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Household determinants of competing land uses in the Amboseli Ecosystem, Kenya

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ABSTRACT

Across several developing countries, appropriate land allocation between competing alternatives is a fundamental problem that continues to be a developmental challenge. Amboseli Ecosystem is a key ASAL land in Kenya whose landscape in resource uses has diversified over the period 1980–2010. Cultivation of crops in an ecosystem that is suited to sustainably supporting livestock and wildlife has resulted in strained use of natural resources. This is evident from fragmentation of communal land, increased human-wildlife conflicts and reduced grazing lands. A clear understanding of the drivers of these land use decisions at the household level is lacking. Therefore, this study determines factors that households are likely to consider when allocating land to different uses in Amboseli Ecosystem. A multinomial logistic regression model using crop production, livestock keeping and wildlife conservation as main categories was used to analyze data from 295 households. Results show that acquisition of more secure land tenure resulting in settlement near water resources and development of road infrastructure, are key drivers towards crop production. Other significant factors include age of the household head, land size, household income and credit access. To ensure sustainable flow of ecosystem services from Amboseli Ecosystem, emphasis should be placed on policies that do not encourage crop production. These include cessation of expansion of infrastructure and continued conservation of water resources. The latter is particularly important in supporting co-existence of wildlife and livestock.

1. Introduction

Natural resources are valuable assets that provide economic services to people including commercially exploited resources such as fishery, land, wildlife, and forests (Hanley and Barbier, 2009). The efficient and sustainable[1] use of these assets can lead to long-term economic gains. In Kenya, most of these assets are found in the Arid and Semi-Arid Lands (ASALs) that are often characterized by low and erratic precipitation but their economic importance cannot be underrated (Omollo et al., 2018). The high biodiversity values (habitat diversity, Amboseli elephants, and rich birdlife), scenic values (Mt. Kilimanjaro, authentic Maasai culture, etc.), cultural values and social values enable the support of 26–30% of the country's human population, 50% of livestock and 70% of wildlife in Kenya (Amboseli Ecosystem Management Plan, 2008; National Land Use Policy, 2017).

Amboseli Ecosystem is one of Kenya's ASALs well known for wildlife conservation. Currently, the main economic activities include livestock keeping, crop production, tourism and related activities such as hotels, lodges and curio shop businesses. Minor economic activities include bee keeping, charcoal burning, mining of limestone and quarrying (Mburu, 2013). This diversity of economic activities is realizable partly because of the exceptionally high resource values in the Ecosystem.

Land is a unique resource in that its efficient allocation, in combination with other production factors, determines the level of productivity and returns. Traditionally, pastoralism was practiced in Amboseli Ecosystem following a semi-nomadic and transhumant way of life (Amboseli Ecosystem Management Plan, 2008). This always favored wildlife conservation because National Parks and Reserves in Kenya often lack enough space to accommodate wildlife sustainably. Thereby, the surrounding community lands are dispersal and migratory corridor areas for wildlife (Okello, 2005). This created a sustainable pastoral-wildlife interaction, coexistence and interdependence.

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1 Efficiency in the use of natural resources is achieved when the combination of inputs and outputs, and their distribution makes people better off whenever there are changes in the economy. Sustainability, on the other hand, refers to the process of improving the quality of human welfare without destroying the environment or affecting the wellbeing of other people especially in a manner that affects the ability of future generations' enjoyment of the same resources (Mensah and Castro, 2004).

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However, between 1980 and 2010 the social economic lifestyle of the pastoralists in the Ecosystem has changed to include adoption of a more sedentary way of life and introduction of other economic activities especially cultivation of crops (Campbell et al., 2003). This change in land use is driven (though partially) by macro-level factors such as rising human population, climate change, and changes in land use policy where land previously held in trust and under communal ownership is now being fragmented into smaller privately-owned parcels (Kristjanson, 2002; Campbell et al., 2003; Greiner et al., 2013).

From literature, notable microeconomic factors driving land use changes are documented. In China, rising rural income was the primary driver of farmland conversion to forests and grasslands (Li et al., 2013). In Ugandan highlands, older farmers had a tendency to leave land fallow for long periods while as formal education increased, plot abandonment was reported compared to cultivation. In addition, farmers ́attitude and plot characteristics influenced land use changes in Uganda (Bashaasha et al., 2006). In Kenya, changes in land use in Kakamega forest favouring bush land and agriculture were influenced by demographic, geographical and agricultural shocks (Mburu et al., n.d.). Although these past studies on drivers of land uses produced important results, they are inapplicable to the current area of study in the ASALs of Kenya. Mburu et al. (n.d.) studied a tropical forest and relied on village leaders and elders to give information on the socioeconomic and demographic data over a thirty-year period. This could have been inaccurate since it is a long time to recall and there was no prior recording of the information. The study by Bashaasha et al. (2006) was done in the highlands and may also not be applicable in the Kenyan ASALs. Therefore, the need for the current case study on the household factors that determine choice of competing land uses in Kenyan ASALs.

Land subdivision and fencing off parcels of land for crop production poses a threat to sustainable management of land in the Amboseli Ecosystem at the household level. This is because it results in declining livestock carrying capacity that in turn lead to declining wellbeing of pastoral household members in subdivided group ranches (Boone et al., 2005). With continued reduction of land size, households are forced to keep fewer animals that can graze in the available parcels (Thornton et al., 2006). Consequently, herd sizes have reduced significantly and livestock keeping is no longer the only major livelihood. Households are forced to seek alternative economic activities such as crop production. In addition, the Kenyan government has been seeking privatization of land in the Ecosystem, a move seen as an initial step towards development by non-conservationists (Boone et al., 2005). This is despite increasing concerns on the threat to wildlife and biodiversity from the conservationists (Okello, 2005; Western et al., 2009; Lewis, 2013; Fitzgerald, 2013).

Although optimal land allocation is achieved when the aggregate discounted social returns from land uses over time are maximized (Barbier and Burgess, 1997), this is seemingly not the case in this Ecosystem. The inclusion of new economic activities such as crop production has strained the available land resource and is increasingly contributing to the soaring human-wildlife conflicts in the Ecosystem. Thus, the subdivision of the group ranches, the resultant reduced grazing lands and declining carrying capacity for the livestock and wildlife is not a solution for sustainable management of the Ecosystem (Boone et al., 2005; Norton-Griffiths and Said, 2010; Amwata and Mganga, 2014; Gichohi et al., 2014; Okello and Novelli, 2014).

From literature, and as earlier stated, macroeconomic forces driving these transformations are well studied and documented (Norton--Griffiths, 2000; Campbell et al., 2003; Boone et al., 2005; van der Valk, 2008; Farmer and Mbwika, 2012; Makokha et al., 2013). However, the micro-drivers are not well articulated. Thus, understanding of factors influencing household decisions on land uses can facilitate a discourse on improvement of management of the Ecosystem in order to ensure efficiency and sustainability in its use. Therefore, the objective of this paper is to assess household determinants of competing land uses within the Amboseli Ecosystem. This is with a consideration of three land use categories including crop production, livestock keeping and wildlife conservation. The findings of this paper are expected to add on to the scarce land and natural resource literature on competing land uses and inform decisions on appropriate policies for the short and long-term planning of the Amboseli Ecosystem. This is in line with the Amboseli Ecosystem Management Plan (, 2008–, 2018), Kenya's blueprint Vision 2030, and Sustainable Development Goal 12 (SDG 12) on responsible production and consumption of natural resources.

2. Study area

Amboseli Ecosystem is located in Kajiado County in the southern part of Kenya. It is estimated to be 5700 km^2 in size and administratively consists of Amboseli National Park and surrounding six group ranches: Kimana (Tikondo), Kuku, Olgulului (Olararashi), Imbirikani, Rombo, and Selengei (Amboseli Ecosystem Management Plan, 2008). From the perspective of Agro-Ecological Zones (AEZ)[2] in Kenya, the Ecosystem is classified under Zones V and VI, which are typically arid and semi-arid lands (Bulte et al., 2006). Rainfall is bimodal and low, at an average of 350 mm per annum. Precipitation peaks are in March-April and October - December. Temperatures range from 20^0c to 30^0c with a low of 10^0c being experienced in the eastern slope of Mt. Kilimanjaro. The coolest period is between July-August and the hottest months are November - April (Bulte et al., 2006; Ministry of Agriculture, Livestock and Fisheries, 2014). Water available in numerous swamps sustains the ecosystem and its habitats. These swamps are fed by subsurface water that percolates through volcanic rock from the forested catchments of Mt. Kilimanjaro and Chyulu Hills (Kimana Integrated Wetland Management Plans, 2008). As indicated in the introduction, the Ecosystem has very diverse economic activities. The latest one is crop production, which arose from the subdivision of communal land to private parcels. Thus, the households in the Ecosystem no longer practice extensive pastoral systems and nomadism. Tourism has also shown a growing trend in the period 1980–2010 as evidenced by the establishment of many lodges and camping sites in the Ecosystem.

The study was specifically conducted in the Kuku, Rombo and Kimana Group Ranches (Fig. 1) of the Ecosystem. This is mainly because these group ranches have features that form a good representation of the entire ecosystem. This is particularly in relation to the main economic activities of livestock production, crop production and wildlife conservation, land tenure and group ranch organization structures. For example, Kuku Group Ranch lies on the wildlife corridor between Chyulu Hills/Tsavo National Park and Amboseli National Park/Kilimanjaro area (Okello, 2005) favouring wildlife related activities. It is relatively drier than the rest of the group ranches and still under communal land ownership. Kimana Group Ranch is completely subdivided and therefore has private land tenure. The presence of Kimana Community Sanctuary and the Amboseli National Park implies that a lot of the surrounding privately owned plots in Kimana are used as dispersal area for wildlife. At the same time, with full subdivision of land, some landowners have freely fenced off areas surrounding swamps and are irrigating crops (Fitzgerald, 2013). Besides, Kimana Group Ranch is also at a proximate distance to Nairobi, favouring access to large markets. In Rombo Group Ranch, both rain-fed and irrigated agriculture is practiced, with a focus on horticultural crops mainly onions, tomatoes, and

[2] Agro-ecological zones (AEZs) are land areas defined based on combinations of soil, landform and climatic characteristics. In Kenya, there are six AEZs; I (Agro-Alphine), II (High potential), III (Medium potential), IV (Semi-Arid), V (Arid) and VI (Very Arid). Zone V occurs in lower elevations and has a rainfall of about 300–600 mm. The natural vegetation is a short grass savannah with small leafed thorny trees and bushes. Zone VI occurs at lower elevations also and has mainly bushland with very short perennial grass. Therefore, it is suitable for ranching - if the grass (the standing hay for the dry season) is not eradicated through overgrazing (FAO, 1996).

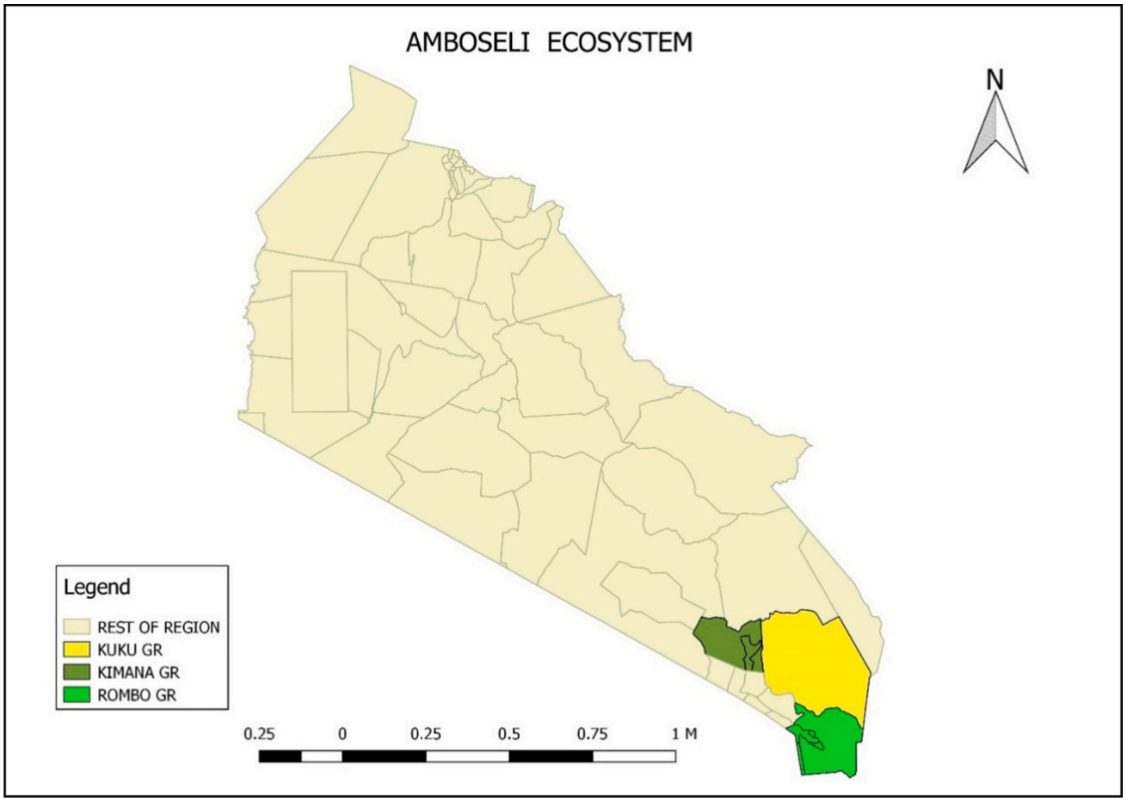

Fig. 1. Group Ranches of the Amboseli Ecosystem targeted in the study.
Source: Adopted from Njuguna (2017)

Asian vegetables. Tourism is not well developed and therefore only a few investment opportunities from wildlife conservation can be derived (Mburu, 2013).

3. Methods

3.1. Conceptual framework

Following Adom et al. (2018), Fig. 2 presents the various factors hypothesized to influence land uses in Amboseli Ecosystem and their interrelationships. The study used rational choice theory to explain landowner's behavior of choosing land uses that have the highest benefits. The theory states that individual's choices are determined by alternatives that maximize utility under given constraints (Sato, 2010). Assuming landowner i has to choose from Y land uses, the rational choice theory suggests that landowners will choose a land use option Yi that maximizes utility, for example improved welfare. Although the utility that is being maximized is not observable, it is influenced by

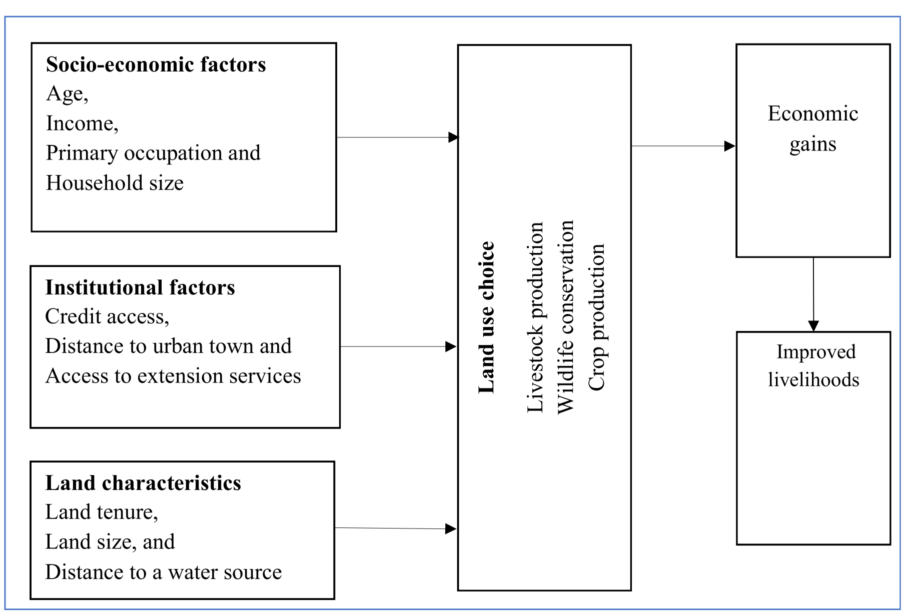

Fig. 2. Conceptualization of the determinants of land use options in the Amboseli Ecosystem.

observable and non-observable factors. Informed by literature, this study hypothesized that the choice of land use is a function of the observable factors (socio-economic, institutional and land characteristics). The unobserved factors are captured in the error term of the empirical model presented in Section 3.2.

3.2. Empirical framework

In order to operationalize the relationship between land use choices and the determinants, landowners were asked what they considered their main economic activity among crop production, livestock keeping, and wildlife conservation alternatives. These choices gave rise to three categorical but unordered options. Multinomial Logistic regression (MNL) or Multinomial Probit regression (MNP) analyses methods are appropriate in cases where the options are multiple and unordered. These estimation methods consider mutually exclusive choices. The choices provided to the respondents were distinct from each other rendering the Independence of Irrelevant Alternatives redundant. The MNL model was used in this study because choice probabilities in the model are relatively simple, and computers can maximize the resulting likelihood function almost instantaneously, even for large number of choices. This is unlike MNP where choice probabilities involving multiple integrals may often fail to converge or provide useful estimations (Kropko, 2008). Similarly, the MNL model is appropriate when data captures characteristics of individuals as opposed to both individual characteristics and choices attributes (Greene, 2003) which are rather costly to obtain for a researcher. The independent variable values are assumed to be logistically distributed.

According to Greene (2003), the MNL model borrows from random utility model concepts where for the i^{th} household with j land use choices, the utility from choice ij is expressed as;

$$U_{ij} = X_{ij} + \varepsilon_{ij} \quad (1)$$

Where U_{ij} = Utility of land owner i with j land use choices and having chosen option j, for example crop production, X_{ij} are the independent variables such as access to credit and ε_{ij} is the error term.

If the i^{th} household chooses J, then U_{ij} is assumed to be the maximum among the J utilities. Therefore, MNL is driven by the probability that choice j is made. The probability from the j^{th} choice can be modelled as shown in Eq. (2).

$$P(Y_i = J) = exp^{\beta_j X_i} \Big/ \sum_{k=0}^{J} exp^{\beta X_i}, \; j = 0, 1, \ldots, J \quad (2)$$

The functional form of Eq. (2) is specified as;

$$Y_{ij} = X_i\beta + W_i\alpha + Z_i\gamma + \varepsilon_i \quad (3)$$

Where Y_{ij} represents a probability of a household i allocating land to the jth activity. X_i is the household socioeconomic attributes, W_i represents land characteristics while Z_i denotes the institutional factors (see also Fig. 2). β,α, and γ are the parameter estimates and ε_i represents the error term.

In MNL model estimation, coefficients give the direction but not the actual effects nor the magnitude. Rather, estimated marginal effects depict the probability of choosing one among the several alternatives. They measure the actual effects of a unit change in each of the explanatory variables relative to a base outcome on the choice of land use options. Since the dependent variable has three alternatives, two equations were estimated providing probabilities for the J+ 1 choice for a decision-maker with characteristics X_i. The βs are the coefficients to be estimated through maximum likelihood method (Damodar, 2004). Table 1 presents the variables used in the MNL model.

Table 1
Description of the variables used in the study.

Variable name	Variable description	Variable type	Unit of measurement
Land use option	Main economic activity as considered by the household head	Categorical	1 =Livestock production 2 = Cop production 3 = Wildlife conservation
Social and demographic characteristics			
Age	Computed from the birth year to 2014	Continuous	Years
Household size	Considered number of people who cooked from the same kitchen in a household	Continuous	Number
Income	The total amount of money earned both on-farm and off-farm	Continuous	Amount in Kenya Shillings
Primary occupation	Main economic activities as considered by the household head	Dummy	1 = Farming 0 = otherwise
Land characteristics			
Land tenure	The property right to land held by the household head	Dummy	0 = insecure land tenure 1 = secure land tenure
Land size	Number of acres owned or accessed by the household head	Continuous	Acres
Distance to a water source	Kilometers to the nearest source of water used in the farm	Continuous	Kilometers
Institutional factors			
Credit access	Household heads who had borrowed from financial institutions and were successful	Dummy	1 = Access 0 =otherwise
Distance to the urban town/ market	Kilometers to the nearest urban town/market centre	Continuous	Kilometers
Extension services	Considered those who received extension services in their farms from any source (private or public sources)	Dummy	1 =Yes 0 = otherwise

3.3. Sampling design and data collection

The sampling frame for the study consisted of all members of the Kuku, Rombo and Kimana Group Ranches. The unit of research and sampling was the household. The sampling frame (Kajiado group ranches registry) was obtained from Kajiado County Lands Office. From the scoping exercise prior to the survey, it was established that Kimana group ranch was fully and completely subdivided hence no more registration of members. This is unlike the other two group ranches where the land registry is updated every year with new members. As informed from the scoping exercise and secondary data from the Ministry of Agriculture Livestock and Fisheries Loitoktok District Office, Kimana group ranch members' population was estimated to have grown by a factor of 2.86 group ranch members between 1980 and 2010. The original number (848) of registered group ranch members in Kimana multiplied this. Therefore, sampling was conducted from a population of 2425 members. As of 2013, Kuku and Rombo Group Ranches had 3429 and 3565 registered members, respectively. Thus, the sample frame of the study comprised 9419 registered members.

Using the Cochran formula (Cochran, 1963) the resulting sample was 295 respondents. Probability proportional to size was used to determine the number of respondents to be interviewed in each group ranch. Systematic random sampling was then applied to determine particular households to be interviewed from each group ranch. From the sampling fraction calculated, every 32nd household in the register was chosen with household number 10 as the starting point. Seventy-six,one hundred and twelve and one hundred and seven respondents were selected in Kimana, Rombo and Kuku Group Ranches, respectively.

3.4. Data analysis

Data collected were analyzed using socio-economic statistical packages: SPSS version 21 and STATA. Descriptive statistics including means, standard deviation (SD), and frequencies were generated for the selected socio-economic characteristics of the sampled households. One-way ANOVA and Tukey post-hoc tests were conducted to compare the means of the continuous variables. MNL analysis was used to assess the factors influencing land use choices.

4. Results

4.1. Land uses in Amboseli Ecosystem

As expected, livestock keeping (55%) was the most important source of income among households in Amboseli Ecosystem (Fig. 3). Approximately 30% of households in the Ecosystem practiced crop production. This can be attributed to the changing lifestyles of the Maasai community, which is partly influenced by the immigration of non-Maasai communities into the area and partly by the changes in dietary preferences from largely animal-based diet to inclusion of crops (Kimana Integrated Wetland Management Plans, 2008).

4.2. Characteristics of the sampled households

The results (Table 2) showed that households that engaged in wildlife conservation had a statistically significant ($P < 0.05$) larger land size (40.5 ± 34.39 acres) compared to those engaged in livestock keeping (28 ± 25.79 acres). Households that engaged in livestock keeping were statistically ($P < 0.05$) larger than those engaged in wildlife conservation (5.0 ± 2.02 members). Shorter distance to a water source was found to be statistically significant ($P < 0.05$) for the households engaging in crop production (1.6 ± 1.69 kilometers) compared to those keeping livestock (2.3 ± 1.64 kilometers). Similarly, longer distance to the nearest urban town was statistically significant ($P < 0.001$) for wildlife conservation (13.65 ± 9.28 kilometers) compared to crop production (7.2 ± 7 kilometers). There was no significant difference among the three economic activities with regards to mean age of the household head and the household income.

As shown in Table 3, households that kept livestock (97%) and those that produced crops (91%) had on-farm activities as the primary occupation of the household head. Interestingly, households with a secure land tenure were noted to engage in wildlife conservation (71%) compared to livestock keeping and crop production at 39% and 53%, respectively. Majority of the households involved in all the three economic activities reported low access to credit facility and extension services.

4.3. MNL model results of drivers of choice of competing land uses

From the MNL model diagnostics, the McFadden R squared (Pseudo R^2) was 0.2829 with a small p-value of 0.000. This shows the model fitted the data well. The resulting marginal effects of the estimated model are presented in Table 4. Age of the household head, net income, land size, land tenure, distance to water sources, and distance to urban town and access to credit were found to significantly influence the choice of land use. Livestock production was used as the base alternative and crop production and wildlife keeping as the alternatives. This is because livestock keeping has been the traditional economic activity while other settlers and governmental organizations in Amboseli introduced crop production and wildlife conservation respectively later on. As such, the interpretations of results reflect movement from livestock production, which allowed co-existence of livestock and wildlife in undisturbed environments, to crop production and wildlife conservation.

5. Discussion

The probability of choosing crop production relative to livestock keeping decreased by 0.74% for every one-year increase in age. This implies that households with younger household heads were more likely to plant crops rather than keep livestock. Notably, crop production involves activities whose returns accrue in a short term. These include horticultural crops that require about three months to mature, unlike livestock that take longer. Though this finding is in line with other results that showed that older farmers are risk -averse to adoption of new ideas (Howley et al., 2012), it also indicates that crop production is being adopted as one of the livelihood diversification strategies in the Ecosystem.

The probability of choosing wildlife conservation relative to livestock keeping increased for every acre increase in the land area owned by the households. This means that those with larger tracks of land have adequate dispersal areas for the wildlife to graze and drink, and therefore could easily engage in wildlife conservation and its related activities such as tourists' visits to Maasai *manyattas* and curio shops, and accommodation of tourists' in hotels.

Ownership of a title deed (a proxy for secure land tenure), increased the probability of choosing crop production as the main economic activity relative to livestock keeping. The result concurs with Serneels and Lambin (2001) and Kamau et al. (2018). Serneels and Lambin (2001) found that secure land tenure favored engagement in private enterprises

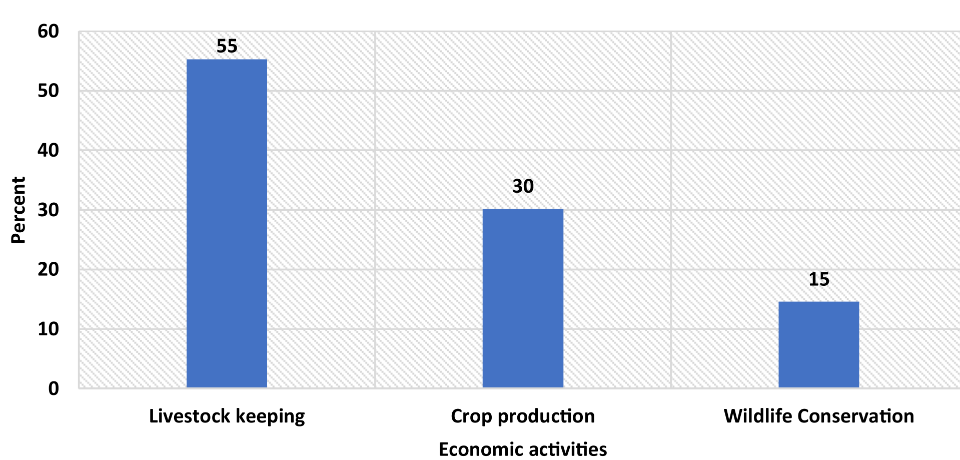

Fig. 3. Main economic activities in Amboseli Ecosystem.

Table 2
Descriptive statistics of continuous explanatory variables of the MNL model.

Variable	Livestock keeping (n = 163) Mean	Standard deviation	Crop production (n = 89) Mean	Standard deviation	Wildlife conservation (n = 43) Mean	Standard deviation	*F*-value	*P*-value
Mean age of the household head (years)	45.5	13.50	41	12.21	48	11.92	5.25	0.0058
Household size	5.0	2.02	4.7	2.05	4.2	1.59	**3.24****	0.0406
Household income (Ksh)	215275	199587	766639	4744847	73681	58881	1.59	0.2056
Land size (acres)	28.0	25.79	28.9	27.98	40.5	34.39	**3.58****	0.0291
Distance to nearest water source (km)	2.3	1.64	1.6	1.69	4.5	2.48	**38.29*****	0.000
Distance to urban town (km)	9.52	7.68	7.2	7	13.65	9.28	**10.21*****	0.0001

Statistical significance level: ***1% and * *5%

Table 3
Hypothesized nominal explanatory variables of the MNL model.

Variable		Frequency (%) Livestock keeping (n = 163)	Crop production (n = 89)	Wildlife conservation (n = 43)
Primary occupation of household head	Farm	157 (97)	81 (91)	33 (77)
	Off-farm	5 (3)	8 (9)	10 (23)
Land tenure	Secure	59 (39)	43 (53)	29 (71)
	Insecure	94 (61)	38 (47)	12 (29)
Credit access	Accessed	62 (38)	24 (27)	6 (14)
	Not accessed	10 1(73)	65 (73)	37 (86)
Extension services	Accessed	28 (17)	25 (28)	13 (30)
	Not accessed	135 (83)	64 (72)	30 (70)

Percentages are in parentheses

such as crop production in the Mara Ecosystem. This is enhanced by tenure security as landowners can make decisions at a household level including fencing off their land parcels to increase exclusivity of property rights. Such decisions are, as expected, likely to negatively impact on the objective of biodiversity and wildlife resource conservation.

The results also show that for every kilometer increase of distance to the nearest source of water, the probability of choosing wildlife conservation increased and the probability of choosing crop production reduced. The viability of crop production and especially under irrigation is highest when water is readily available. Nearness to water point also reduces cost of water pumping. At the same time, livestock requires more regular watering compared to wildlife therefore as the distance to water sources increase, wildlife was preferred. Besides, wildlife can easily cover long distances looking for water without affecting their body condition unlike livestock. This finding confirms that crop production in Amboseli is mostly occurring near water sources such as swamps that feed the Ecosystem (Okello and Kioko, 2011). This may stand as a key threat to the sustainability of the Ecosystem if water resources are not efficiently utilized. Crop cultivation in swampy areas also contributes to increased human wildlife conflicts in the Ecosystem since wild animals are easily attracted to the crops as they go to water and especially during dry periods (Mburu, 2013).

Access to credit decreased the likelihood of engaging in crop production and wildlife conservation relative to livestock keeping. This is because households may use livestock as collateral to access credit. This is unlike in crop production where the success of the enterprise cannot be guaranteed considering the arid nature of the Ecosystem. In addition, wildlife cannot be directly considered (it is not a private good) unless a household invests in tourism-related activities such as hotels and lodges. Besides, the ease with which households can depend on livestock animals as an income safety net makes livestock more favorable than wildlife conservation in securing credit both formally and informally. This is also related to the results of the annual household income variable, which showed that there is a decreased probability (7.38%) of engaging in wildlife conservation relative to livestock keeping as a household gets more income. Unlike livestock, wildlife benefits are not necessarily in direct monetary terms but in form of benefits such as school, bursaries, settlement of hospital bills, etc. and thus they are often not easily quantified. In cases where they are monetary, e.g., leasing of pastoral land for conservation purposes, payments are received by the households on annual basis, making it a less reliable source of disposable income especially with the community's poor finance management skills (Fitzgerald, 2013). Livestock can easily be liquidated whenever there is need for income.

Chances of allocating land to crop production relative to livestock keeping decreased on every kilometer increase in distance to an urban town. This variable is a proxy for infrastructure and market access.

Table 4
Marginal Effects from Multinomial Logistic Regression Estimates.

Independent Variables	Crop production Marginal effects	P values	Standard Errors	Wildlife conservation Marginal effects	P values	Standard Errors
Age	-0.00736	**0.004*****	0.00257	0.00025	0.774	0.00089
Land Size	-0.00030	0.820	0.00132	0.00094	**0.033****	0.00044
Household Size	0.00780	0.652	0.01729	.0015746	0.755	0.00505
Primary Occupation	-0.23975	0.147	0.16515	-0.13747	0.271	0.1248
Land Tenure	0.11668	**0.065*****	0.06327	0.03467	0.236	0.02929
Distance to water	-0.05972	**0.004*****	0.02086	0.02842	**0.000*****	0.00767
Credit	-0.1002	**0.098***	0.06054	-0.04716	**0.043****	0.02333
Net income	0.04266	0.223	0.035	-0.0738	**0.000*****	0.01846
Distance to urban town	-0.00931	**0.065*****	0.00504	0.00140	0.313	0.00139
Extension	0.10828	0.187	0.08207	0.01061	0.716	0.02922

***,**,* Significance levels at 1%, 5%, 10% respectively

There are minimal chances that roads are in good shape considering the Ecosystem's role as a dispersal area for wildlife in Amboseli National Park and also as a migratory corridor to Tsavo National Park. This implies that any form of infrastructural developments such as construction of roads is expected to disturb flow of use and non-use values derived from wildlife resource. In contrast, poor road network leads to higher cost of transportation, which limits access to markets favoring livestock keeping as opposed to crop production (Serneels and Lambin, 2001). Notably, unlike crop produce, livestock can easily trek to the market.

6. Conclusion and policy recommendations

The analysis of competing land uses in this study enables us to draw conclusions on considerations made by households as they choose the economic activity to engage in. While traditionally livestock keeping and wildlife conservation co-existed sustainably, crop production, a relatively new venture, is mostly being adopted by the younger generations. It is most likely that households with younger members are pushed by harsh economic conditions to crop farming since they do not have other sources of income or are not in gainful employment with the rising unemployment levels in Kenya. Thus, one key policy intervention to enhance conservation of wildlife in the Ecosystem would be to introduce alternative income generation opportunities for the youth. Such opportunities could include bee keeping which would not interfere with wildlife conservation and should, (just like the crops), generate income for the households within short gestation periods. After all, honey is a high value commodity with a market price of US$ 10 per kilogram or higher depending on the market.

Households with larger tracks of land easily engage in wildlife conservation related activities. This can possibly serve as an indicator for the need for policy interventions that target households with large land holding and enable them diversify their livelihoods to wildlife friendlier economic activities such as creation of private wildlife sanctuaries which can even employ more people as the population in the Ecosystem increases. Households with large land holdings should be encouraged to allow wildlife to move freely in their lands and negotiate for lucrative leases with tour companies and individuals that love cropping wildlife.

Results of this paper have indicated the need to discourage subdivision of land and acquisition of more secure land tenure (private land), settling near water resources and development of infrastructure such as roads since these are key drivers towards crop production in an ecosystem that is supposed to accommodate livestock and wildlife. It is clear that in such an ASAL ecosystem, crop production cannot sustainably coexist with wildlife, and it is an inefficient way of resource use if both monetary and non-monetary benefits of wildlife are considered. Therefore, the study recommends consideration of a long-term land use policy that does not advocate for land subdivision and expansion of existing infrastructure to ensure sustainability of the Ecosystem. Such a policy could be based on existing plans such as the Amboseli Ecosystem Management Plan (, 2008–, 2018) and place emphasis on creating or enhancing economic activities that favor co-existence of livestock (free ranged) and wildlife. This way household choice towards expansion of crop production would not be favorable and the status quo of livestock keeping and wildlife conservation would be maintained. In addition, and with the cessation of crop production, the few water resources, e.g., swamps that contribute immensely to the sustainability of the Ecosystem would be protected.

7. Limitations of the study and suggestions for future work

The question of what determines the choice of competing land uses in Amboseli Ecosystem was the focus of this study. The study did not look at the optimal allocation of the competing land uses. Further, data gathered in the study were based on group ranches membership only. The membership registry is limited to the ethnicity of the Maasai community. Therefore, it was not possible to establish the role of immigrants in the introduction of new economic activities such as crop production.

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CRediT authorship contribution statement

Evelyne Njuguna: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft preparation. **John Mburu.**: Writing – review & editing, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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