ENVIRONMENTAL SCIENCE

Land Use Changes and Their Effects on Wildlife Conservation in the Amboseli Ecosystem, Kenya

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Published November 2026

Abstract

This paper reviews how changes in land use around Amboseli National Park in southern Kenya have affected wildlife and its conservation. The park covers only about 392 square kilometres, while the wider ecosystem of about 8,500 square kilometres is made up mainly of Maasai group ranches on which wildlife depends for grazing, water and movement during much of the year. Published studies, aerial census results and management documents were reviewed and analysed by theme. Since the 1970s the group ranches have been subdivided into individual parcels, pastoralists have settled permanently, and irrigated farming has spread around the swamps fed by springs from Mount Kilimanjaro. Fences, settlements and farms have reduced the area open to wildlife and blocked routes between the park and neighbouring areas in Kenya and Tanzania. Where subdivision and settlement have taken place, wildlife numbers have fallen sharply, while communal rangelands have kept more wildlife. Loss of dispersal areas has also concentrated elephants and other animals inside the park, contributing to woodland loss, and has increased conflict between people and wildlife over crops, livestock and water. Droughts, such as that of 2009, cause heavy losses where animals cannot move freely. The paper presents a framework linking drivers, land use change, ecological effects and conservation outcomes, and recommends land-use zoning, protection of wildlife corridors, support for community conservancies and lease schemes, and fair sharing of tourism income with landowners.

Keywords: Amboseli; group ranches; human-Wildlife Conflict; land Subdivision; wildlife Corridors

1 Introduction

Land use change is one of the main causes of biodiversity loss worldwide, as natural habitats are converted to farms, settlements and infrastructure [1]. In the savannas of East Africa, much of the wildlife lives outside national parks, on land used by pastoralists for livestock grazing. The way this land is owned and used therefore has a large influence on the survival of wildlife populations [2, 3].

The Amboseli ecosystem in Kajiado County, southern Kenya, is one of the best known examples. Amboseli National Park, gazetted in 1974, covers about 392 square kilometres around a set of swamps fed by groundwater from Mount Kilimanjaro [4]. The wider ecosystem, which covers about 8,500 square kilometres, includes the group ranches of Olgulului-Ololarashi, Kimana, Eselenkei, Mbirikani, Kuku and Rombo, and links to West Kilimanjaro in Tanzania and to the Chyulu Hills and Tsavo West National Park [5, 6]. In the dry season, wildlife gathers near the permanent water in and around the park; in the wet season, most animals spread out onto the group ranches. The park alone is far too small to hold the wildlife it is known for [4].

Over the past five decades, the group ranches around Amboseli have been subdivided, pastoralists have settled permanently, and irrigated farming has spread near the swamps outside the park [7, 8]. These changes affect the space, water and movement routes on which wildlife depends. The object-

ives of this paper are to describe the main land use changes in the Amboseli ecosystem and their causes, to review the evidence of their effects on wildlife populations and habitats, and to identify conservation measures suited to the area.

2 Methodology

The study is a critical review of published literature and official documents. Sources were found through Scopus, Web of Science and Google Scholar using the terms Amboseli, Kajiado, group ranch, subdivision, land use change, wildlife, elephants, corridors and human-wildlife conflict. Reports of aerial wildlife censuses, the Amboseli Ecosystem Management Plan and Kenyan laws on wildlife and community land were also reviewed. Reference lists of key studies were checked for further sources.

Sources were included if they reported land use or land cover change in the Amboseli ecosystem or the neighbouring rangelands of southern Kenya, reported changes in wildlife numbers, distribution or habitat, examined human-wildlife conflict in the area, or described the legal and management framework. Peer-reviewed studies and official reports were given priority. The material was grouped under drivers of land use change, types of land use change, effects on wildlife and habitats, and conservation responses. The framework in Section VII was developed from these groups.

3 The Amboseli ecosystem

Amboseli lies on the semi-arid plains north-west of Mount Kilimanjaro. Rainfall is low and variable, and falls in two seasons. Surface water outside the swamps is scarce for much of the year. The main swamps, Enkongo Narok and Longinye inside the park and Kimana, Namelok and others outside it, are fed by springs that carry water from the slopes of Kilimanjaro [9]. These swamps support grazing for wildlife and livestock through the dry season and are the key resource around which the ecosystem is organised.

The area supports elephants, wildebeest, zebra, buffalo, giraffe, gazelles, impala, eland and predators such as lions, hyenas and cheetahs. Its elephants are among the most closely studied in Africa; the Amboseli Elephant Research Project has followed individual animals since 1972 [10, 11]. The Maasai have grazed livestock in the area for centuries, and seasonal movement of both livestock and wildlife between wet-season and dry-season ranges allowed people and wildlife to share the land [4, 12].

Habitats inside the park have also changed. The acacia woodlands that once surrounded the swamps declined sharply from the 1950s. Early studies linked the loss to rising groundwater and soil salinity [13], while later work showed that browsing and bark stripping by elephants, concentrated in the park, played a large part [9, 14]. Local temperatures have risen and rainfall has varied widely over recent decades [15].

4 Drivers of land use change

4.1 Group ranch subdivision

Group ranches were created in Kajiado from the late 1960s, giving registered members joint title to large blocks of land. From the 1980s, many ranches began to subdivide into individual parcels. Members sought individual title to secure land for their children, to obtain loans and to protect themselves against land being allocated to outsiders [7, 8]. Kaputei in northern Kajiado was among the first to be subdivided [16]; Kimana had been subdivided by the early 2000s [8], and parts of other

ranches have since followed [5]. Mbirikani and Olgulului-Ololarashi have remained largely communal for longer, although pressure to subdivide has continued.

4.2 Population growth and settlement

The human population of the area has grown through natural increase and migration from other parts of Kenya. Pastoralists have increasingly settled in permanent homesteads, often near water, schools and trading centres, and have taken up farming alongside livestock keeping [12]. Settled households graze their livestock close to home for much of the year, which increases grazing pressure near settlements and reduces the use of distant pastures [16].

4.3 Markets, roads and water

The road from Emali to Loitokitok improved access to markets in Nairobi and Mombasa and made commercial farming more attractive [5]. Spring water from Kilimanjaro has been channelled to irrigate onions, tomatoes, maize and other crops around Kimana, Namelok and other swamps outside the park [17, 7]. Water is also piped to towns and settlements. Each of these uses reduces the water and swamp area available to wildlife in the dry season.

4.4 Drought

Recurrent droughts have caused heavy losses of livestock, which have pushed some households to seek more secure livelihoods through farming and land sales [7]. Droughts also affect wildlife directly, and are expected to become more severe as the climate warms [18].

Table 1 presents the main land use changes in the Amboseli ecosystem and their effects on wildlife.

Table 1. Main land use changes in the Amboseli ecosystem and their effects on wildlife.

Land use change	Main location	Effect on wildlife
Subdivision and fencing	Kimana, Kaputei and other ranches	Loss of open grazing land; blocked movement
Permanent settlement	Near water, roads and trading centres	Displacement of wildlife; reduced grass production
Irrigated cultivation	Kimana, Namelok and other swamps	Loss of dry-season water and grazing; crop raiding
Urban and tourism growth	Kimana, Loitokitok, park boundary	Habitat loss; more roads and disturbance
Water abstraction	Springs and pipelines from Kilimanjaro	Shrinking swamps; less water for wildlife

5 Effects on wildlife and habitats

5.1 Decline of wildlife on subdivided land

The clearest evidence comes from long-term aerial counts. Western, Groom and Worden [16] compared Kaputei, a ranch that was subdivided and settled, with Mbirikani, a ranch of similar size that remained communal, using 29 counts made between 1974 and 2006. Before settlement, wildlife numbers on the two ranches were similar. After settlement, Mbirikani held about 12,300 animals and Kaputei about 5,300. Six species, including both gazelles, impala, eland, buffalo and giraffe, declined significantly on Kaputei, compared with two species on Mbirikani. The spread of settlement was the

strongest predictor of the decline, while the number of people did not differ significantly between the two ranches. The authors concluded that settlement, and not population growth as such, was the main cause, acting through displacement of wildlife and reduced grass production under continuous grazing. Groom and Western [19] found the same pattern across the southern rangelands of Kenya.

These findings fit wider evidence of wildlife decline in Kenya. Wildlife numbers in Kenya's rangelands fell by about 68 per cent between 1977 and 2016 [3], and declines inside protected areas were similar to those outside them [20], showing that parks depend on the condition of the land around them.

5.2 Loss of dispersal areas and corridors

Fencing of individual parcels, expansion of farms and growth of settlements have reduced the land open to wildlife and narrowed the routes between Amboseli and the Chyulu Hills, Tsavo West and Kilimanjaro [6, 17]. When ranches are divided into small fenced parcels, animals lose access to the variety of pasture and water that they use at different times of year. Hobbs et al. [21] showed that fragmentation of rangelands reduces the ability of both wildlife and livestock to cope with variable rainfall, because animals can no longer move to where grass is growing. Community members in Amboseli reported that grazing land had declined by 30 to 50 per cent over four decades, with the largest losses in the most settled areas [5].

5.3 Loss of swamps and water

Irrigated farming around the swamps outside the park has converted large areas of wetland and its margins into cropland [7, 17]. These swamps were important dry-season sources of water and grazing for elephants, buffalo and other species moving between the park and the eastern ranches. Their conversion forces animals either to remain in the park or to enter farms in search of water and food, which increases conflict with farmers.

5.4 Concentration of wildlife in the park

As land outside the park becomes less available, wildlife, particularly elephants, spends more time inside the park. Western [9] showed that the concentration of elephants in Amboseli contributed to the loss of woodland and to the conversion of woodland to grassland and swamp edge over several decades. An experiment in which elephants were fenced out of small plots showed that woodland regenerated when browsing was removed [14]. Habitat change inside the park is therefore linked to land use change outside it.

5.5 Drought losses

Drought losses are heaviest where animals cannot move to areas with better grazing. A joint Kenya-Tanzania aerial census after the 2007 to 2009 drought recorded declines of about 83 per cent in wildebeest, from 18,538 to 3,098, and about 71 per cent in zebra, from 15,328 to 4,432, in the Amboseli area; buffalo fell by 61 per cent and livestock by more than 60 per cent [22]. Elephant numbers remained broadly stable [22], and later surveys showed that the densities of elephants and other large herbivores in the ecosystem continue to vary with drought conditions [23]. Grazers that depend on the swamps and nearby pastures in the dry season were the most affected.

5.6 Human-wildlife conflict

Conflict between people and wildlife has increased as farms and settlements have spread into wildlife areas. Okello [17] recorded crop damage, livestock predation, competition for water and threats to human safety around Amboseli, with elephants causing most crop losses. Retaliatory killing of lions in response to livestock losses has been a serious problem in the Maasai rangelands [24]. Conflict reduces local support for wildlife and can lead landowners to fence or convert land to reduce their losses [25].

6 Conservation responses

Efforts to conserve wildlife outside the park date back to the 1970s, when an agreement with the Maasai sought to share park revenue and provide water outside the park in exchange for keeping land open to wildlife [4]. Since then, several measures have been introduced. Community conservancies have been set up on parts of the group ranches, often linked to tourism lodges, and some conservation organisations pay landowners lease fees to keep their parcels open and unfenced. Compensation schemes for livestock killed by predators have been introduced on some ranches [24], and community wildlife rangers patrol much of the ecosystem.

The legal and planning framework has also changed. The Wildlife Conservation and Management Act recognises community and private conservancies, wildlife corridors and dispersal areas, and provides for compensation for wildlife damage [26]. The Community Land Act provides a legal basis for communities to hold and manage land jointly, which may offer an alternative to full subdivision [27]. The Amboseli Ecosystem Management Plan zones the ecosystem into areas for wildlife, livestock, farming and settlement, and identifies key corridors [6]. Implementation of zoning has been uneven, however, because much of the land is privately owned and county planning controls have been weak [17, 6].

7 A framework for land use and wildlife in Amboseli

The evidence reviewed can be summarised in the framework shown in Figure 1. Drivers, namely subdivision, population growth, settlement, market access and drought, lead to land use change in the form of irrigated cultivation, permanent settlement, fencing, urban and tourism growth and water abstraction. These changes cause loss of dispersal areas, blocked corridors, loss of dry-season water and the concentration of wildlife in the park. The outcomes are wildlife decline, range contraction, human-wildlife conflict and woodland loss inside the park. Conservation responses, including conservancies, lease schemes, corridor protection, zoning, compensation and tourism revenue sharing, can limit land conversion and restore connectivity. The framework follows the wider finding that land use change results from the interaction of economic, institutional and demographic factors and not from a single cause [28].

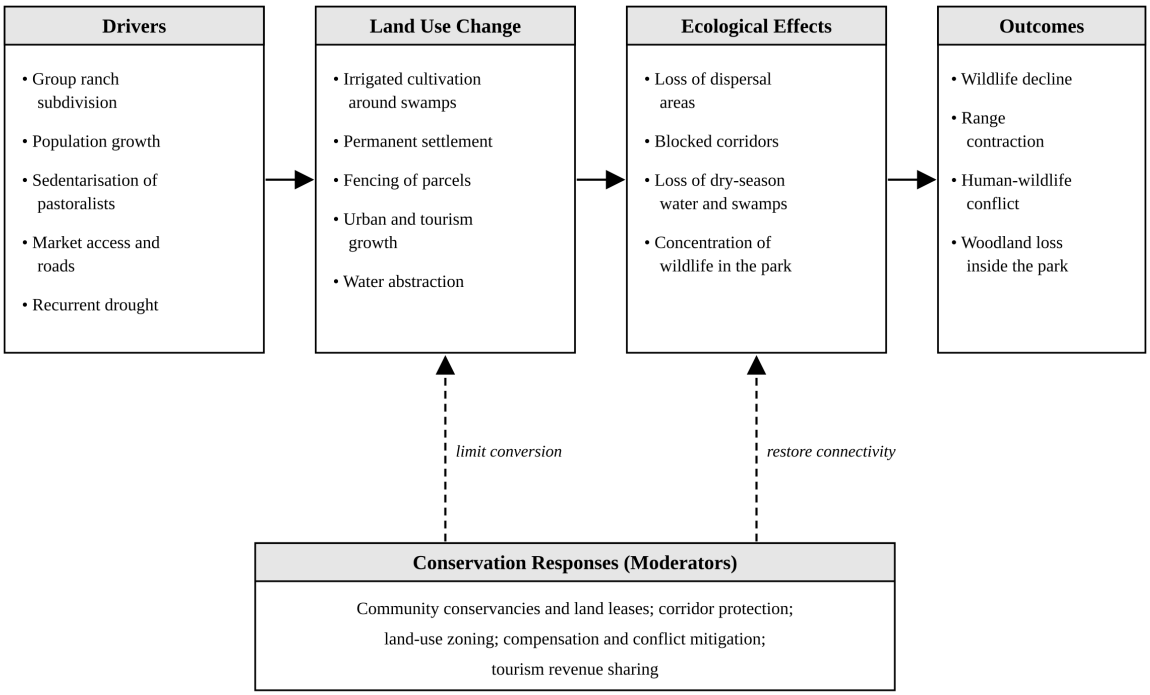


Figure 1. Framework linking land use change and wildlife conservation in the Amboseli ecosystem.

8 Recommendations

Kajiado County should prepare and enforce a land-use plan for the Amboseli ecosystem that sets out areas for settlement and farming and keeps wildlife corridors and dispersal areas free of fencing and permanent structures. The plan should be based on the zones and corridors identified in the Amboseli Ecosystem Management Plan, and should be prepared with the group ranches and landowners.

Lease schemes and conservancies should be expanded so that landowners receive a regular income for keeping land open to wildlife. The payments need to be large enough to compete with farming and land sales, and they should be paid directly and on time to individual landowners. Tourism revenue from the park and from lodges on community land should be shared more widely with the communities that bear the costs of living with wildlife.

Communities should be supported to retain communal tenure where they wish to do so, using the Community Land Act. Where subdivision has already taken place, neighbouring owners can be encouraged to manage their parcels jointly for grazing and wildlife. Irrigation should be regulated to protect the swamps that are most important for wildlife in the dry season, and water allocation should take account of the needs of wildlife as well as people.

Human-wildlife conflict should be reduced through predator-proof livestock enclosures, early warning systems for elephants approaching farms, community ranger patrols and fair and timely compensation. Long-term monitoring of land use, wildlife numbers and movements should continue, and the results should be shared with communities and planners.

9 Limitations and research gaps

This review draws on published studies and reports and does not include new field data. Most of the long-term evidence concerns large mammals, while the effects of land use change on smaller animals, birds, plants and swamp ecosystems are less well documented. The most recent large-scale studies of subdivision effects use data that end in the late 2000s and early 2010s; more recent changes, such as the growth of Kimana town and the expansion of lease programmes, need further study. Future research should map land use change in the ecosystem using recent satellite images, measure the effectiveness of lease schemes and conservancies in keeping corridors open, and assess how irrigation affects the size and condition of the swamps.

10 Conclusion

Amboseli National Park is too small to support its wildlife on its own, and depends on the group ranches around it. Subdivision of these ranches, permanent settlement, fencing and irrigated farming have reduced the land and water open to wildlife and blocked routes to neighbouring areas. Where these changes have taken place, wildlife numbers have fallen sharply, conflicts with people have increased, and wildlife has become concentrated in the park, contributing to woodland loss. Droughts cause the heaviest losses where animals cannot move. The future of wildlife in Amboseli depends on keeping enough of the surrounding land open and connected. This requires land-use planning, protection of corridors, regular payments to landowners who keep their land open, fair sharing of tourism income, and measures to reduce the costs that wildlife imposes on local communities.

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