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Ecological Islands: Wildlife Face Extinction Threat amid Dwindling Wildlife Corridors and Dispersal Areas in Kenya's Amboseli Ecosystem

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Abstract
Kenya's national parks are renowned for their abundance and diversity of wildlife, offering unique opportunities to witness iconic African wildlife in their natural habitats, including the "Big Five". However, threats to wildlife in Kenya are increasing habitat fragmentation, particularly in areas adjacent to parks. The goal of this study was to determine the implications of emerging land use dynamics on sustainable wildlife in Kenya's Amboseli ecosystem. Primary data was obtained from field surveys, 284 household interviews and 12 key informants' interviews, while secondary data was obtained from literature review and benchmarking. The study findings reveal that, despite widespread worries that the group ranch subdivision would divide wildlife dispersal areas, the land subdivision has been implemented in all group ranches in the Amboseli ecosystem, and the ranches are now in various phases of the land subdivision process. The study thus concluded that if the current land dynamics within the study area are not managed, the Amboseli National Park risks becoming an ecological island and may suffer substantial deterioration due to the concentration of animals in small regions and the pressure from adjacent land users. Against this backdrop, the study recommends the identification and mapping of the minimum viable Amboseli-Chyulu conservation area and negotiate with individual landowners (of subdivided land). In the same vein, an urgent consensus is needed on the sharing of resources between different users by formulating a negotiated land use framework that will cater to all the land and resource use, while conserving critical habitats needed by people, and wildlife.

Introduction
The wildlife conservation in parks and reserves (protected areas) dates back to the 18th century when the Western world sought to separate what is perceived as the "human world" from the "natural world" (AET, 2020). This concept was primarily driven by the notion that human activity could not coexist with the natural world, which led to the creation of Yellowstone National Park in 1872. The model spread globally, reaching Africa in the early 1950s (ibid). Protected areas (PAs) have been recognised as one of the most effective and widely implemented strategies to conserve biodiversity, according to Zeng et al. 2023. Establishing borders and confining most anthropogenic disruptions within critical regions, whether by legal or other effective means, helps sustain ecological processes and connections, benefiting the species within them (Maxwell et al. 2020). To date, PAs are the cornerstone of global conservation and central to international plans to minimise global extinctions

(Williams, Rondinin, & Tilman, 2022). As of August 2020, approximately 15% of the world's land had been protected, falling below the 17% Aichi Biodiversity Target 11 (Williams, 2022).

Despite their expansion and role in maintaining long-term biodiversity, studies continue to highlight a calamitous decline in wildlife across the globe. It's estimated that between 1970 and 2020, the size of wildlife populations decreased by 73% worldwide, with Africa experiencing a 76% decline (WWF, 2024). Similarly, there is nearly a half (44 per cent) population decline, with one in five (22 per cent) of CMS-listed species threatened with extinction (UNEP, 2024). The global and regional wildlife decline is also reflected in Kenya. Studies by Ogutu et al. (2016) revealed that Kenya has experienced a 68 per cent loss of wildlife populations in the 21 rangeland counties that are home to over 70% of all land-dwelling wildlife in the unprotected pastoral lands of Kenya. This finding has been attributed to habitat loss due to land use change outside Pas, accounting for approximately 85 per cent of all species decline (Joppa, 2012).

This population decline demonstrates the limitations of PAs and shows that biodiversity preservation requires more than just strict laws and law enforcement. Like Kenya and the rest of Africa, many PAs were established because of the significant wildlife movements and aggregations that occurred there during the wet or dry seasons, which attracted the attention of the colonial administration at that time (Watson, Fitzgerald & Gitahi, 2010). As a result, national parks and reserves were created as geographically distinct areas that overlooked the migratory needs of animals (AET, 2020). Thus, the viability of PAs is threatened by the loss of wildlife habitat (Newmark, 2008), leading to a decline of nearly 70% of wildlife outside PAs over the past thirty years (KWCA, 2024), which is 2% more compared to Ogutu et al.'s (2016) findings. Therefore, the role of land outside PAs for the continued viability of both PAs and wildlife cannot be ignored, especially in Kenya, where over 65% of its wildlife reside outside PAS, either permanently or seasonally. They utilise these adjacent lands as critical dispersal areas, calving grounds, and/or for seasonal movement between protected areas.

The trend in wildlife decline is projected to continue as Kenyan rangelands receive high numbers of immigrants from high-potential areas seeking new agricultural lands. In some arid countries, people are turning to agriculture as land utilisation, as employment opportunities continue to shrink in urban areas (Duraiappah et al., 2013; Gok, 2011). Furthermore, the economic landscape in the ASAL areas of Kenya has led to changing lifestyles and is encouraging urban growth. Although unplanned, the number of urban centres is increasing, and the existing ones are continually expanding. Additionally, with a population growth rate of 2.7 per cent per annum (World Bank, 2013) and the planned increase of irrigable lands in the ASALs, continued wildlife decline is inevitable. Against this backdrop, the study believes that while much of wildlife relies on PA protection, healthy wildlife populations require access to resources in the larger terrain beyond PAs. Thus, the loss of wildlife habitat outside protected areas in Kenya should be halted to ensure the viability, abundance, and diversity of species and to provide resilience to critical ecosystems as climate variability poses new threats.

Method

Study Area

The Amboseli ecosystem spans approximately 5,700 km², extending from Kilimanjaro to the Chyulu Hills, Tsavo West National Park, and the Kenya/Tanzania border. It consists of Amboseli National Park and six group ranches: Kimana/Tikondo, Olgulului/Olararashi, Eselenkei, Mbirikani, Kuku, and Rombo. Together, these areas cover about 5,063.3 km² and lie within the geographical region connecting Amboseli, Chyulu Hills, and Tsavo West National Parks (Figure 1).

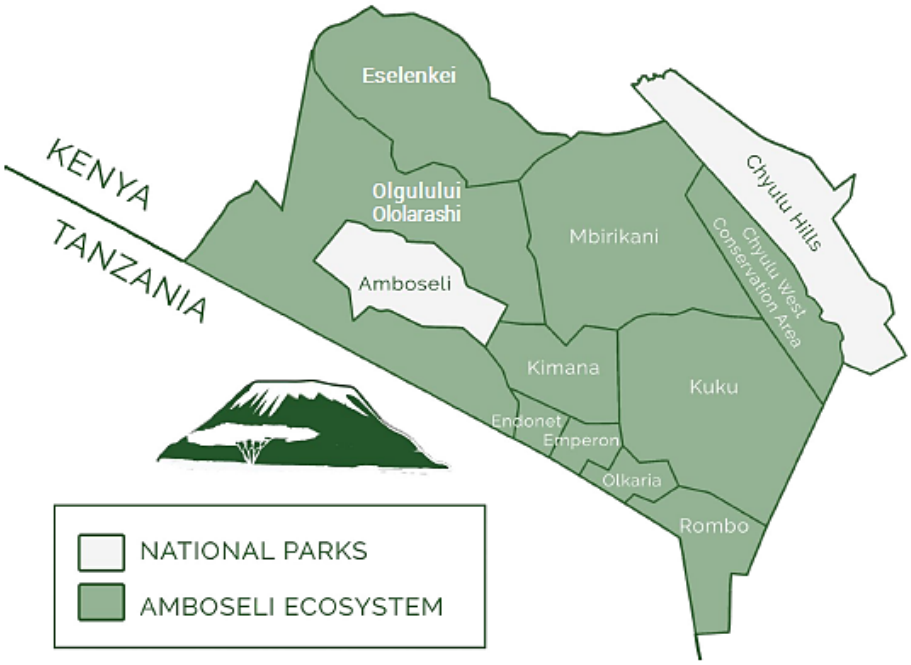

Figure 1: *The Spatial Extent of the Amboseli Ecosystem (Source: AET, 2020)*

The world-famous Maasai people have dominated the Amboseli Ecosystem for millennia, influencing the ecological ethos and cooperation with animals through their pastoral traditions and rich cultural history. The habitat was designated as a UNESCO Man and Biosphere Reserve in 1991 due to the remarkable convergence and coexistence of ecological and environmental systems and native pastoral socioculture (UNESCO, 2023). A network of six crucial corridors, supported by the group ranches, also defines the study area, connecting Amboseli National Park with the neighbouring conservation areas. Specifically, the study was conducted in the targeted Kuku and Kimana group ranches (GRs), within the vital wildlife corridor linking Amboseli and Chyulu National Park. The two group ranches serve as a suitable study area due to the dynamism they have experienced over the last two decades, making it one of the most highly threatened wildlife dispersal routes (GoK, 2017).

Target Population

It's estimated that Kimana and Kuku have populations of 2,425 and 3,429 persons, respectively (KWS, 2020). With a 10% margin of error, 99% confidence level, and 50%, this resulted in a sample size of 301. However, due to logistics, the vastness of the area, non-responsiveness, and some questionnaires not returned, a total of 284 questionnaires were sampled.

Key Informants

State Actors consisted of officials from various agencies directly or indirectly involved in wildlife conservation on land outside of protected areas. A purposive sampling approach was used to identify essential informants, as these sample units possess unique qualities due to their positions or knowledge base. This enabled the researcher to better explore and understand specific themes and issues.

Non-State Actors: comprised stakeholders who have participated in long-term research programmes and community wildlife conservation initiatives in the study area. Some non-state actors interviewed

included representatives from the Centre for Wildlife Management Studies, Amboseli Ecosystem Trust, Big Life Foundation, and Amboseli Trust for Elephants.

Data Collection

Literature Review: As guided by the study objective, the search criteria for the literature review included, among others, land dynamics outside protected areas, the protected area (PA) approach, and wildlife conservation beyond protected areas. Through document analysis, the study sought to understand the contents of written materials to enable triangulation with primary data collected from the field. These were gathered from online sources such as the Directory of Open Access Journals (DOAJ) and various government agency portals, including the Kenya Law Reports (KLR).

Household Survey: Data was collected from households using a semi-structured questionnaire consisting of open-ended questions. The questionnaire aimed to elicit interviewees' perceptions regarding land use choices within the study area, observed ecosystem changes, and involvement in ecosystem governance. A simple random sampling method was employed to select the households included in the interviews.

Key Informant Interviews: Structured interviews were conducted to gather data and information from key sources within the area. Semi-structured questionnaires facilitated these face-to-face interviews.

Field Survey/Observation: As detailed in the observation matrix, additional data were collected by observing the various phenomena under study. The researcher, aided by a local guide, compiled field notes that described what was observed. Photography, note-taking, and a recording device such as a Dictaphone for later transcription were employed during transect walks.

Land use land cover changes: The land use land cover changes (LULCC) data for the study area from 1990 to 2018 were obtained from the Directorate of Resource Surveys and Remote Sensing (DRSRS). The LULCC data encompassed seven land uses in the ecosystem: farm/cropland, settlement and urban areas, forestland, grassland, woodland, wetland/swamps, and other lands (built areas, roads, dried up and human settlements).

Data Analysis

All study issues raised in the questionnaire were tallied and synthesised in the Excel spreadsheet. The frequencies of interviewed household heads providing specific responses and the differences in frequencies for certain responses to an issue were summarised. To establish factors influencing particular responses and relationships with specific attributes, a chi-square cross-tabulation analysis was employed using SPSS Version 22. The results were then presented as descriptive analysis, including charts, frequency distributions, and analytical tables.

Data on land use and land cover changes were visually interpreted to create land use maps from 1990 to 2020. Extracting information from these maps regarding land use changes involved technical procedures for integration, utilising a combination of Google Earth Pro and geographical information system (GIS) software. The various maps obtained from the DRSRS were overlaid using the ArcView computer program, resulting in maps displaying land use changes in the study area from 1990 to 2020. Lastly, qualitative interview data and field notes were transcribed and refined. Analysing key informant interviews involved summarising the narratives, categorising responses, and collating and filtering to extract dominant themes.

Results and Discussion

Respondents Profile

The socio-dynamic characteristics of the respondents in the study areas are presented in **Table 1.** The total number of respondents was 284, with 63% male and 37% female. Similarly, the majority (96%) of households were headed by men, while only 4% were headed by women. The disparity between the two genders has been attributed to unjust land allocations during group ranch subdivisions. The few women who are household heads either own inherited land, mostly from deceased husbands, or are immigrants who purchased it (Gona and Atieno, 2020). The average household size was seven members across all the group ranches, which is slightly higher than the national average household size of 5 members (KNBS, 2005). According to the survey, most household respondents were slightly above middle age (36-45 years old), representing 37%. Only 15% of the respondents were between 18 and 25 years old, 25% were between 26 and 35 years old, and cumulatively, 23% were above 46 years of age (Table 2). Results showed a mean age of 45 for the household heads, indicating that most fall within the active working age category.

Regarding education, the majority of household heads (60%) had no formal education, 21% had completed primary level, while 14% and 6% had attained secondary and tertiary levels of education, respectively (Table 2). The low education levels among over half of the households in the study area align with the 2019 housing census, which revealed that about 31% of Kajiado County residents have no formal education (KNBS, 2019). This situation is primarily attributed to cultural factors, where education is not prioritised, as the nomadic lifestyle does not allow them to remain in one area. Additionally, the region's vastness makes schools far from homes, forcing students to trek long distances, ultimately leading to school dropouts (ibid).

Livestock keeping (49%) is the primary occupation for the households. Approximately 31% indicated that mixed farming (livestock and crop farming) is their primary occupation; 10% indicated they had an off-farm activity such as formal salaried employment, 3% were self-employed in business, while 3% practice wildlife conservation (conservancies) as their primary occupation. The various household heads have an average of 27 years of experience in livestock production, 13 years in crop production, and 30 years in wildlife conservation. Older household heads have more experience in livestock keeping and wildlife conservation as their main engagement, compared to younger household heads, who engage in crop production. As people age, they become more tolerant of conservation issues and are more likely to engage in wildlife conservation than crop production (Mutanga et al., 2015).

Table 1: Socio-Demographics of the Respondents

Variable	Sub-Variables	Response in percent %
Gender	Male	63
	Female	37
Age	18- 25 years	15
	26– 35 years	25
	36– 45 years	37
	above 46 years	23
Education	Never been to School	60
	Primary	21
	Secondary	14
	Post-Secondary/Tertiary	6
Primary Occupation	Livestock Keeping	49
	Crop farming	31
	Formal salaried employed	10
	Self employed	3
	Conservation (land leased as a conservancy)	3
Years of Experience	Livestock production	27
	Crop farming	13
	Conservation	30

Source Author, 2023

The dominance of livestock production was expected, as this region has traditionally been pastoral for decades. The primary livestock raised in the study area include cattle, goats, sheep, and chickens. Crop production, a new land-use choice that contradicts expectations given the ecosystem's largely arid and semi-arid nature, has recently become an essential economic activity. This land use is primarily practised in Kimana GR, where all the land is subdivided, allowing landowners to lease parcels for crop farming. It is worth noting that communities within the study area continue to practice wildlife conservation through conservancies, especially in Kimana GR, where communities have leased their land for conservation. The leading leasing organisations are the Maasai Wilderness Conservation Trust (MWCT) in Kuku GR and the African Wildlife Foundation (AWF) in Kimana GR.

The Role of the Amboseli Ecosystem

Respondents perceive the Amboseli Ecosystem as crucial for several reasons, including its support for local livelihoods, tourism, and biodiversity. The four leading roles of the ecosystem are livestock production (24%), provisioning services for water used in farming and domestic purposes (22%), biodiversity and conservation (16%), and tourism (18%). Livestock output has increased significantly as the Maasai community's traditional livestock rearing is supported by the environment, making it a key economic resource. Tourism: The Amboseli National Park (ANP) and adjacent conservancies draw visitors, creating job opportunities in hospitality, guiding, and other tourism-related businesses. Regarding livelihoods and resource usage, the environment is vital for local pastoral groups, providing grazing land, water resources, and other essentials. Concerning the cultural importance of the environment, the ecosystem has sustained the traditional way of life (pastoralism) of the Maasai community over the years.

Threats to the Amboseli Ecosystem

The local communities identified various challenges as the main threats to the Amboseli Ecosystem. The majority of the respondents indicated group ranch subdivision, privatisation, and changes in land use (40%), habitat loss and degradation (26%), pasture and water resource issues (17%), and human-wildlife conflict (HWC) (5%). Other threats include the effects of frequent drought and climate change (12%). Land use transformation in pastoral areas such as Kajiado increases competition for

pastoralists, who require open landscapes to access seasonal pasture and water resources for their livestock, particularly during climate shocks like droughts (Moiko et al., 2019). Climate change and land fragmentation are recognised as two of the most significant drivers of change in pastoral lands (Galvin et al., 2008). These drivers interact to reduce rangeland productivity, necessitating adaptation options as well as appropriate policy and an enabling environment to mitigate the resulting impacts (ibid).

Changing Land Tenure and Land Use

For decades, the study area has been characterised by traditional group ranching land use; however, the study findings indicate a changing land tenure, which now poses the greatest threat to the viability of the Amboseli ecosystem. The Kimana GR has been subdivided into individual land parcels measuring 25 ha. The trend is similar in Kuku GR, where land subdivision has occurred in the arable areas bordering Kimana GR and Tsavo West. Of the total land size of 96,000 ha, only 18,712 ha (19%) remains unsubdivided within Kuku GR. Most households within Kimana GR (87%) support the subdivision, citing security of land ownership and facilitation of land development as the main reasons. The desire to practice agriculture or lease land and receive money directly from those interested in cultivation has been another motivation behind group ranch subdivision (Campbell, 2000). On the other hand, within Kuku GR, the majority (58%) oppose land subdivision, citing concerns that it will lead to rampant selling of land, unequal subdivision among members, reduced grazing area, and that few are likely to benefit from the subdivision (10%) as the primary reasons.

It is noteworthy that property rights are instrumental in promoting the sustainable use of land and natural resources (Aggarwal and Elbow, 2006). If property rights are not adequately defined, there is a risk of conflict over resource usage or overexploitation, leading to the tragedy of the commons. Similarly, secure property rights ensure involvement in crucial land and natural resource management decision-making processes. Most (65%) continue to advocate for land subdivision, despite understanding that it will further divide animal dispersal regions and disrupt their travel patterns. This explains why subdivision has been implemented in all group ranches in the Amboseli ecosystem, and the ranches are currently in various phases of land subdivision (KWS, 2020). Given the current trajectory, there is a need to examine land use strategies to ensure a sustainable minimum area is preserved to support healthy animal populations and traditional pastoralism once the group ranches are subdivided (AET, 2020).

Land Use and Cover Trends

All the study respondents reported a significant shift in land use patterns in the study region, indicated by a change from pastoralism and wildlife protection to crop farming, human habitation, town commercial and industrial activities, and other land uses. Competition over land, water, and pasture among group ranches in the Amboseli area is more intense in Kimana GR than in Kuku GR due to an active economy centred around agriculture and substantial ecotourism investments (such as tourist lodges) (ibid) and an efficient transport network (Njuguna, 2017; AET, 2020). The area has been a primary source of horticultural produce for Mombasa and nearby urban communities for over thirty years (Campbell, 2000). Most respondents (85%) considered crop cultivation more beneficial than pastoralism, while 15% thought the opposite. The main reasons cited for the shift in land use to agriculture included widespread poverty (38%), prolonged droughts (26%), and lifestyle changes (15%). Other external reasons encompassed population increase (13%), changes in government policy (3%), and insufficient benefits from wildlife conservation (5%).

The above findings are corroborated by the LULCC analysis in Table 2. The results show that cumulatively, forest land, wooded grassland, and wetlands have reduced. In contrast, cropland (a combination of perennial and annual crops), open grassland, and other lands (built areas, roads, bare

land, and human settlements) have increased. The study also established that none of the areas that were formerly wetlands but were later converted to farmland ever returned to wetlands. Field surveys further confirmed the role played by wetlands in irrigated farming in the study area.

Table 2: *Area (Km2) and Cumulative Percent Land Cover Types in the Study Area*

Land Use Cover Type	1990 (Km²)	2000 (Km²)	2010 (Km²)	**2020** (Km²)	% cumulative increase (+) or decrease (-)
Forest	272.63	357.73	215	229.47	**-84.17**
Cropland	109.14	91.42	231.12	431.19	**+395.08**
Wooded Grassland	5142.85	5054.16	4373.34	4765.73	**-92.67**
Open Grassland	2002.35	1839.63	2472.54	2026.67	**+101.21**
Wetland	24.12	15.43	24.75	12.71	**-52.69**
Other land	249.15	439.09	483.52	331.56	**+133.08**
Total Land Area	**7,800.24**	**7,800.24**	**7,800.24**	**7,800.24**	**100.00**

Source: DRSRS and Modified by Author, 2023

Impacts on Wildlife Movements and Population

Spatial analysis of wildlife movements within the study area reveals irrigated farming, settlements, and fencing as the main threats facing the ANP-Kimana-Kuku-Chyulu corridor. For instance, the entrance to Kimana Community Wildlife Sanctuary (KWCS) is almost entirely blocked, except for a 50-meter-wide space secured through an easement lease by the Big Life Foundation (**Figure 2**). Furthermore, the Oloitotok-Emali Road (tarmacked road) has divided KWCS, thus increasing the risk of wildlife being struck by vehicles (road kills), a symptom of a broader human-wildlife conflict stemming from habitat loss and encroachment.

Figure 2: *A constricted wildlife migratory corridor at Kimana crossing into Kimana Sanctuary (Source: Author, 2023)*

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Similarly, the research discovered that the eastern side of Kimana Sanctuary, which connects to Motikanju, is now under threat due to the proliferation of communities and the consequent agricultural encroachment (conflict zones) on the Kuku GR side. Furthermore, more than half of the ANP-Kimana-Kuku-Chyulu corridor (circled) is completely blocked by privately owned property that has been sold to individuals, leaving only 60–80m (Figure 3).

The impact of privatisation and burgeoning permanent settlements on wildlife in the formerly open pastoral lands is well documented in Amboseli following the subdivision of the Kaputei Group Ranches. According to Western and Mose (2020, in Kaputei GR, wildlife production fell significantly (τ = -0.18, p = 0.05) after land subdivision. In contrast, wildlife on the neighbouring Mbirikani Group Ranch increased significantly (τ = 0.217, p = 0.0207) across the open lands. The findings from the two ranches, one subdivided and privatised, and the other open to free-ranging herds of wildlife and livestock, explain that this will not be any different in the study area where the combined pressures of land and land use changes over the last three decades have caused pastures to shrink, decline, and interrupt wildlife movements.

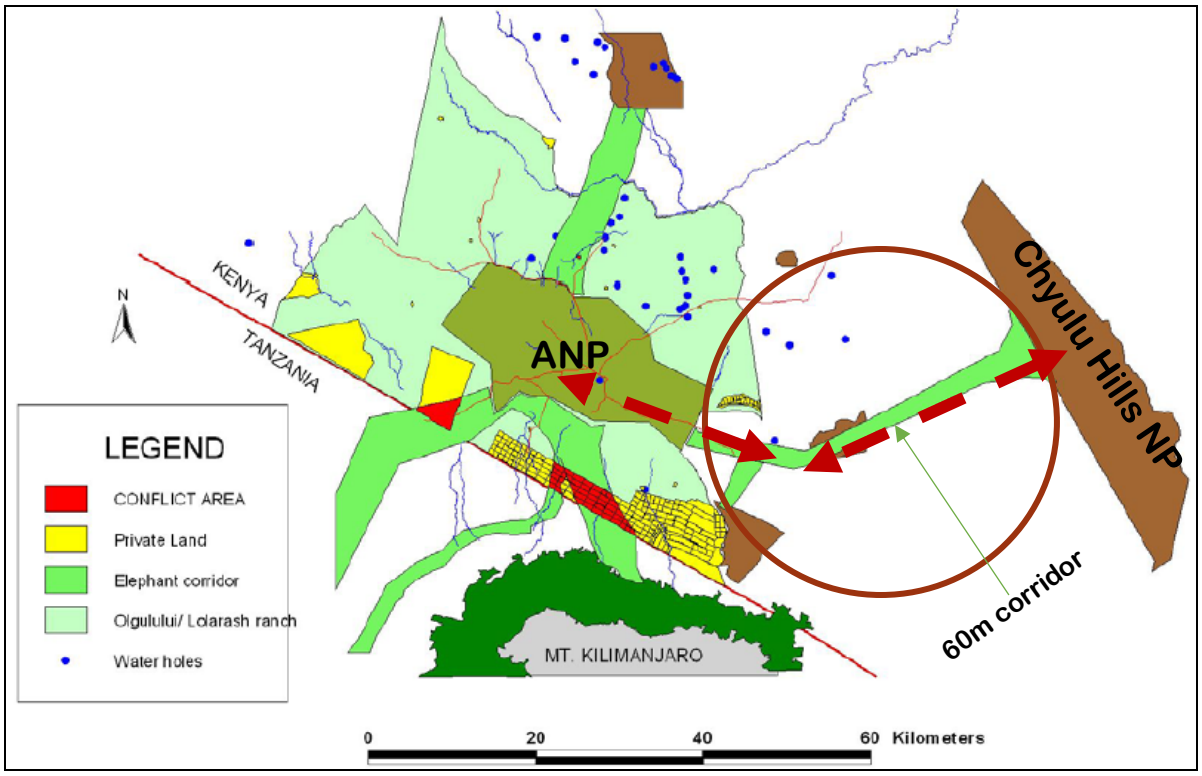

Figure 10: Animal Movement and Land Conflicts within the Study Area (Source: Author, 2023)

Conclusion

The findings of the study demonstrate that the survival of Amboseli wildlife is a race against mounting social and economic development, and the future of Kenya's wildlife depends on the ability to conserve wildlife while balancing the needs of the people, including their financial expectations. Land use and tenure transformation continue to fragment the ecosystem, thus jeopardising its social, economic, and ecological sustainability. On the bright side, the fragmentation of group ranches into individual plots has also resulted in the establishment of several conservancies. While this presents an opportunity for conservation, one of its major drawbacks is their size and disconnect from other

ecosystems. This highlights the need for a conservation connectivity framework to ensure the long-term survival of wildlife and ecosystems by preserving and enhancing the physical and ecological connections between habitats.

The need to discourage the subdivision of land and the acquisition of more secure land tenure (privatisation) is evident in the paper, as these are key drivers of land use changes in the study area. One policy recommendation is to clearly identify and map the minimum viable Amboseli-Chyulu conservation area and negotiate with individual landowners of subdivided land. Similarly, for landowners willing to amalgamate their land for conservation, the establishment of community–owned wildlife sanctuaries is encouraged, not only to expand wildlife ranges but also to bring wildlife-based tourism benefits directly to the people. Wildlife sanctuaries fully owned by individual landowners (or groups of organised landowners) are likely to succeed more than those owned jointly in communal ownership due to accountability and transparency issues (Okello et al., 2011).

Equally, while protected areas such as the ANP have been established for wildlife conservation, due regard must be paid to the surrounding landscapes, which include largely communal and private lands that also serve as wildlife dispersal areas for the protected regions. Therefore, an urgent consensus is needed on the sharing of resources between different users, and it is recommended to formulate and adopt a negotiated land use plan that will cater to all land and resource uses.

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