Contributions of the Agro-Pastoral Livelihoods to Land Cover Change In Kajiado West Sub-County

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Abstract
Agro-pastoral communities face challenges due to land cover change. Land tenure, consequent land subdivision and expansion of settlements, cultivation and development has led to a shift of livelihood activities from the traditional livestock keeping and cultivation of crops to logging, charcoal trading, quarrying, sand harvesting and land encroachment by the growing population at 5.5% per annum. Minimal research has been conducted and documented on how land cover change at present influences the livelihood of agro-pastoralist. The overall objective of the study was to evaluate land cover change and its influence on the nature of agro-pastoral livelihoods in Kajiado West Sub-county, Kenya. The specific objective of the study was to determine the contribution of the agro-pastoral livelihoods to land cover change. The study used the following theories tragedy of the commons, pressure and release model. The study used correlational research design and descriptive research design in obtaining data. The study population included agro-pastoralist households, institutions associated with environmental conservation in the sub-county, church, village elders, sand and stone business owners. The sampling techniques for the study were stratified random sampling, purposive sampling and cluster sampling. The sample size was 387 respondents selected from the Keekonyokie, Iloodokilani and Ewuaso Oo Nkidong'i. Data gathering was done between April, 2016 and November, 2017 through multiple methods. The study used both qualitative and quantitative methods of data analysis. Primary data was collected through questionnaires as a main collection instrument for, households, key informant interviews, Focused Group Discussions, Observation and Geographic Information Systems. Secondary sources were from theses publications, online journals, Google earth Kenya data and Landsat 8 images. Data analysis was through use of descriptive statistics, using both numerical and non-numerical data. Analysis was done using correlation, chi square, multiple regression and Arc GIS version 10. The study findings indicate that land cover change in Kajiado West Sub-county is eminent due to the sources of livelihood of the households in the sub-county as a result of informal employment in the area at 40.3% the community has resorted to alternative livelihoods, urban centres have led to an increase of built up area in the sub-county this is from 0.006 ha in 2016 to 2.09 ha in 2016, grassland for animal grazing has reduced from 51.05 ha in 1984 to 16.46 ha in 2016 this is attributed to land cover change with a shift from agro-pastoralism to mining activities such as stone mining, sand harvesting and charcoal trading. The changes on land cover have a great impact on the households whom suffer from typhoid, amoeba and cholera. The dust from the mining sites has led to households suffering from flu. The households have mechanisms to curb land degradation through communal activities of which they use to influence the community to conserve the environment. Majority of the agro-pastoralist livelihoods were negatively influenced by quarrying and sand harvesting in the sub-county creating serious land cover effects. The community needs to be involved in conservation mechanisms to conserve the environment.

Keywords: land cover, livelihoods, pastoralism and resources

INTRODUCTION

People have been modifying land to obtain livelihoods and other essentials such as food for thousands of years. The current rates, extents, and intensities of land cover change are far more significant than ever in history, driving unprecedented changes in

ecosystems and environmental processes at local, regional and global scales. These changes encompass the most significant ecological concerns of human populations today, including climate change, biodiversity loss and pollution of water, soils, and air (Erle, 2016). Land cover change, in the long run, affects how communities conduct activities due to adverse effects of land cover change.

The demand for arable land, grazing, forestry, wildlife, tourism and urban development are more significant than the land resources available. To address the identified critical issues in land use management within a development-oriented approach poses challenges to all stakeholders and requires integrative solutions across the policy, socio-economic, and environment sectors (GOK, 2011).

Today, nearly 200 million nomadic and transhumant pastoralists throughout the world generate income and create livelihoods in remote and harsh environments where conventional farming is limited or not possible (IFAD Kenya, 2010). In the world rangelands and grass, lands host a diverse flora and fauna. The agro-pastoralists in Kajiado County derive products from the natural environment of which contribute to rural income and development (Rogei, 2012).

The agro-pastoral communities continue to face numerous challenges in their lifetime due to land cover change. Overall, high rates of land cover change are experienced within regions where land productivity is highly dependent on socio-economic drivers. In the end, climatic and environmental conditions limit intensive agricultural and pastoral activities (Laure, Thomas, Sohl, and Kristi, 2015). The changes in land tenure, have led to the subdivision and expansion of settlements and development of infrastructure in Kajiado West Sub-county, which have adversely affected agro-pastoral populations. For example, habitation in the Amboseli ecosystem was 1000 in the year 1973 increasing to over 10000 by the year 2000 and at a faster rate in areas with a higher occupancy or arable potential. Cultivated land in Eastern Kajiado has risen from 400 km2 in 1989 to over 900 km2 by 1994 (Kioko & Okello, 2010).

The study was carried out in Kajiado West Sub-county of Kajiado County. The study focused on land cover change and its influence on the agro-pastoral community in the sub-county. The study was undertaken from April 2016 to November 2017. This constituted proposal writing, data collection, analysis, and presentation of findings. Furthermore, the study investigated the strategies adopted by agro-pastoral communities to cope with land cover changes through relevant agencies working in the Kajiado County.

Effects of land cover change

Kenya has a landmass of about 582,350 km^2 of which only 17 % is arable while 83% consists of semi-arid and arid land (ASAL). Climate change is mainly attributed to human factors in the case of Kajiado West Sub-county; the difference is observed on areas with vegetation cover being converted to barren land due to mining, sand harvesting and charcoal burning (GOK, 2010).

Preservation of agricultural areas is essential to maintaining the open space setting and the rural character of the region. Successful development of diversified agriculture in Kenya, land needs to be protected, dedicated, and committed primarily to agricultural use. In addition to the rural community and farming boundaries, guidelines are established to protect agricultural lands from other development. Excellent and cohesive agrarian fields should be preserved for agricultural production and not be put to any other incompatible land use (GOK, 2010). Generally, the standard should be the same size of the river on both sides of the river, with a minimum of 2 m

and up to a maximum of 30 m. Protection of the soil against erosion: plow and plant along the contours, practice crop rotation, apply manure to crops, leave crop residue on the ground and practice terracing.

Land cover change

Land cover refers to the vegetation (natural or planted) or human-made constructions buildings) which occur on the earth surface. Water, ice, bare rock, sand and similar surfaces also count as land cover (UNEP, 2016). There are numerous changes on land cover from a global, regional and local perspective. In the case of Kajiado livelihoods adversely affect the environment.

According to GOK (2016b), land in Kajiado is mainly used for livestock rearing and crop growing. There is a significant change in land use in the urban areas where industrial and commercial use is gaining momentum. There is a growing level of land speculation in the urban areas of the county, leading to the excessive subdivision of land to small and sometimes uneconomical plots. Sand harvesting is active all rivers which are seasonal. There is also small-scale mining, limestone, and salt in the county; other activities include quarrying, ballast mining and sand harvesting in Kajiado River. Overgrazing, charcoal burning, extraction of firewood and cultivation lead to the vegetal reduction. In the lower parts of Mt. Kilimanjaro, indigenous trees have been cleared to create room for agriculture.

According to Blaikie (1994), poor people's livelihoods and health are the two most important resources for them, which are adversely affected by hazard events and resultantly increase the vulnerability of the poor to future hazard events. Mining effects are long-lasting and change the land use almost irreversibly. In the process of mining, vegetation and over-burden must be removed and stockpiled elsewhere (Simon, 2014).

Effects of soil erosion on the environment

Erosion is a global problem globally; topsoil is eroding faster than it can be replaced in over a third of the world's croplands. Both natural and anthropic factors are inducing land degradation processes even human factors remains the most important. There is a tremendous amount of research on land degradation but persists a gap in obtaining updated and, critical, comparable data. The knowledge is dispersed, focused on local/ regional experiments and without links to a general framework analysis and interpretation (Halbac-Cotoara, 2015).

Globally, about two million ha of soil, equivalent to 15 percent of the Earth's land area has been degraded through human activities (GRIDA, 2015). The consequences of land degradation have reduced land productivity, socio-economic problems, including uncertainty in food security, migration, limited development and damage to ecosystems.

Causes of land degradation

The world's croplands are in decline due to the pressure of human activities. The patterns are different in the various regions. In North America, agriculture has been responsible for 66% of the soil loss, while in Africa, overgrazing is responsible for about half of the soil degradation significantly enhance soil erosion rates (UM, 2016). In the world, 21.5 million people have been forcibly displaced by weather-related sudden onset hazards – such as floods, storms, wildfires, extreme temperature. In the case of Kajiado West, adverse impacts of climate change are compounded by local environmental degradation, which has aggravated deforestation and land degradation (GOK, 2010). The agro-pastoralist engaging in deforestation and sand harvesting activities have led to the drying of water sources.

Kajiado West also experiences flash floods in the urban areas due to land use activities. Forest cover in Kenya reduced from 12% in the 1960s to 7 % at present. Deforestation has considerably affected the ability of Kenya's five main Water Towers to act as water catchments for major rivers and lakes, which are the primary sources of water for daily consumption in rural and urban areas (GOK, 2010). Further, climate change is exacerbating

human-wildlife conflicts. Pastoralists in search of pasture and water have encroached into game parks, chasing wildlife away from their natural habitats. The drought has also pushed lions and other wildlife closer to waterholes and vegetation near to human settlements (GOK, 2010).

The potential of erosion on hill slopes shows that steep areas close to the channels supply most of the fine sediment during a flood event (Kirsch *et al*., 2012). In small mountainous basins where damages due to windstorms occur, the proportion of land exposed to erosion may modify the risk for the downstream areas. Sustainable forest management set to minimize these downstream impacts requires a proper evaluation of the basin response to changes in forest and vegetation cover. Direct observations are limited, so that distributed rainfall-runoff models coupled to erosion models can help in such evaluations.

Previous studies by Constance, Sally, and Andreas (2010), livelihood strategies arrangements have been made to bring about climate change mitigation in drylands that simultaneously contribute to climate change adaptation should be a critical area of focus in post-Kyoto mechanisms. Both mitigation and adaptation benefits need to be addressed alongside interventions that address associated socio-political and economic barriers, such as land tenure constraints and inadequate services for, and political marginalization of, pastoral and agro-pastoral communities.

Adaptation techniques to land degradation

Pastoralist's mitigation on the effects of climate change has been to run a small business, which has also increased their dependence on the market. The impact of climate change is brought about by land degradation in Kajiado West Sub-county this is mainly attributed to land use activities (Mwakaje, 2013). Viable options and interventions exist today. They include using: improved crop varieties and livestock breeds; farming approaches to reduce risk and improve nutrition; making farming for communities living in on marginal lands more resilient; and methods for making the best possible use of the scarce water available. Approaches such as

diversification of cropping systems, more efficient water management, and conservation agriculture can contribute to securing livelihoods for rural people and increasing food security for the dry land countries.

Declining land sizes and longer distance to watering points forms the rationale of the observed behavior changes among households.

According to a study by IAASTD (2016), industrial agriculture is not superior to small-scale farming in economic, social and ecological terms. There is a new paradigm for agriculture in the 21st century, which recognizes the pivotal role that small farmers play in feeding the world population. Farming is a vital source of livelihood to the community living in Kajiado West Sub-county. Farming activities indicate the measures which household members have taken to secure a stable income to the family.

RESEARCH METHODOLOGY

Study Area

The study was carried out in Kajiado West Sub-county which lies at the southern edge of the former Rift Valley province, about 80 km from the Kenyan capital Nairobi (KNBS, 2013). It is situated between Longitudes 36^0 20’ and 36^0 50’ East and between Latitudes 1^0 0’ and 1^0 30’ South. The area covers 7,910.80 km^2 as per the 2009 population census the population of 106,933 persons (KNBS, 2009).

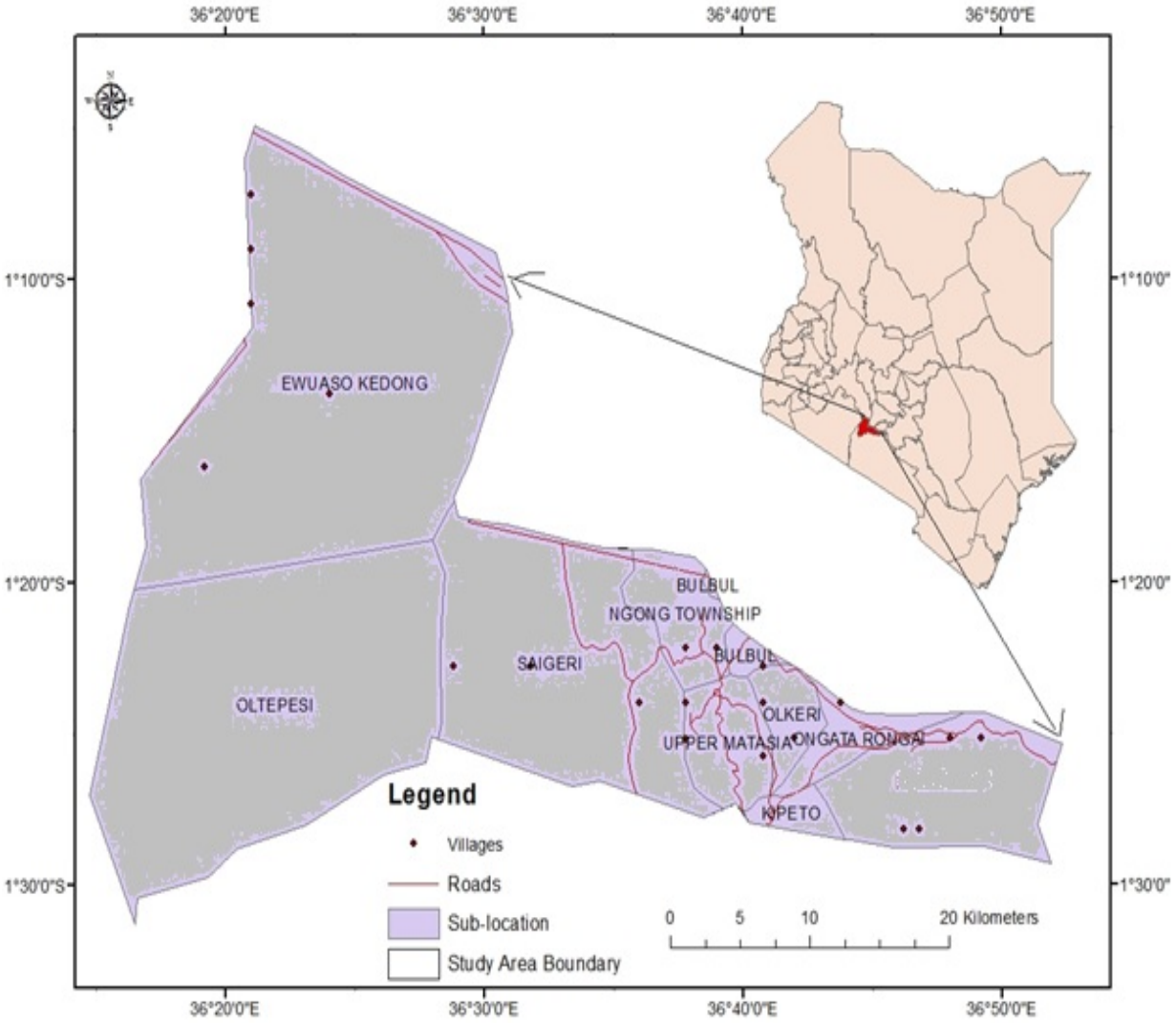


Figure 3. 1: Study area Kajiado West Sub-county

Source: KNBS (2009)

Study population

The dominant ethnic group inhabiting in Kajiado West Sub-county are the Maasai. Other minor ethnic groups also the County are Kikuyu, Kisii, Somali, Kamba, Luo, Luhya and Kalenjin (KNBS, 2009). The Maasai are partly segregated along territorial group lines. The Maasai regional groups in the County include Ildamat, Ilkaputiei, Ilkeekonyokie, Ilkisonko, Iloodokilani, Ilmatapato, Ilmoitanik, Iluasin-Nkishu, Ilkankere and Ilpurko.

The study mainly targeted the agro-pastoralist households, institutions associated with environmental conservation in the sub-county; Kiserian Environmental Dam View Group (KEDVG), GOK through the county representatives, church, village elders sand and stone business owners. As key stakeholders in Kajiado West Sub-county, they have a good understanding of the livelihood zones and activities about how land cover has changed over time. The study captured the demographics such as age, gender, and class of the population allows for more reliability of the survey (Kombo & Tromp, 2016).

Sampling Strategies

Stratified random sampling involves dividing the population into homogeneous subgroups and then taking a simple random sample in each subset. The sample is selected in such a way as to ensure that specific subgroups in the population are represented in the example in proportion to their number in the community. This method is appropriate when the researcher is interested in issues related to gender, race, age disparities in the population (Kombo and Tromp, 2016). Stratified random sampling ensured that the study population gets equal chances of being represented in the study. With a stratified random sample, every household in the community will have a fair chance of being selected. The use of stratified random sampling reduces bias.

Purposive sampling is defined as a method whereby the study deliberately targets a group of people believed to be reliable for the research (Kombo & Tromp, 2016). This applies both for quantitative and qualitative studies. The purposive sampling technique assisted in arriving on the three wards in Kajiado West Sub-county. The power of purposive sampling lies in selecting information-rich cases for in-depth analysis relating to the central issues being studied.

Cluster sampling is used when the total area of interest is a big one, a convenient way in which a sample can be taken is to divide the sub-county into a number of smaller non-overlapping regions and then to randomly select a number of these smaller areas with the ultimate sample consisting of all units in these small areas or clusters

(Kothari, 2011). The clustered study area was Keekonyokie 187 households, Iloodokilani 61 households, and Ewauso Kedong 139 households. This gave a total of 387 respondents. The study used Fischer's formula in obtaining the sample population.

The household sample size for Kajiado West Sub-county was drawn from a population of 104,300 (KNBS, 2009). According to Mugenda & Mugenda (2003), in social science research, a formula can be used to determine a sample size from a large population. Hence the study used Fischer's formula in obtaining the sample population.

$$\boldsymbol{n = \frac{z^2pq}{d^2}}$$

Where-:

n is the desired sample size (if the target population is greater than 10,000)

z = standard normal deviate at a confidence interval of 95% (1.96)

p = proportion in the target population estimated to have characteristic being measured.

$^q = 1 - p$

d = level of statistical significance set or Alpha (0.05)

$$n = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)^2} = 384 \text{ household heads}$$

: Distribution of the sample population

AREA NAMES	STUDY POPULATION	SAMPLE SIZE (N)
	(N	
Keekonyokie	36,562	187
Iloodokilani	11,832	61
Ewuaso Oo Nkidong'i	27,182	139
Total	75,576	387

Source: KNBS (2009)

Data Collection Methods and Techniques

Data collection refers to the gathering of information to serve or prove some facts (Kombo & Tromp, 2016). Data collection is vital for a study to address an issue thoroughly. Primary and secondary data were collected for this study.

Primary data

Primary data is information gathered directly from the respondents. According to Kombo & Tromp, (2016) primary data is obtained through questionnaires, interviews, focus group discussions, observation, and experimental studies. It, therefore, involved creating new data. The study used primary data with attributes of the households, gender, education levels, income levels, and duration of stay in the Sub-county, sources of income and adaptation techniques and practices on how they impact their livelihood strategies. Household questionnaire (Appendix I) was used because the study is concerned mainly with the views, perceptions, and feelings of the respondents and such variables which cannot be directly observed. This enabled the survey to obtain quantitative data from the closed-ended sections and qualitative data from the open-ended sections.

Secondary data

The secondary data refers to already collected and documented or published information. Secondary data obtained included land use activities, technological mechanisms and livelihood strategies information about the target groups and the area. The secondary data included maps, terrain data and approved published reports, remote sensing through the use of Landsat eight images 1984, 1996, 2006 and 2016 from the Regional Centre for Mapping of Resources for Development, Digital Elevation Models (DEM).

Summary of sampling strategies and data collection instruments

Data Collection Instrument	Target Population Unit	Sampling Method	Sample Size
Questionnaire	Households	Stratified random sampling	387
Interview Guide	Professionals	Snowball	50
Interview guide	Government officials / NGOs	Purposive	20

Source: Researcher (2016)

FINDINGS

The study used both qualitative and quantitative methods of data analysis. According to Mugenda and Mugenda (2003), qualitative research includes designs, techniques, and measures that do not produce discrete numerical data. The information is in words rather than numbers. The data collection and analysis include socio-economic data, spatial data, and information on livelihood adaptation strategies. Quantitative data design, techniques, and measures that produced discreet numerical data.

Quantitative data was input into the statistical package for social scientists (SPSS – version 20) since it is the latest version. It is also compatible with the current operating system the study used after data collection. Measures of central tendency are used to determine the standard measurement from a sample of the size in a study (Mugenda and Mugenda, 2003). The method of data analysis and presentation was through percentages, means, frequencies tables, figures, and charts. The findings on satellite imagery were presented in the form of overlay maps, DEM, pictures, graphs, tables and pie charts.

All the independent variables were manipulated to see how they affected the dependent variable. aAnalysis of the data, every variable in the questionnaire was assigned numerical representation and the responses from each respondent coded using a defined coding scheme to facilitate data analysis easily.

Causes of land cover change

The study sought to find out the reasons for land cover change by asking the respondents to indicate how land is used in Kajiado West Sub-county. This was to assist in identifying the effect of the land cover change on agro-pastoral communities. Figure 1.1 shows the study findings on causes of land cover change.

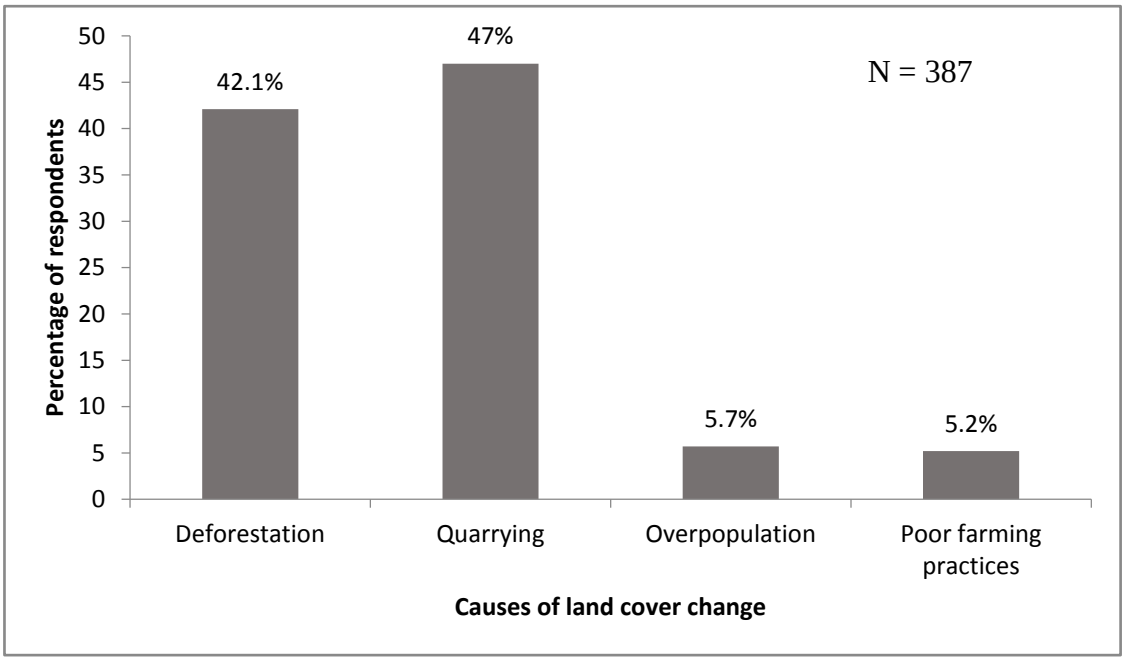


Figure 1.1: Causes of land cover change, Kajiado West Sub-county

Source: Field Data (2016)

The study findings indicate that 47.0% (182) of the households viewed quarrying as the leading cause of land cover change, followed by deforestation 42.1% (163), overpopulation 5.7% (22) and reduced farming practices 5.2% (20) of the total population. Thus, the livelihood activities of the households significantly influence the nature of land cover change. This is mainly attributed to the quarrying activities and deforestation.

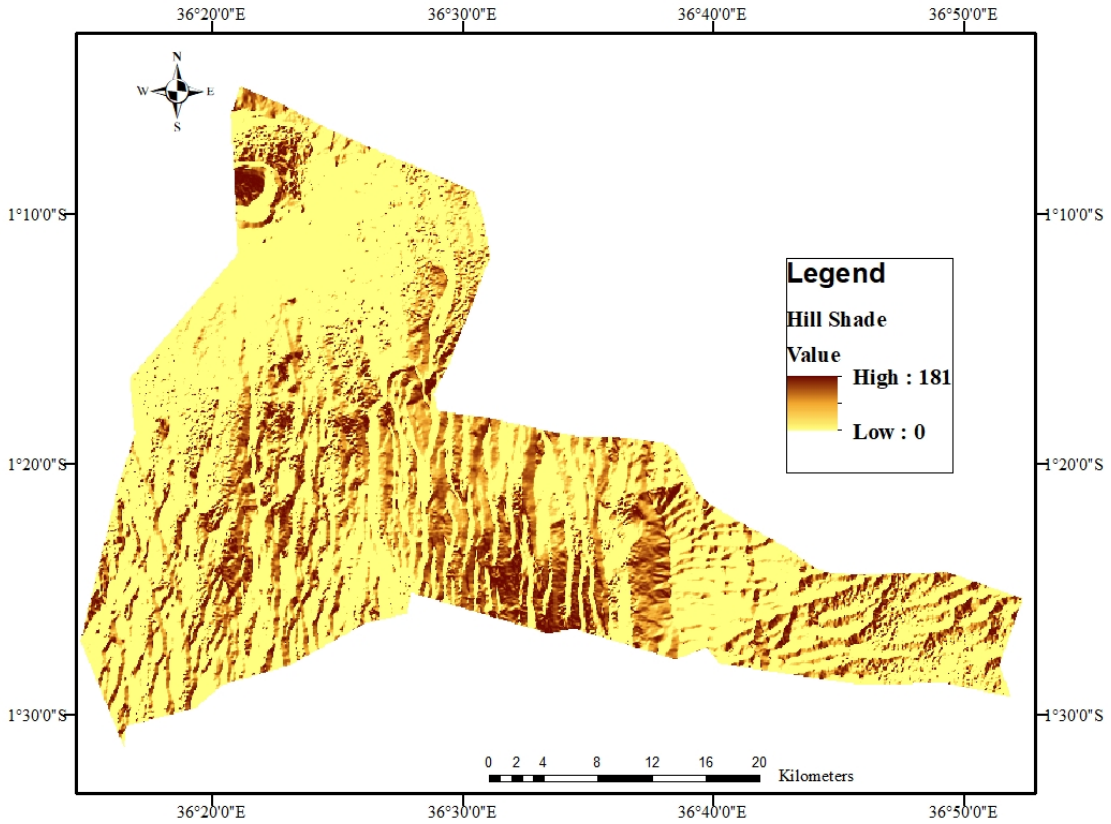


Figure 1.2: Hill shade map, Kajiado West Sub-county

Source: WRI (2016)

Figure 5.3 shows the highest point is at 1653.88 m in Ewuaso Kedong and 1872.34 m in Keekonyokie location. The darkest colors represent the most senior, while the light shaded parts indicate the lowest points. Quarrying is mostly carried out in areas served by the high areas, where stone and sand resources are readily available while agricultural activities are carried out in the lower regions, represented by light shade.

Plate 1.1: An abandoned quarry in Keekonyokie location, Kajiado West Sub-county

Source: Author (2016)

Plate 5.2 shows a quarry site in Keekonyokie location. The study findings indicate that quarrying is one of the causes of land cover change in the sub-county. This is attributed to both past and present quarries. The land is left bare and cannot be put to any other useful use by the locals.

Livelihood activities of Households

The study sought to find out the livelihood activities of households by both observation and questionnaire. The respondents stated how they used their land. Figure 5.4 shows the study findings.

Plate 1.2: Free range goats grazing in an open field

Source: Author (2016)

Plate 1.3 shows free-range goats grazing in an open field in the sub-county. The agro-pastoralist culture allows free range grazing. The grazing of livestock on open pastures adversely affects land cover change, leading to vegetal cover loss and soil erosion. This at the end contributes to barren land that cannot be used for grazing and farming activities.

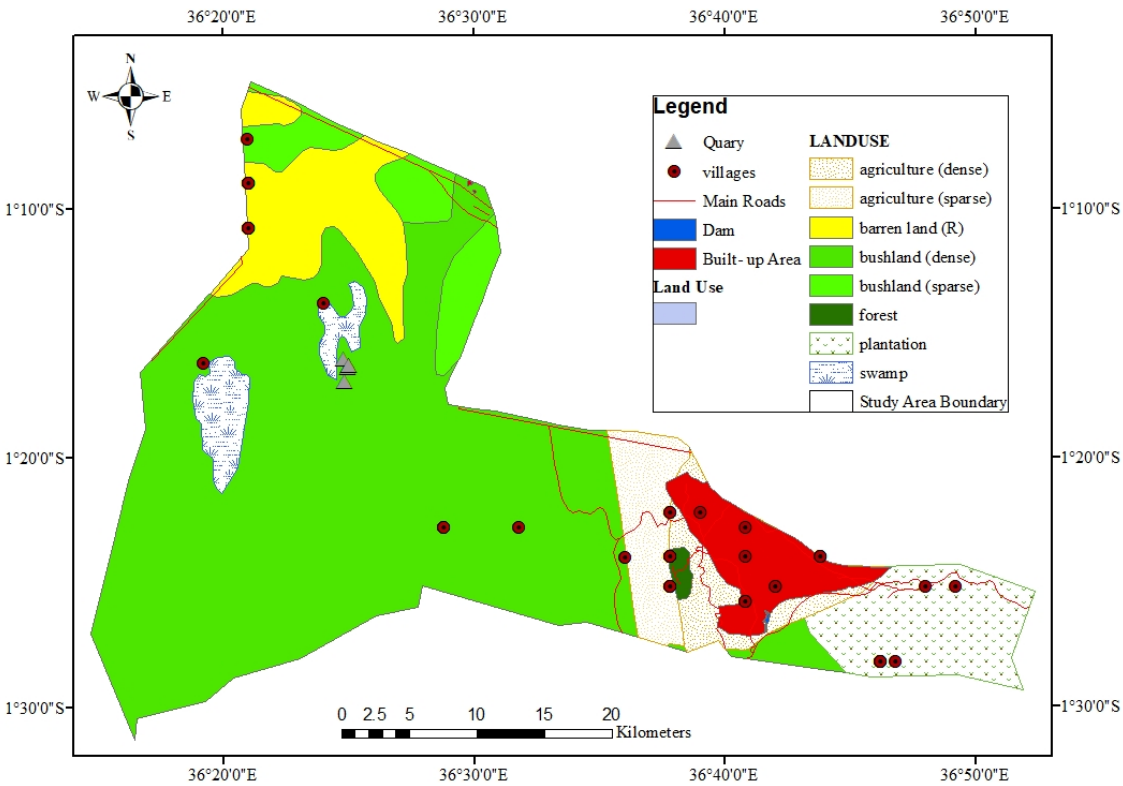


Figure 1.4: Land use map, 2016

Source: WRI (2016)

Figure 1.4 shows land use in Kajiado West Sub-county. A large proportion of the area is bushland, concentrated mainly in the western part. Agriculture is practiced both sparsely and densely in parts of the eastern side, where there exists a small forested area. Some barren land is found in the Northern section. From the focused group discussion and observations, most of Ewauso Kedong area is barren land, hence the sand harvesting and quarrying activities are paramount. The lower part of the sub-county however, is suitable for agriculture and therefore densely populated.

Land use, Kajiado West Sub-county, 2016

Land use type	Area, km^2

Bushland (dense)	9.683
Agriculture (dense)	143.02
Plantation	142.70
Bushland (sparse)	124.26
Barren land	137.95
Agriculture (sparse)	76.14
Swamp	39.80
Settlement	0.86
Forest	0.93
Grassland	1.86
Total area	**677.2**

Source: WRI (2016)

Table 1.1, in conjunction with Figure 1.5, land use area as follows: agriculture (dense) 143.02 km^2, agriculture (sparse) 76.14 km^2, bushland (sparse) 124.26 km^2, bare land 137.95 km^2, grassland 1.86 km^2, settlement 0.86 km^2 and forest 0.93 km^2. Migration from outside the sub-county has led to land use change, villages have cropped up, leading to the creation of urban areas while the barren land is used for quarrying as a means of livelihood, hence the land cover change.

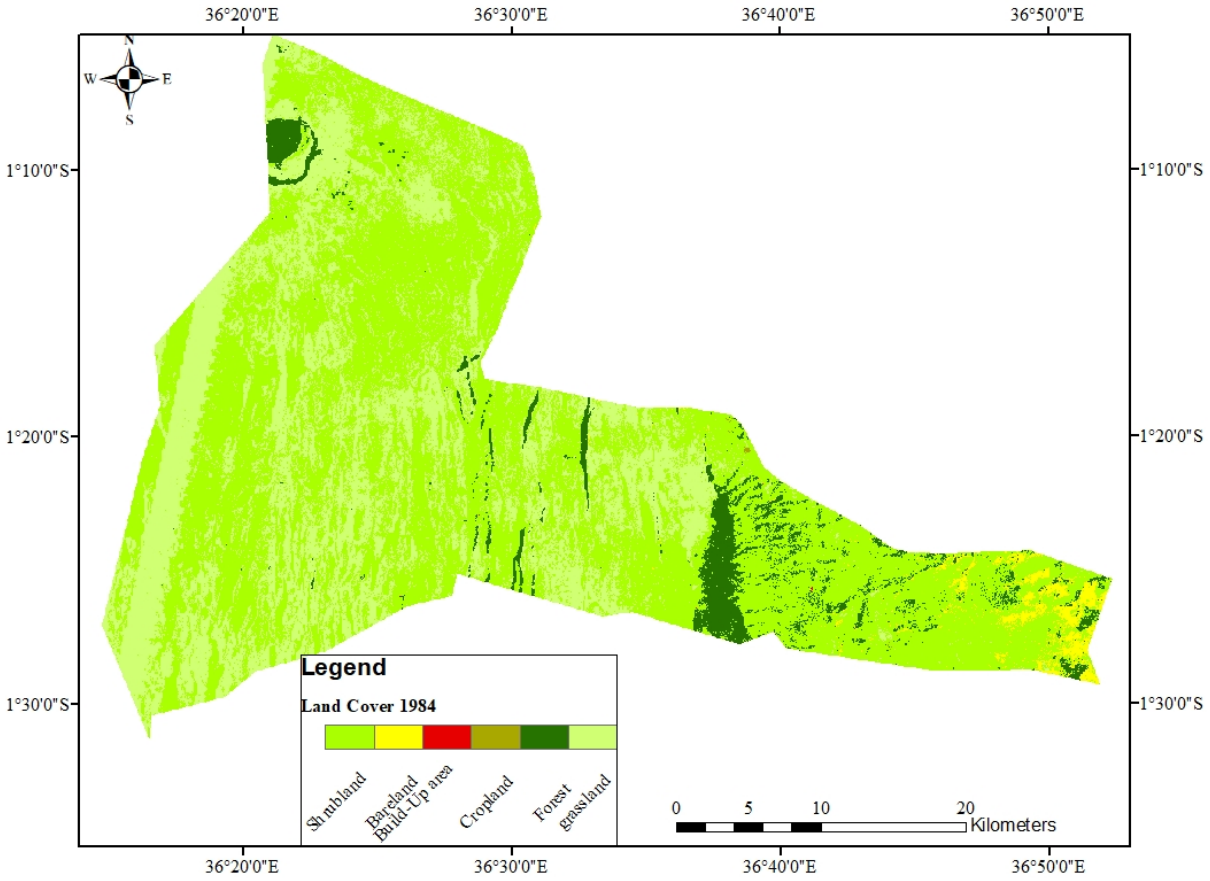
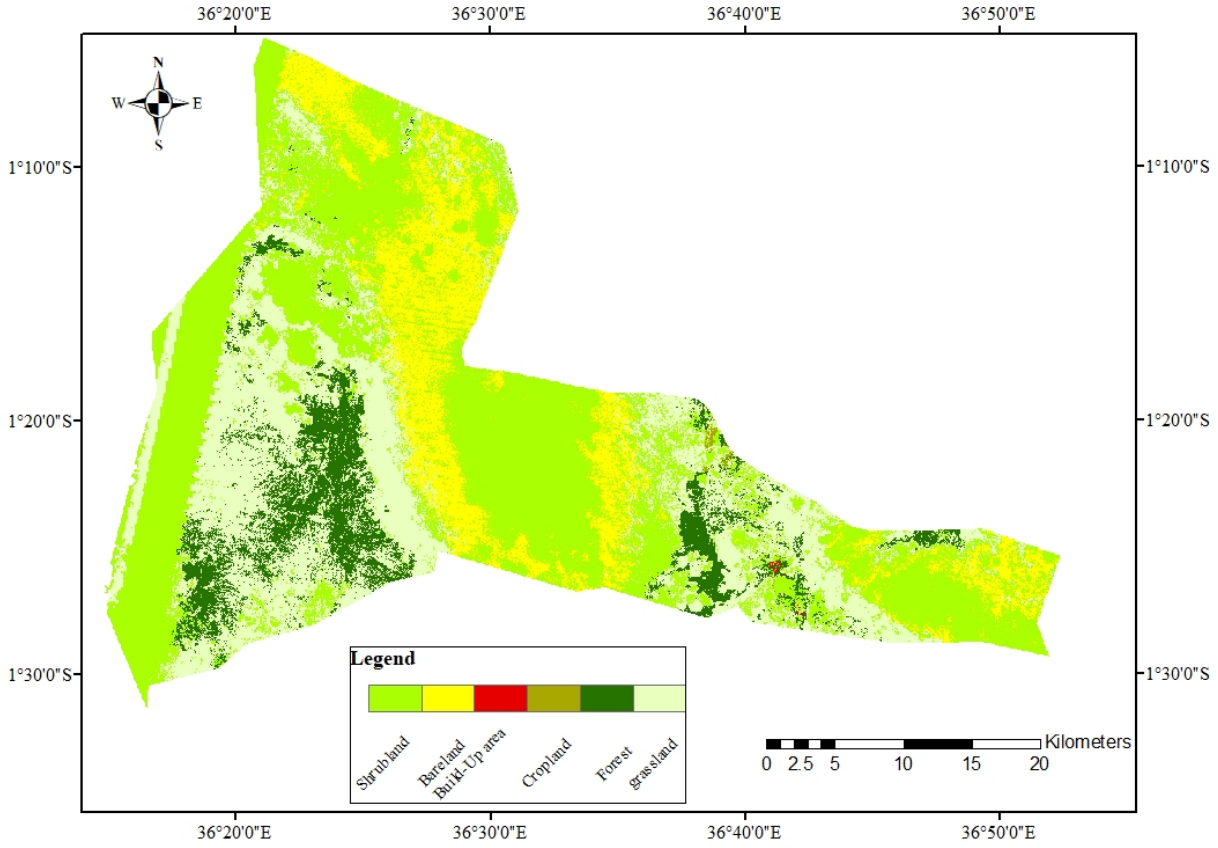


Figure 1.1: Land cover map, Kajiado West Sub-county, 1984

Source: USGS (2016)

The study findings based on Figure 1.6, shows land cover as forest 7.06 ha, urban 0.0066 ha, cropland 0.0327 ha, bare land 2.31 ha, grassland 51.05 ha and shrub land 89.63 ha. In 1984, shrubland covered the most significant section of the county, at 89.63 ha. The 1984 map is the base map with minimum human interaction on the natural resource base. The agro-pastoralists mainly utilized the land for livestock pasture and with only a small part 0.0327 ha being used for cropland.



Land cover map, Kajiado West Sub-county, 1996

Source: USGS (2016)

From Figure 1.7, the study findings, indicate land cover as follows: forest 12.72 ha, built up area 0.057 ha, cropland 0.18 ha, bare land 7.61 ha, grassland 40.1 ha and shrub land 89.46 ha. The human interaction with land has led to an increase in acreage under crops from 0.0327 ha to 0.1792 ha over a twelve year period. Built up area is also changing from 0.0066 ha to 0.057 ha due to rural, urban migration in search for livelihoods.

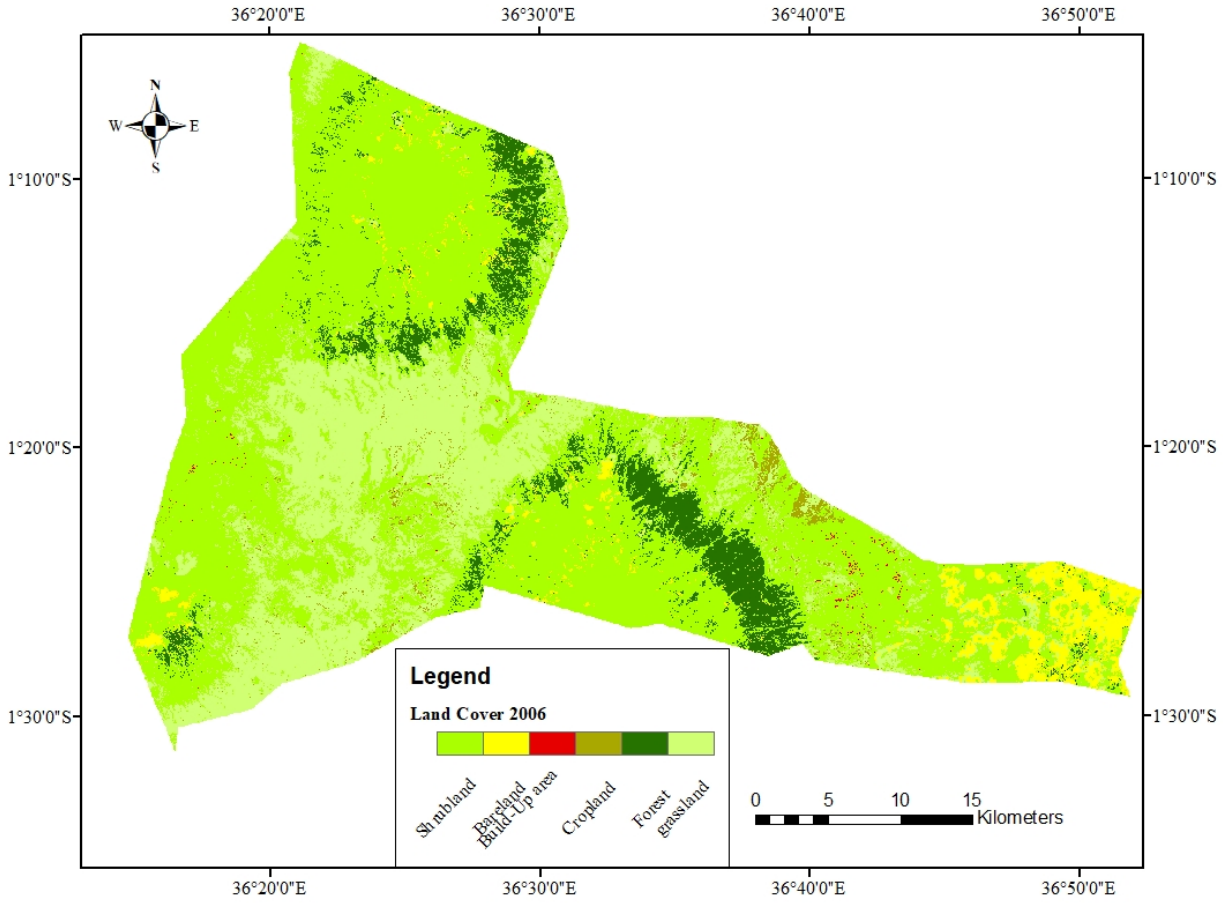


Figure 1.2: Land cover map, Kajiado West Sub-county, 2006

Source: USGS (2016)

The study findings, based on Figure 1.8, show that the land cover in 2006 was: forest 11.85 ha, built up area 1.49 ha, cropland 1.65 ha, bare land 7.10 ha, grassland 37.14 ha and shrubland 90.84 ha. The natural resource base was not significantly affected by a land cover change. This is because between 1996 and 2006, the decrease in forest cover was from 12.71 ha to 11.84 ha and an increase in the built-up area from 0.0572 ha to 1.495 ha., while grassland area decreased from 40.06 ha to 37.14 ha due to crop cultivation which increased from 0.179 ha to 1.65 ha.

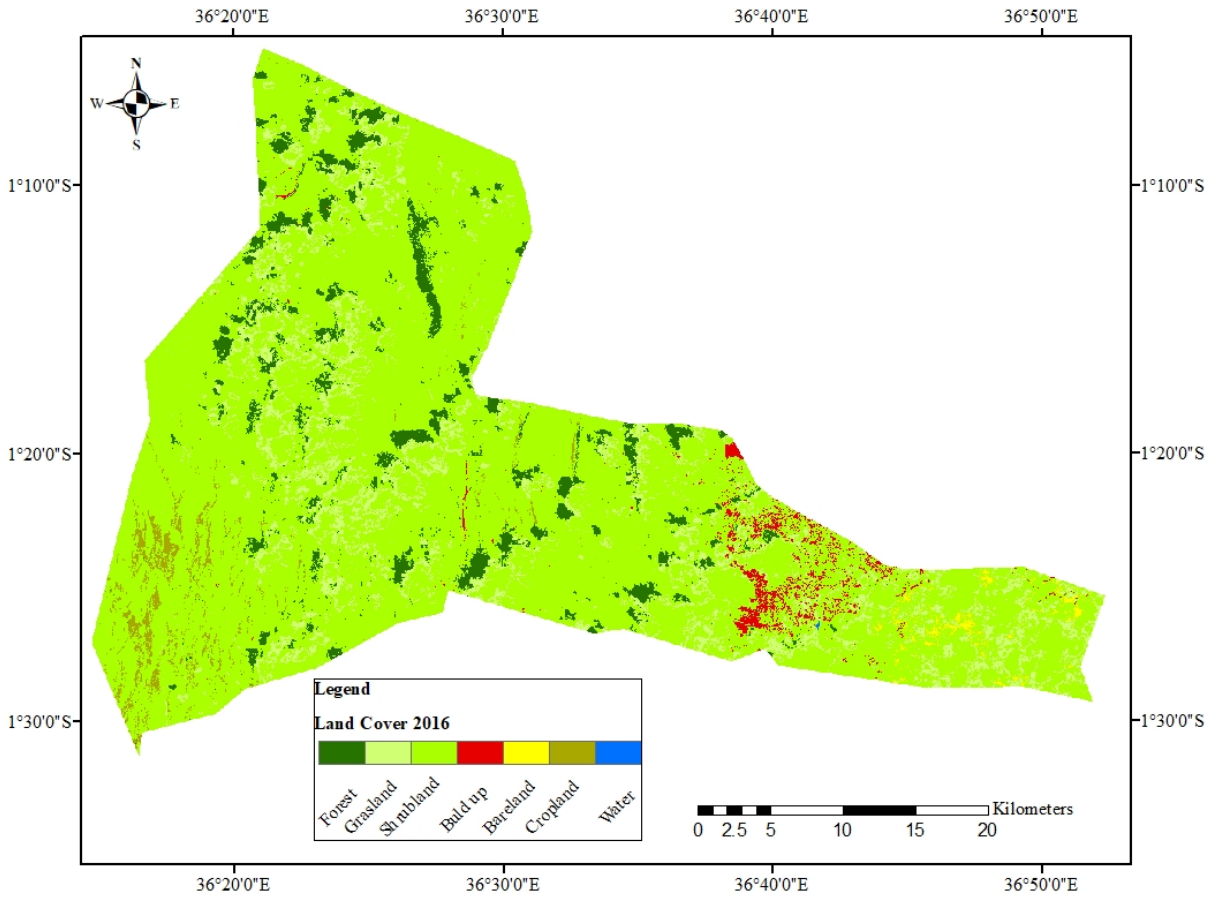


Figure 5.3: Land cover map, Kajiado West Sub-county 2016

Source: USGS (2016)

The study findings based on Figure 1.9, show the land cover map 2016 of Kajiado West Sub-county as follows: forest 8.40 ha, built up 2.09 ha, cropland 2.51 ha, bareland 0.68 ha, grassland 16.46 ha and shrub land 119.94 ha. Between 1984 and 2016, the community has been adversely affected by the land cover change. This is due to the population explosion that has led to land encroachment and a decrease in grassland cover from 51.05 ha. To 16.46 ha. Hence, the agro-pastoralists have resorted to other livelihood mechanisms such as quarrying and small-scale businesses. There has been an increase in built-up area from 0.066 ha. To 2.09 ha. and crop cover from 0.0327 ha. To 2.51 ha between 1984 and 2016.

Natural resources available

The study sought to find out the natural resources that are available in the sub-county. These include stone, trees, sand, and water. Observation and questionnaires did this. Table 1.2 shows the findings.

Table 5.1: Natural resources available Kajiado West Sub-county

Natural resources available	Percentage
Stone	38.5
Trees	40.8
Sand	13.4
Water	6.2
Others	1.0
Total	**100.0**

Source: Field Data (2016)

The findings indicate the following: that majority of the households' view trees 40.8% (158) as the primary natural resource, 38.5% (149) reported that stones are predominantly found in the area, followed by sand 13.4% (52) and water 6.2% (24). Trees are the most powerful natural resource, developed by stone and water.

Observation and Focused group discussions indicated that sub-county has vast natural resources such as stone, trees, water and sand that are used for economic activities. The key informant interviews also showed that wild animals such as cheetahs and leopards which are a tourist attraction.

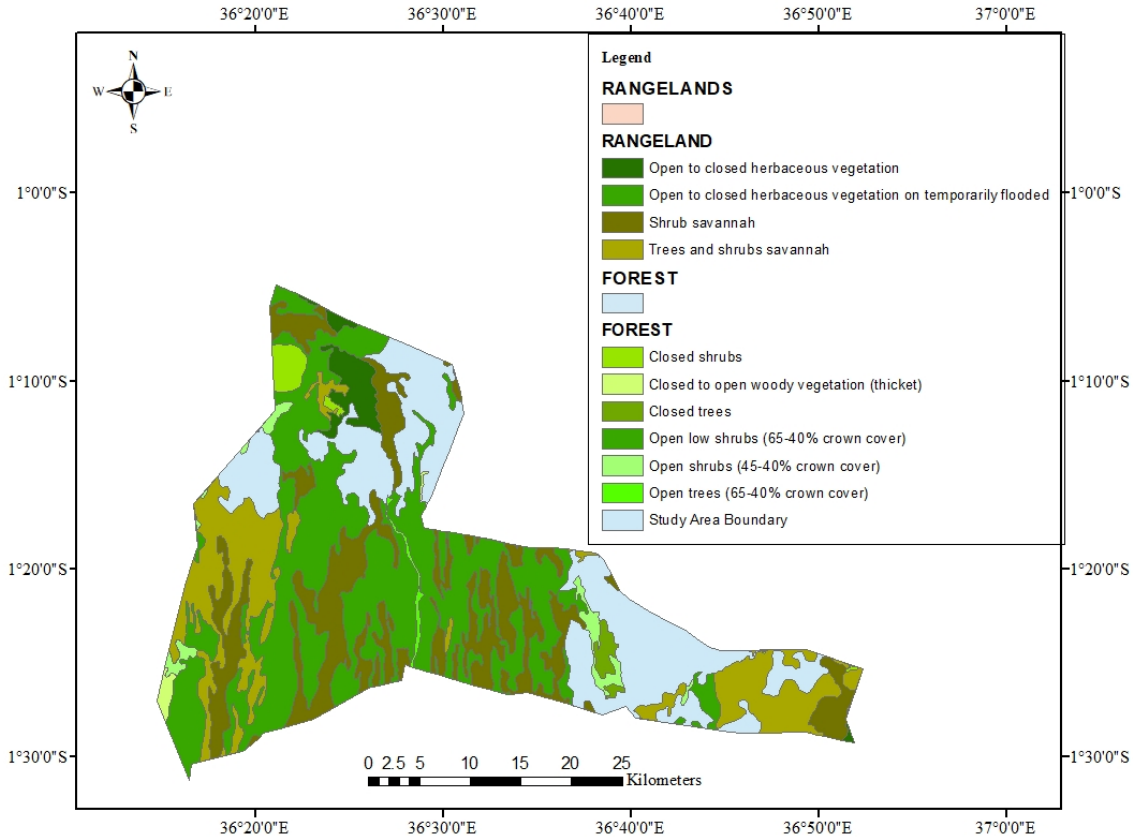


Figure 5.4: Vegetation cover map, Kajiado West Sub-county, 2016

Source: WRI (2016)

Figure 1.10 indicates that the vegetation comprises shrubs and scattered trees. Low shrubs occupy the most significant part of the sub-county covering an area of 5 km^2; trees cover 0.14 km^2 as shown in Table 5.3. This is attributed to the arid and semi-arid region in which Kajiado West Sub-county is located.

Table 5. 2: Vegetation cover, 2016

Vegetation type	Area, km^2
Open low shrubs (65-40%)	5.06850915
Closed trees	0.13871015
Open trees (65-40%)	0.05776060
Open shrubs (45-40%)	0.89482031

Closed to open woody vegetation (thicket)	0.00246696
Closed shrubs	0.20758683
Total coverage	**6.65935192**

Source: Field Data (2016)

Table 1.3 shows the vegetation cover composition of Kajiado West Sub-county in 2016. Open low shrubs comprise an area of 5.1 km^2, closed trees 0.14 km^2, open trees 0.058 km^2, open shrubs km^2, closed and open woody vegetation (thicket) 0.0025 km^2 and closed shrubs 0.21 km^2. The total area is 6.67 km^2. The sub-county is covered by open low shrubland, which is used for pasture. There is human-wildlife conflict in the sub-county. Communities encroach on shrubland, and this leads to land cover change.

A relationship between environmental issues affecting agro-pastoralists and livelihood strategies adopted

		Environmental issues affecting Kajiado County	**Livelihood strategies adopted in the county**
Environmental issues affecting Kajiado County	Pearson Correlation	1	.216**
	Sig. (2-tailed)		.000
	N	387	387
Livelihood strategies adopted in the sub-county	Pearson Correlation	.216**	1
	Sig. (2-tailed)	.000	
	N	387	387

Source: Field Data (2016)

** Correlation is significant at the 0.01 level (2-tailed).

The environmental issues affecting Kajiado West Sub-county has a significance of 1 which is a perfect correlation directly coefficient in the livelihood strategies adopted in the sub-county. This, therefore, implies that the community is aware of environmental issues affecting them and as such, they have resorted to policies which mitigate land cover change.

The relationship between land use and land cover change

		How is land used where you live	Causes of land degradation
How is land used where you live	Pearson Correlation	1	.065
	Sig. (2-tailed)		.203
	N	387	387
Causes of land cover change	Pearson Correlation	.065	1
	Sig. (2-tailed)	.203	
	N	387	387

Source: Field Data (2016)

Land use has a significance of 1 which is a perfect correlation directly coefficient in causing land cover change. This, therefore, implies that how land is used in the sub-county has adverse effects on the environment leading to the land cover change in the sub-county.

Regression analysis of the causes of land cover change

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.241[a]	.058	.048	.76716	.058	5.872	4	382	.000

Source: Field Data (2016)

Income earned per month, gender of respondents, level of education and duration in Kajiado accounted for significant variance in causes of land degradation, $R^2 = .058$, $F(4,382) = 5.872$, $p < .001$. The standardized beta coefficients indicated that income earned per month (Beta = .248, $p < .001$), gender of respondents (*Beta* = .015, $p < .001$), level of education (*Beta* = -.052, $p < .001$) and duration in Kajiado (*Beta* = .014, $p < .001$) were significantly and negatively related to causes of land degradation.

Regression analysis of livelihood strategies

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.296[a]	.087	.078	.44349	.087	9.151	4	382	.000

Source: Field Data (2016)

Income earned per month, gender of respondents, level of education and duration in Kajiado accounted for significant variance in livelihood strategies adopted in the county, $R^2 = .087$, $F(4,382) = 9.151$, $p < .001$. The standardized beta coefficients indicated that income earned per month (Beta = -.221, $p < .001$), gender of respondents (Beta = -.109, $p < .001$), level of education (Beta = -.052, $p < .001$) and duration in Kajiado (Beta = -.137, $p < .001$) were negatively related to livelihood strategies adopted in the county.

Regression analysis of land cover change

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.345[a]	.119	.110	1.65520	.119	12.895	4	382	.000

Source: Field Data (2016)

Income earned per month, gender of respondents, level of education and duration in Kajiado accounted for significant variance in land cover change in the county, R^2 = .119, F(4,382) = 12.895, p < .001. The standardized beta coefficients indicated that income earned per month (Beta = .132, p < .001), gender of respondents (Beta = .015, p < .001), level of education (Beta = .025, p < .001) and duration in Kajiado (Beta = .297, p < .001) were significantly related to causes of land cover change.

Regression analysis of natural resources available

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.250[a]	.063	.053	.89919	.063	6.370	4	382	.000

Source: Field Data (2016)

Income earned per month, gender of respondents, level of education and duration in Kajiado accounted for significant variance in natural resources available , R^2 = .063, F(4,382) = 6.370, p < .001. The standardized beta coefficients indicated that income earned per month (Beta = .248, p < .001), gender of respondents (Beta = .015, p < .001), level of education (Beta = -.052, p < .001) and duration in Kajiado (Beta = .014, p < .001) were negatively and significantly related to natural resources available.

Discussions

According to the research, sand harvesting results in the transportation of boulders, soil and uprooted tree stumps downstream by rainwater during flood events. Quarry and sand merchants do not participate in environmental management, in the sub-county. Thus, the loss of biodiversity has an adverse impact on life, property and the environment.

The study is in agreement with Kirsch *et al.*, (2012), who states that spatial patterns of potential erosion are mainly on the hill slopes. This indicates that steep slopes close to the rivers supply most of the fine sediment during flood events. In small mountainous basins where damages due to windstorms occur, the proportion of land exposed to erosion may modify the risk for the downstream areas. A sustainable forest management program is set to minimize these impacts, which require a proper evaluation of the basin response to changes in forest and vegetation cover.

According to a study by UNEP (2016), the movement of an estimated 450 million people from rural to urban areas by 2050 will place enormous strains on civic institutions, infrastructure, financial and other resources, while also exacting huge demands on land for settlement. Combatting this challenge will require sound spatial planning at all levels of governments to ensure that cities can cope with growing urban population. Making rural areas more attractive to the youth through investment in agricultural development is another critical intervention.

The study is in agreement with ROK (2013), where the vegetation type in the sub-county is determined by altitude, soil type, and rainfall. In many instances, it has been modified by animal and human activity. The vegetal cover is scarce in low altitude areas and increases with altitude. Ground cover throughout the sub-county varies seasonally with rainfall and grazing intensity. Canopy cover ranges from less than 1% on densely settled areas to about 30% on steep hills.

The study is in agreement with GOK, (2013), in Kenya, the adverse impacts of climate change are compounded by environmental dilapidation (illegal encroachments and settlements, logging and livestock grazing), which have among others, further encouraged deforestation and negatively impacted land cover change.

According to a study by GOK (2010), forest cover in Kenya, for instance, has fallen from 12% in the 1960s to less than 2 % at present. This has considerably affected the ability of Kenya's five main water towers to act as water catchments for major rivers and lakes, which are the primary sources of water. Furthermore, climate change is exacerbating human-wildlife conflicts. Pastoralists in search of pasture and water have encroached into game parks, interfering with natural wildlife habitat. The drought has also pushed the wildlife closer to waterholes and human settlements.

Another study by GOK, (2009), states that natural resources are increasingly under pressure as a result of unequal utilization. This has resulted in pollution, soil erosion, resource depletion and extinction of some flora and fauna like amphibians and water lilies. Kenya faces a significant challenge in planning for sustainable use of the natural resource in the face of the limited arable land, water, minerals as a result of rapid population growth, poverty, and limited financial capital. Increased economic activities negatively impact on the environment. Pressure on land due to population growth coupled with the introduction of exotic production technologies is causing erosion of traditional conservation strategies. Commercialization of production systems has also encouraged unsustainable use of land-based resources.

The study agrees with GOK (2016a), the primary sources of water for both domestic and livestock use in the sub-county are: piped water, rivers, springs, dams/pans and shallow wells. Surface water sources are above average due to above average rains in the pastoral and agro-pastoral zones.

The study findings also agree with GOK (2010), that the results of human activity, reflected by the change in vegetal cover or by development, are always regarded as features of the land. Of the total land surface area, approximately 17% is of high and medium potential agricultural use, while 83% is

classified as arid and semi-arid land. The regions contributing to siltation of Lake Magadi comprise upper and lower catchment covering Keekonyokie and Suswa wards of Narok East Constituency. This is attributed to the tree logging and disturbance of the topsoil in Kajiado West Sub-county; hence the high levels of siltation to Kajiado North Sub-county.

According to research by GOK (2010), water resources are under pressure due to soil erosion and siltation, water catchment destruction, low-level compliance with water quality regulations, inefficient water use strategies, invasive alien species, uncontrolled sand harvesting and over-abstraction of water resources. Also, there is no existing framework between countries for the utilization and management of the shared water resources.

According to a study by GOK (2016a), open water sources are contaminated as a result of shared sources by both livestock and domestic use. Poor sanitation and hygiene have contributed to the contamination of public water sources in the sub-county. About 80 percent in the urban areas and only 20 percent in the rural areas use pit latrines. There has been no evidence of an increase in the number of toilets from the year 2015.

I. CONCLUSION

The study evaluated agro-pastoral livelihood activities that have contributed to land cover change and agro-pastoral livelihood strategies in Kajiado West Sub-county. The study identified the livelihood strategies of agro-pastoral communities that have been affected by population explosion. The research findings from to the County Government, the population growth rate is set at (5.5%). This is due to an influx of people in business from other counties. The majority of the people interviewed had lived in the

sub-county for less than a year. The community actively depends on agriculture and cattle rearing as a means of livelihood.

The study also set out to determine the contribution of the agro-pastoral livelihoods on the land cover change in Kajiado West Sub-county. The research indicated that quarrying and deforestation had adversely contributed to the land cover change. The FGDs revealed that most people hire out their land to charcoal traders and quarry companies. The findings also showed that quarrying affects the population, the majority of whom agreed that they were at risk of suffering from various diseases, noise pollution, the safety of their children and contamination of water from the effluents that from the industries. The agro-pastoralist communities are also heavily involved in quarrying and sand harvesting occupations. Thus, pastoralism is decreasing due to newer methods of making a living. From the findings, satellite images of 1984, 1996, 2006 and 2016 indicate that there occurred a significant change in land cover. The research findings reveal that land cover change has led to a rise in diseases such as malaria, cholera, and typhoid. See plate 1.1 showing a section of an abandoned quarry site filled with stagnant water.

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