperature of around 20.60^{0}C, with humidity that ranges between 50% to 70%. In addition, the average rainfall ranges between 900mm to 1833 mm annually and is of rolling topography. It is characterized by relatively fertile volcanic soils with river banks having traces of black cotton soils and endowed with sufficient water resources including Kuja, Nyamador, Kira, Misadhi, Olando, Kichuri, and Odundu rivers (County Government of Migori, 2023).

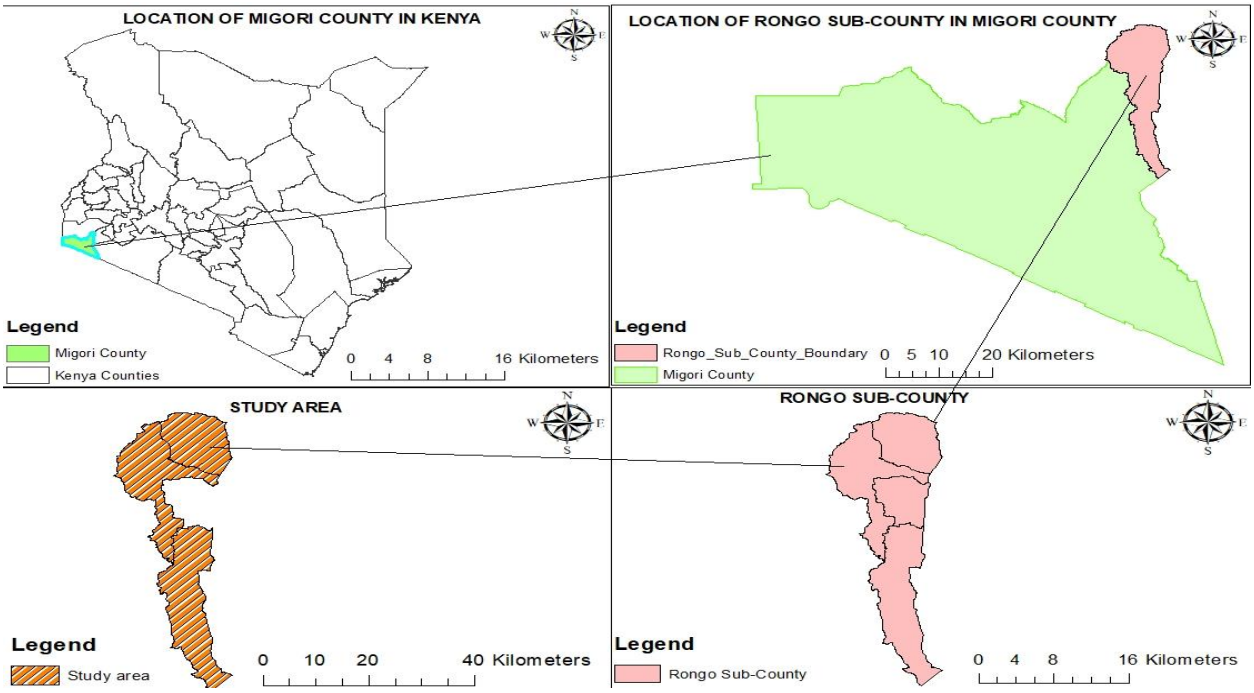

Figure 1: The Extent of the Study Area
Source: Author, 2024

MATERIALS AND METHODS

The study employed a descriptive design and adopted the use of both qualitative and quantitative types of data from primary and secondary sources. The rural locations within the Sub-County have a population of 86260 (41243 males and 45017 females) and a total household number of 19210 (KNBS, 2019) which formed the target population for the study. Cochran's formula was used to determine a calculated sample size of at least 384 respondents which was distributed in equivalent fractions to the population in the six rural locations. Cluster Sampling was used to select the representative samples from the selected locations while purposive sampling was employed in selecting Key informants from various institutions.

Methods of Data Acquisition

The study acquired information on population size through desktop review. Landsat images were equally extracted from the USGS Earth Explorer portal. Further, interview schedules were employed in data collection from 8 different vital informers that had been identified. Additionally, A questionnaire that had both closed and open-ended questions was used to collect both qualitative and quantitative data. Observation Checklist was employed in the acquisition of real-time information, analysis of phenomena in land use change, and authentication of the information obtained through HSQ and KII. A focus group discussion guide was used by trained facilitators to collect data on trends in land use change. The data that contained participants' feelings and thoughts (Acocella, 2012) was captured through audio and video recordings from 16 miners at kanga machine area in South Kamagambo, and 8 miners at Ndege Oriedo centre in North Kamagambo. 11 business people at Kangeso in West Kamagambo, and 19 farmers at Kitere hills.

Data Analysis

Analysis of remotely sensed data was actualized by the use of a Geographical Information System where land use change was analysed from the year 2002 to the year 2022 at intervals of five years. Landsat images corresponding to different intervals were imported into the Arc Map 10.4.1 and using the data management tool, composite bands were created for each sub-period. The

area of Interest (AOI) was then extracted and classified using a supervised image classification. The land use classification map was thus presented for different sub-periods in Figure 2. Change detection analysis was used to merge the data on each land use, consequently.
Qualitative data was analysed by first labelling (coding) important phrases about the activities and opinions. Data was then classified into sub-categories in conformity with the themes already identified. Quantitative data were also cleaned, coded, and analysed on a thematic basis using both the Statistical Package for Social Sciences (SPSS) version 25.0 software and Excel spreadsheet. The descriptive statistics were presented in tables and graphs for easier visualization and interpretation.

RESULTS AND DISCUSSION

Trends in Land Use Change in Rongo Sub County between 2002 and 2022

Analysis of the remotely sensed data revealed that there was a massive LUC between the years 2002 and 2022 as demonstrated in Figure 2 below.

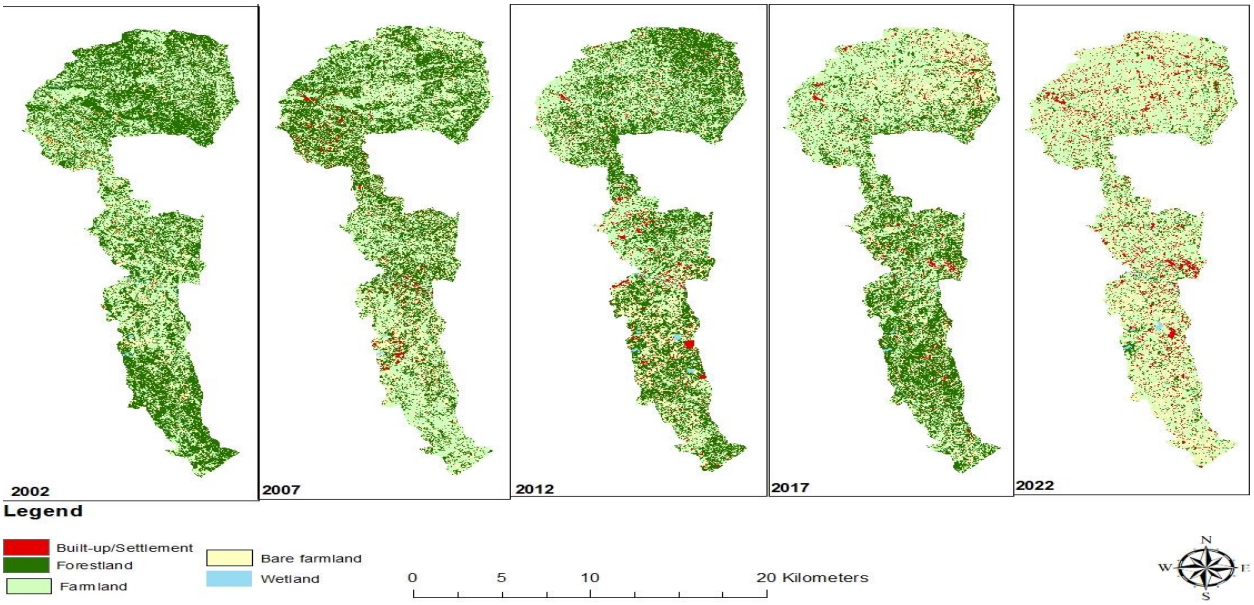

Figure 2: Land use Change between 2002 and 2022

The summed area changes for each land use kept changing every five years within the study period (Table 1), with the areas under agricultural activities and settlement experiencing positive changes while the area under forest consistently demonstrated decline every five years except for the period between 2012 and 2017. The study findings have also demonstrated that agricultural land increased by 8.8% between 2002 and 2007 (Table 1). However, between 2007 and 2012, agricultural land was reduced by 802.3ha (4.2%). Nevertheless, in 2012, the use of land for agricultural activities increased without deviation and growingly up to the year 2022 (Figure 3). The impact of the increase in land area under agricultural activities in the first five years is mirrored by the decline in forest land in the same period (Figure 3). Similarly, the slight decrease in agricultural land between the years 2007 and 2012 is reflected by the increase in the area occupied by Built-up/settlement and forest land in the same period.

Table 1: Trend in Land Use Change in Rongo Sub County between 2002 and 2022

Land Use Class (2002)	**Area (ha)**	**%**			
Agricultural Land	9171.5	48.3	0	0	0
Built-up/Settlement	213	1.1	0	0	0
Forest Land	9510	50	0	0	0
Wetland	61	0.3	0	0	0
Land Use Class (2007)	**Area (ha)**	**%**	**Sum area change**	**Positive % Change**	**Negative% Change**
Agricultural Land	10835.3	57,1	1663.8	8.8	
Built-up/Settlement	503.3	2.7	290.3	1.5	
Forest Land	7557.4	39.9	-1952.6		10.3
Wetland	59.1	0.3	-1.9		0.01
Land Use Class (2012)					
Agricultural Land	10033	53	-802.3		4.2
Built-up/Settlement	842.4	4.4	339.1	1.9	
Forest Land	7980	42	422.6	2.2	
Wetland	94	0.5	34.9	0.9	
Land Use Class (2017)					
Agricultural Land	11795.4	62	1762.4	9.3	
Built-up/Settlement	764	4	-78.4		0.4
Forest Land	6364	33.5	-1616		8.5
Wetland	32	0.2	-62		0.3
Land Use Class (2022)					
Agricultural Land	15674	83	3878.6	20.5	
Built-up/Settlement	1733	9.1	969	5.1	
Forest Land	1382	7.2	-4982		26.3
Wetland	165	0.8	133	0.7	

Forest land decreased between the years 2002 and 2007 due to the expansion of the settlement and agricultural land in the same period. Additionally, the constant decline of the forest land between 2012 and 2022 is mirrored by the continuous increase in agricultural and settlement lands during the same period. The slight increase in forest land between 2007 and 2012 is reflected by the slight decrease in agricultural land in the same period. The wetland remained undisturbed from the years 2002 and 2012. Nevertheless, between the years 2012 and 2017, it experienced a colossal decrease due to the high rate of agricultural land use.

Built-up/settlement increased slowly and continuously up to the year 2022. However, there was a much greater increase in the built-up/settlement between 2017 and 2022 which was equally reflected in the exponential decrease in forest land in the same period. From the foregoing analysis, the trend in land use change in the study area between 2002 and 2022 involved a consistent modification of forest land into agricultural land and settlement as shown in Figure 3 below.

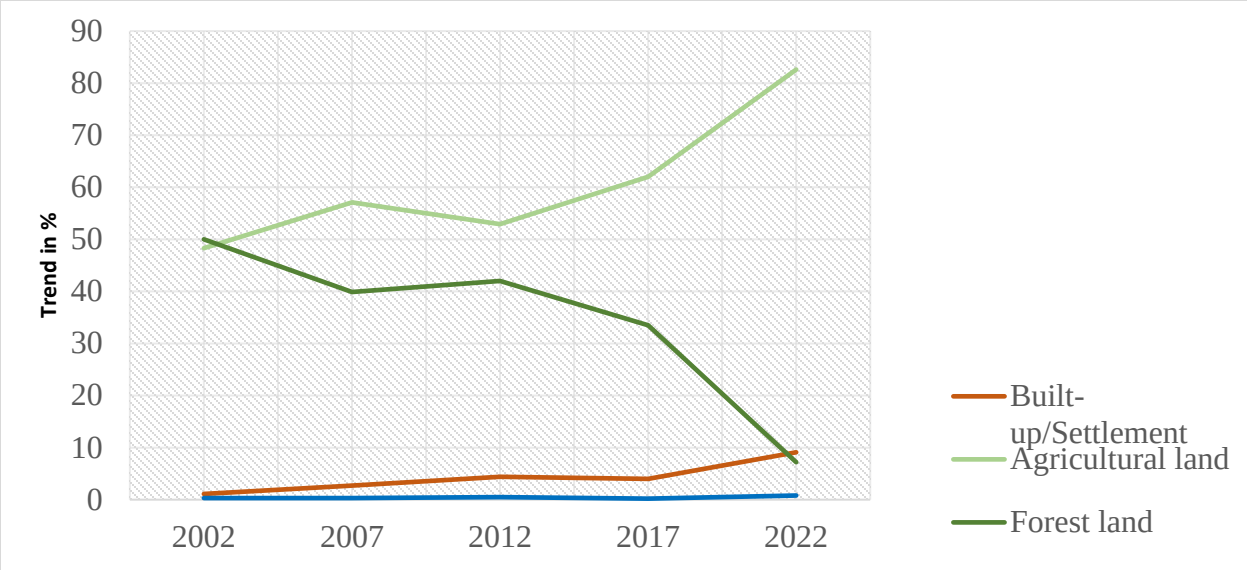

Figure 3: The Trend in Land Use Change in the Study Area

Similarly, the information obtained from the Field Observation and Household Survey questionnaire (HSQ) established that 61% of the people living in the study area converted their agricultural lands to residential while 85% indicated that their farmlands were formerly forest lands as shown in Table 2 below.

Table 2: Respondents' original use of homestead land and farmland

LAND USE	RESPONDENT	PERCENTAGE
Original Use of the Homestead Land		
Forest	126	33%
Agriculture	235	61%
Residential	5	1%
Wetland	4	1%
Not aware	14	4%
Respondent No.	**384**	
Original Use of the Farmland		
Residential	17	4%
Forest	327	85%
Wetland	2	1%
Mining	1	0.26%
Not aware	37	10%
Respondent No.	**384**	

Data from HSQ supported by qualitative data from FGD and Field observation equally revealed that the trend in land use change in rural areas of Rongo Sub-County involves the conversion of forest land into agriculture and agricultural lands to settlement. The majority of the respondents (44%) described the land use trend as from agriculture to settlement, 21%, forest to agriculture, agriculture to mining was mentioned by 3%, agriculture to forest 4%, 2% mentioned agriculture to road, and 24% of the respondents were not aware of the trend in land use change (Table 3). Nevertheless, wetland to agriculture and wetland to settlement were never mentioned by any respondent. This finding is in concurrence with the data obtained from remotely sensed images that showed massive modification of forest land into farmlands and negligible change in wetland areas between the years 2002 and 2022. Table 3 below describes the discernment of the respondents as regards the land use trend in the study area.

Table 3: Respondents' description of trends in land use change in their area of residence

LAND USE TREND	RESPONDENTS	PERCENTAGE
Agriculture- Residential	169	44%
Agriculture -Mining	13	3%
Forest-Agriculture	82	21%
Agriculture-Forest	17	4%
Residential-Commercial	5	1%
Wetland-Agriculture	0	0%
Agriculture-Education	8	2%
Wetland-Settlement	0	0%
Residential-Education	0	0%
Agriculture-Road Infrastructure	9	2%
Not Aware	81	24%
Total =	**384**	

Population Growth

Information obtained from the KNBS through desktop review established that the population of the study area has been rising steadily by 45.5% from the year 1999 to the year 2019 (Table 4). This growth in population impacts the household size and the rate of consumption in the study area consequently influencing the need for settlement as demonstrated by the increasing households since the year 1999. This finding is in line with a study conducted by Bradbury *et al*. (2014) that also showed households as significant aspects in the analysis of the impact of the human population on the environment.

Table 4: Population census for the years 1999, 2009, and 2019 and their respective changes

Location	Population						
	1999	**% Change**	**2009**	**% Change**	**2019**	**overall change 1999-2019**	**%Change**
South Kamagambo	12573	5.6	15895	5.1	18898	6325	10.7
East Kamagambo	14140	7.1	18340	6.6	22249	8109	13.7
West Kamagambo	19187	4.7	21982	5.5	25264	6077	10.2
North Kamagambo	13391	5.4	16574	5.5	19850	6459	10.9
Total	**59291**	**22.8**	**72791**	**22.7**	**86261**	**26970**	**45.5**

Source: KBNS., 2000, 2010, and 2019

The study equally revealed that the number of households in the study area is increasing even with the gradual population growth rate (Table 5). For instance, the population of the study area increased by 22.7% between the year 2009 and 2019 while the households increased by 34.7% during the same period. This finding equally aligns with a similar study that indicated an increase in household size as a driver of the growing household number (Gu *et al*., 2017).

Table 5: Households in the area of study in the years 1999, 2009, and 2019

Location	**1999**	**change**	**Household % Change**	**2009**	**change**	**% Change**	**2019**
South Kamagambo	2645	584	4.6	3229	1200	9.5	4429
East Kamagambo	3182	658	5.2	3840	1130	8.9	4970
West Kamagambo	3814	564	4.4	4378	1124	8.9	5502
North Kamagambo	3036	330	2.6	3366	943	7.4	4309
Total	**12677**	**2136**	**16.8**	**14813**	**4397**	**34.7**	**19210**

Source: KBNS., 2000, 2010, and 2019

Information obtained from HSQ equally revealed that the average household size in rural areas of Rongo- Sub-County is 4.8 (Table 6).

Table 6: Respondents' average household size

HOUSEHOLD NO. 384	No Household members	Percentage
Male	811	44%
Female	1033	56%
Total number of household members	1844	
Average Household size	4.8	

This finding aligns with the data obtained from the census of 1999, 2009, and 2019 where the average household sizes were 4.7, 4.9, and 4.5 respectively (Table 7). Considering the finding on the average household size in the study area, it means that there is a high consumption rate thus necessitating the expansion of farmlands in the study area to facilitate more food production.

Table 7: The average household size in the years 1999, 2009, and 2019

Year	Population	Household	Average Household number
1999	59291	12677	4.7
2009	72791	14813	4.9
2019	86261	19210	4.5

Source: KBNS., 2000, 2010, and 2019

Demographic Characteristics

Age and gender distribution

Information obtained from HSQ established that 62% of the households are male-headed 38% of the households are headed by females (Table 8). This finding indicates that most land use decisions are influenced by the male gender which thus agrees with a related study conducted by Kieran *et al*. (2015) that also showed most land ownership and decisions regarding land use are associated with the male gender.

Table 8: Respondents' distribution by age and gender

AGE BRACKET	HOUSEHOLD HEAD	PERCENTAGE	MALE	FEMALE
Below 20	2	1%	0	2
20-29	20	5%	11	9
30-39	90	23%	54	36
40-49	129	34%	85	44
50-59	72	19%	46	26
60-69	49	13%	28	21
Above 70	22	6%	14	8
Total No. of Respondents	**384**	**Distribution by Gender**	**238**	**146**
		Percentage	**62%**	**38%**

Further, the same data similarly showed that the majority (56%) of the household members are female and 44% are male (Table 9). This finding aligns with the KNBS (2019) data on population distribution by gender where the study area population was 52% female and 48% male.

Table 9: Household members distribution by gender

HOUSEHOLD NO. 384	No of Household members	Percentage
Male	811	44%
Female	1033	56%
Total number of household members	1844	

Additionally, the household members who are dependent on the household heads are 32% and fall within the age bracket of 10-19 (Figure 4). This high dependency in the study area is influencing LU decisions to enhance the standards of living and conditions. The finding aligns with related studies that showed household decisions as a key driver of land use change (Ahimbisibwe *et al*., 2019). Further, as the population within the aforementioned age bracket increases, the dependency ratio will similarly increase thereby impacting the consumption rate and settlement demand which eventually influence the household decisions on land use. This finding is supported by the information from the FGD where the majority of the participants indicated high reliance on land resources for the enhancement of household livelihood.

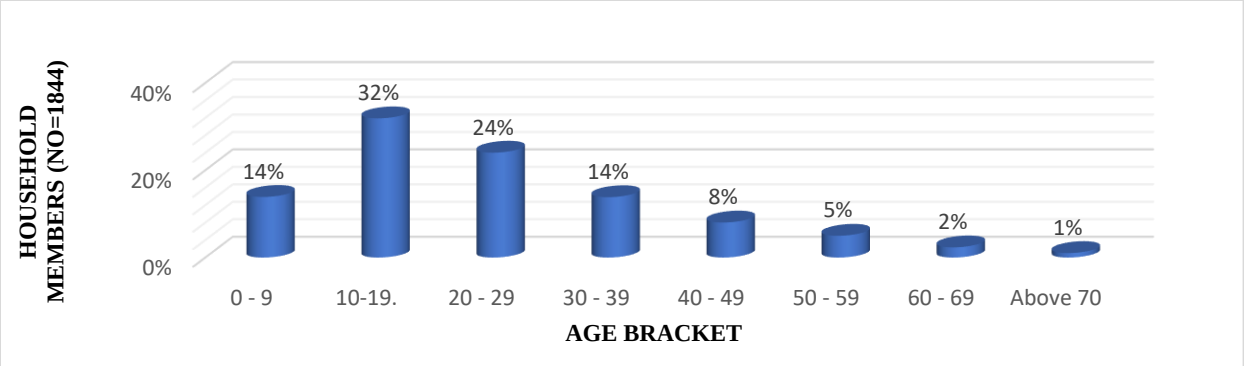

Figure 4: Household member's age distribution

Information obtained from HSQ established that there is a high fertility rate in the rural population of Rongo Sub-County due to the high number of household members falling within the age bracket (20-59). Given the fact that the female population forms 56% (Table 9) of the household members, it means they are the majority within the bracket. This age bracket is generally a productive age for women, and in the findings, it contains 51% of the household members (Figure 5). The high population of women within the productive age is reflected in the constant household size within the study area thus influencing the consumption rate. This finding aligns with a related study by Vander Borght & Wyns, (2018) that also showed the age of the female partner as a factor influencing the spontaneous probability of conception. Similarly, the same age bracket contains an economically active population thus influencing the decisions on land use as they struggle to enhance their livelihood from land resources.

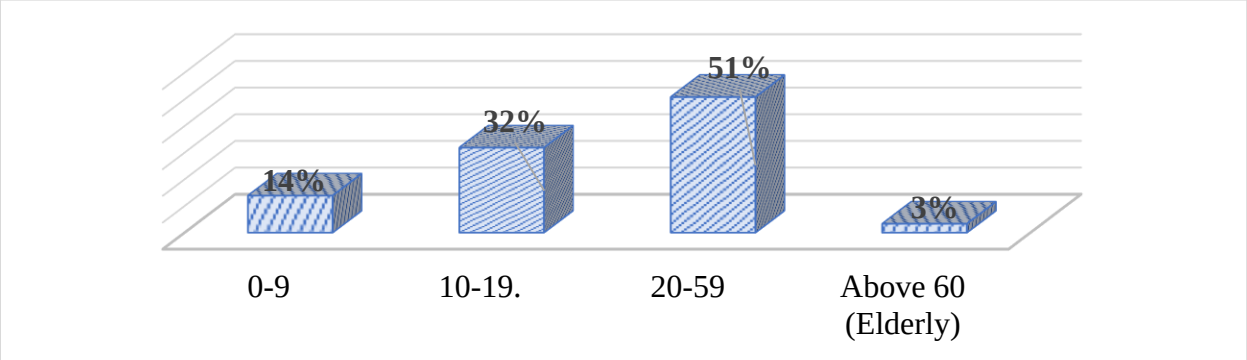

Figure 5: Household member's distribution in terms of reproduction and labour

Distribution of Native and Non-native Population

Information obtained from HSQ revealed that the majority (94%) of the respondents are natives and only 6% are non-native. Further, the information obtained from FGD and KII showed that the study area hosts all tribes of Kenya when the students of the University and other institutions of higher learning are in session. Data obtained from HSQ also revealed that the majority (43%) of the (23) non-native people who stay in rural areas of Rongo sub-county stay because of education, 22% business, for 17% mining, 13%, formal employment, and 6% Construction works (Table 10).

Table 10: Factor influencing in-migration in Rongo Sub-County

Influencing Factor	Respondent	Percentage
Business	5	22%
Civil servants	3	13%
Construction works	1	6%
Education/student	10	43%
Mining	4	17%
Total	**23**	**100%**

This finding and the information obtained by FGD revealed that the non-native population influences the provision of other services of land use in rural areas due to their different needs and objectives when moving into an area. This finding conforms with the information obtained from the KII that also indicated that the establishment of the University and other institutions of higher learning in the study area has triggered in-migration for the people seeking education services thus impacting food consumption and housing services within the study area. Similarly, the finding agrees with related studies that also indicated non-native population as a key driver of land use change due to their influence on population size thereby putting pressure on land resources (Jones *et al*., 2018; Msofe *et al*., 2019; Soby, 2017)

CONCLUSION

The study established that the trend in rural land use change in Rongo Sub-County involves the modification of forest land into farmlands and settlements. This was shown by the change in the area coverage for each land use class every five years from 2002 to 2022. The data equally showed a minimal change in wetlands during the study period. Similarly, the study found that Population size influences the trend in land use change in the rural areas of Rongo Sub-County. This influence is triggered by the growth in population that impacts the household size and the rate of consumption, consequently influencing the need for settlement and expansion of farmlands. The findings of this study will assist in curbing and moderating incompatible land uses, predicting future scenarios, and developing strategies to achieve more desirable developments.

Thus, the study recommends that the county government in collaboration with the National Government should develop and initiate policies that can influence the path, size, and speed of agricultural and settlement transition tendencies in rural areas and equally, conduct regular and wholistic sensitization and training of the rural farmers on the sustainable approaches of maximizing harvests on small farms to preclude the expansion of farmland as the only way of maximizing yield. Given the findings, future studies should also focus on the potential for ecological restoration and land management in rural areas. However, the study had challenges obtaining data from National and County Government officials due to their tight engagement and the prevailing administrative nature of government offices, thus, affecting the comprehensiveness of the data that had to be corroborated with the information obtained through the literature review.

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