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Factors and Ecological Impacts of Wildlife Habitat Destruction in the Serengeti Ecosystem in Northern Tanzania

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Abstract
Despite the considerable worldwide efforts to establish the wildlife protected areas - a strategy construed as the most feasible in maintaining the high quality habitats for healthy wildlife populations - destruction of wildlife habitats has remained the leading threat to biodiversity. This destruction, taking different forms (i.e. degradation, fragmentation or outright loss) is a function of the growing human activities - prompted mainly by such factors as poverty, demographic factors, land tenure systems, inadequate conservation status, development policies and economic incentives. This paper reviews these contributing factors and presents the associated ecological impacts – manifested by a decline of wildlife populations and local extinction of species. Provision of adequate conservation status to critical wildlife habitats, addressing the problem of human population growth, adoption of poverty reduction strategies that are conservation-friendly and discouraging the destructive development policies are recommended as the measures to mitigate the problem. Other measures entail genuine involvement of the local communities in conservation, provision of adequate economic incentives, relevant research and participatory land use planning. In conclusion, the paper argues that, given the nature of the problem, if a lasting solution is to be realized, habitat loss should be viewed as a multisectoral rather than a single sectoral issue. Therefore different stakeholders should play an active role in halting and pre-empting the problem. We propose criteria for selection of the relevant stakeholders.

Key words: Tanzania, Serengeti ecosystem, wildlife, protected areas, habitat destruction

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1. Introduction

Wildlife is a land resource of cultural, ecological and economic significance. It is a renewable resource whose survival depends, among other factors, on the quality of habitats. The importance of habitats is derived from their ecological roles in provision of shelter, breeding places, dispersal and foraging grounds for a variety of wildlife species. They also allow free movement for animals to other geographical localities where access to critical resources for (wildlife) survival and exchange of the genetic material occur. Wildlife habitats are, therefore, critical components for ecological integrity and the long-term survival of the ecosystem.

Destruction or loss of wildlife habitats reduces their potential utility. Hunter (2002:193) defines three forms of habitat destruction (viz. degradation, fragmentation and outright loss). While habitat degradation is "the process by which habitat quality for a given species is diminished", fragmentation "is the process by which a natural landscape is broken up into small parcels of natural ecosystems, isolated from one another in a matrix of lands dominated by human activities". Outright loss of habitats occurs when habitat quality is so low such that the environment is no longer usable by a given species.

Although previously habitat changes were relatively a minor factor in decline of species, being overshadowed for centuries by overexploitation and introduction of exotic species (Soule et al. 1979; WCMC 1992), their relative importance has increased in recent decades. Habitat loss has emerged the most severe threat to biodiversity worldwide (Brooks et al. 2002b; IUCN 2004; Naeem *et al.* 1999; Smith and Smith 2003) threatening some 85% of all species classified as "threatened" and "endangered" in the IUCN's *Red Lists* (IUCN 2004). It is the most pervasive to birds, mammals and amphibians. It affects 86% of all threatened birds, 86% of threatened mammals and 88% of threatened amphibians (www.iucn.org/themes/ssc). The effect of other threats is relatively lower. For instance, overexploitation affects only 30% of threatened birds, 33% mammals and 6% amphibians while introduction of alien species affects 30% and 11% of threatened birds and amphibians, respectively (ibid).

Human activities such as overgrazing, deforestation, bush fires, mining, urbanization and cultivation are the principle causes of habitat destruction (See e.g. Kauzeni 1995; Kideghesho 2005; Mwalyosi 1992). These activities are expanding in line with human population growth and poverty increase. Maintaining the high quality habitats and ensuring the long-term ecological integrity is therefore increasingly becoming an important management challenge. Establishment of wildlife PAs has been adopted as the most feasible strategy to this end. Currently some 104,791 PAs covering a total area of about 20 million km^2 or 12.7% of the earth's surface (Chape *et al.* 2005) have been created. This is a dramatic increase compared to only 8,500 PAs covering some 7.7 km^2 (equivalent to 5.2% of the earth's surface) existed in the last decade (IUCN/CNPAA 1990; Pretty and Pimbert 1995).

The PAs, have, however, been criticised for inadequacy as self-sustaining entities in guaranteeing the long-term survival of flora and fauna. Bennet (1997) outlines four reasons for this inadequacy: (1) PAs do not represent all natural communities; (2) most PAs are too small to maintain viable populations of all species and to maintain natural ecological processes; (3) movement patterns of many animals regularly cross PAs boundaries; and (4) PAs are not protected from surrounding land use categories and may, therefore, be degraded by processes arising in the surrounding landscapes.

The above reasons augment the importance of ecological linkage and the ecological unit of sufficient size to encompass as wide a contiguous range of ecological communities as possible. Ecological isolation has numerous ecological consequences. For example, it limits flow of genes between wildlife populations in different geographical localities and, therefore, may lead to genetic erosion. It may also limit natural dispersal of organisms and thus

exacerbating the risk of extinction in case of natural catastrophes such as epidemics, drought, fire, earthquakes or floods. In addition, ecological isolation may be detrimental to species that require large ranges and those with complex requirements at different stages in their life cycles or at different seasons.

Some scientific studies have led to predictions and generalizations on the ecological impacts of isolation and small ecological units. Predictions of Soule *et al* (1979) for loss of large mammals in East Africa suggest that when the areas are isolated for 50, 500 and 5,000 years without intervention of scientific management, the smallest reserves may lose 23%, 65% and 88% of the species. In contrast the risk is lower for largest reserves. They may lose 6%, 35% and 73% in the respective time intervals. Likewise, extrapolations from estimates for habitat loss have led to the most widely quoted generalizations that, loss of 90% of habitat results in loss of half of the species present (WCMC 1992: Meffe and Carroll 1997).

In Africa loss of wildlife habitats is a widespread phenomenon. The current loss is estimated at 60% (Newmark & Hough 2000). Human population pressure is cited as the main contributor to this loss, mainly through deforestation prompted by increased demand for arable land, settlements and fuelwood. The majority of sub-Saharan Africa's population is dependent on fuelwood: 82% of all Nigerians, 70% - Kenyans, 80% - Malagasies, 74% - Ghanaians, 93 - Ethiopians, 90% - Somalians and 81% - Sudanese (Hinrichson 1994).

Tanzania, one of the African countries, is by no means exceptional to this scenario. According to the World Resources Institute report on status of the world habitats in the late 1980s, the country had 43% of its original habitats (ca. 886 200 km^2) lost (WRI 1989). Local extinction of fauna species and increased number of species that are prone to extinction in different localities manifest the impact of this loss (e.g. Miller and Harris 1977; Newmark 1996; Hassan 1998; Gamassa 1998; Brooks *et al* 2002; Kideghesho 2001).

Understanding the contributing factors and ecological impacts inflicted by habitat destruction on biodiversity is essential in devising the effective mitigative measures. In this paper we use the literature and our personal experience on Serengeti ecosystem to review the process of habitat destruction by attempting to address the following questions: (1) What are the factors contributing to habitat destruction (2) What are the ecological impacts and how could these impacts be mitigated? Before embarking to these questions we provide brief description of Serengeti

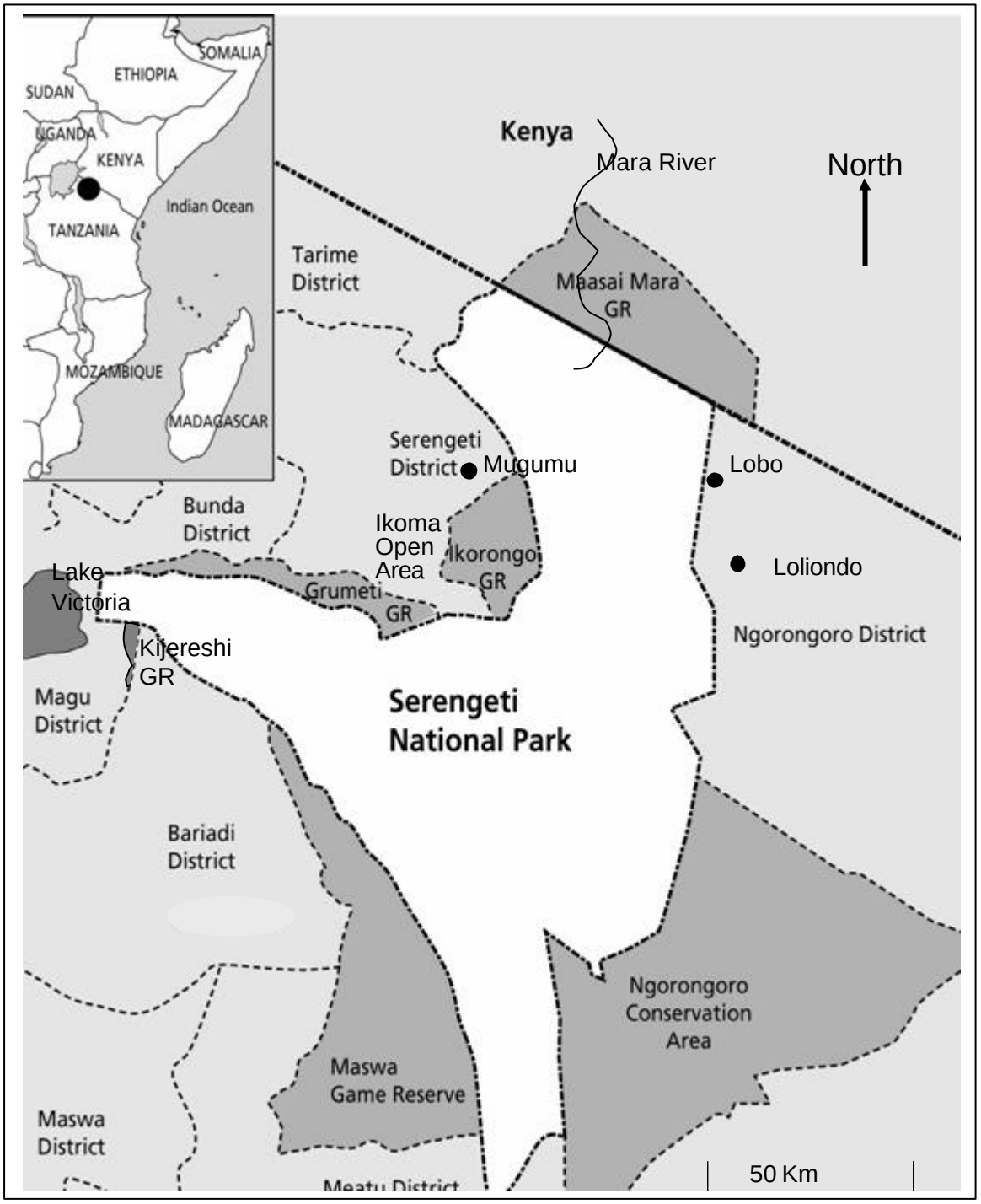
Serengeti Ecosystem

Serengeti ecosystem is located in the northern Tanzania and extends to south-western Kenya between latitudes 1^0 and 3^0 S and longitudes 34^0 and 36^0 E. It spans some 30,000 km^2 and forms one of the important cross-border conservation regions in the world. The ecosystem – a home to about 70 larger mammal and some 500 avifauna species – supports one of the largest herds of migrating ungulates and the highest concentrations of large predators in the world (Sinclair 1979; Sinclair and Arcese 1995a). Its high diversity in terms of species is a function of diverse habitats ranging from riverine forests, swamps, kopjes, grasslands and woodlands.

Over 80% of Serengeti ecosystem is legally protected through a network of protected areas (PAs) (Figure 1), although the management regimes to some are too weak to guarantee their effective protection. These PAs include Tanzania's Serengeti National Park - SNP (14,763 km^2), Ngorongoro Conservation Area - NCA (8,288 km^2), and Kenya's Maasai Mara National Reserve - MMNR (1,368 km^2). NCA and SNP together were designated as one Biosphere Reserve in 1981 and were inscribed separately on the World Heritage List in 1979 and 1981 respectively (UNESCO 2003). Also included in the PAs network are four Game Reserves (GRs): Maswa (2,200 km^2), Ikorongo (563 km^2), Grumeti (416 km^2) and Kijereshi (65.7 km^2). Loliondo Game Controlled Area – GCA (4,000 km^2) and Ikoma Open Area – OA

(600 km^2) are the lowest categories of the PAs and, therefore, are the least protected against human impact.

Figure 1:Location of the Serengeti Ecosystem in Northern Tanzania



Neither human settlement nor extraction of natural resources is permitted in the SNP and MMNR. The legal uses are research and game viewing. In the GRs licensed trophy hunting is permitted. However, settlements are prohibited. Virtually all uses, other than unlicensed hunting and cultivation, are allowed in the GCAs. Limited cattle grazing, firewood collection, hunting (game cropping, resident and trophy hunting) and bee keeping are allowed in the Ikoma Open Area.

Although the PAs network in Serengeti is considered sufficiently large enough to ensure its survival (UNEP/WCMC 2000), the pressures facing the ecosystem contradict this assumption. The long-lived motto for the ecosystem: 'Serengeti shall not die' (Grzimek and Grzimek 1960) is being undermined. Central to this threat is a human factor. Serengeti is a multiethnic region comprised of over 20 tribes (Emerton and Mfunda 1999) earning their living through crop production, livestock husbandry, charcoal burning, hunting and mining. These activities, taking place both within and outside the PAs, have detrimental impacts on wildlife habitats and, consequently, wildlife populations. There is considerable human encroachment for agriculture in SNP and Maswa GR. Mining and settlements are increasing on the migratory corridors and dispersal areas along the western boundary of the SNP (Kideghesho *et al.* 2005). Mechanised agriculture has taken place around MMNR, an area previously considered as a critical calving ground for wildebeest (Ottichilo *et al.* 2001a).

In 1995, Sinclair and Arcese (1995a) estimated that 40% of the Serengeti Ecosystem's original area (ca. 30,143 km^2 in 1910) had been lost. According to them, the loss was accelerating rather than abating and that it was taking place largely within the legal boundaries of the park. They reported the greatest loss between 1960s and 1990s, despite the great efforts the researchers and conservationists had invested in the area. In the last 25 years about 30 and 40% of park's vegetation community has been changed, leading to a change in fauna populations (Sinclair in Morell 1997).

Showing concern over the status of wildlife habitats in the ecosystem, Bernhard Grzimek, an author of the book "Serengeti shall not die" stated that:

> 'Areas, which we knew as wilderness, are now heavily settled and cultivated. Each day the park becomes more of an island, and pressures on its boundaries continue to grow. We must urgently renew our vigilant custodianship, lest we lose this asset for all mankind' (MNRT 1985:2).

3. Factors contributing to habitat destruction

In this section some factors contributing to habitat destruction or loss are discussed. These factors entail: poverty, population growth, land tenure systems, development policies, economic incentive and inadequate conservation status. The conceptual model below summarizes these factors and discussion for each factor follows.

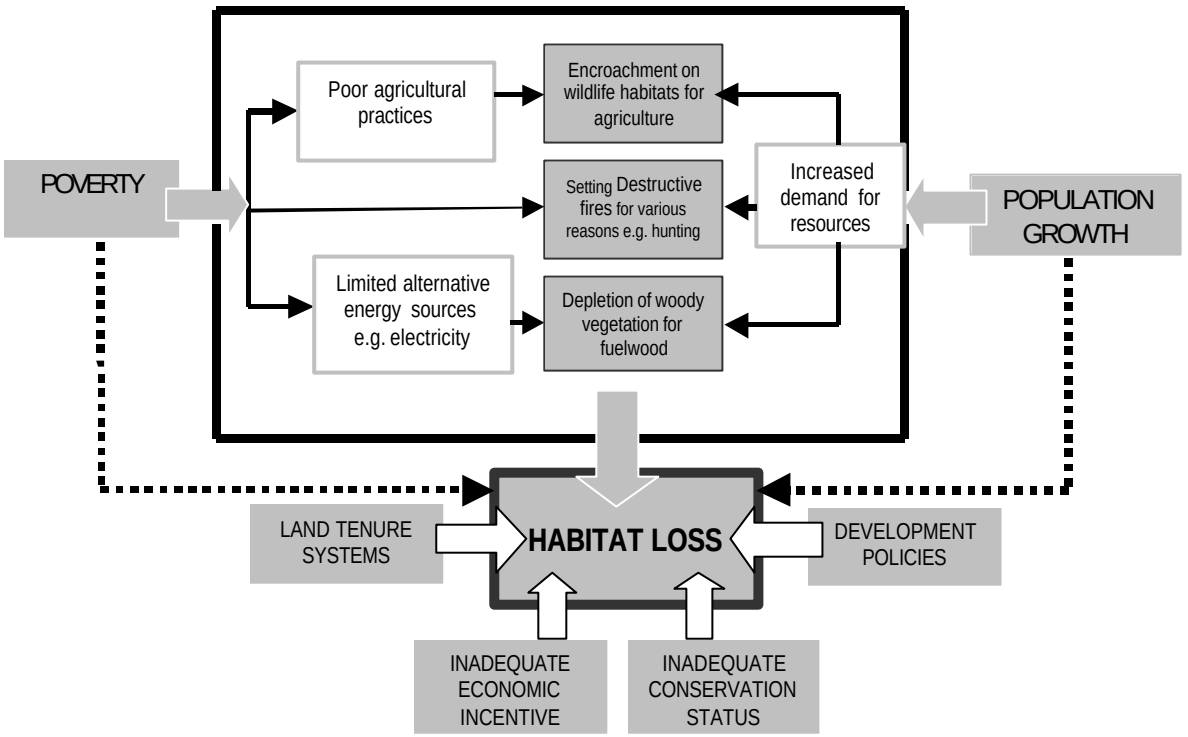
3.1 Poverty

Poverty is defined as "a state of deprivation associated with lack of incomes and assets, physical weakness, isolation, vulnerability and powerlessness" (Chambers 1987:8-9). It is considered a rural phenomenon in Tanzania, where about 22% and 39% of its population live below the food poverty line and basic needs poverty line, respectively (URT 2002). The proportions living below US$1 and US$2 per day are 19.9% and 59.7%, respectively, thus making 41.6% of the population live below the national poverty line (UNDP 2003). Serengeti is not exceptional – and probably the situation is much worse.

Mara Region, in which much of Serengeti falls, ranks sixth in terms of poverty among the 21 administrative regions of Tanzania's mainland, with a regional annual per capita income of TAS 118,591 or US$119 (URT 2002). Gross annual income per household from

crop production in Bunda and Serengeti is estimated at US$555 and 679 (Emerton and Mfunda 1999), respectively. Kauzeni (1995) and Johannesen (2002) reported a much lower income of between US$150 to 200 per household. Taking an average of 6 persons per each household for both districts (URT 2002), average expenditure for each individual is evidently far below US$1 per day.

Figure 2: A conceptual model depicting the factors contributing to habitat loss in the Serengeti Ecosystem, Tanzania



Due to low purchasing power, villagers in Serengeti can barely afford modern and improved technologies and agricultural inputs required for high crop production. Yet more production is inevitable in order to cope with high demand for food created by rapid human population growth. Expansion into new lands - including sensitive areas for wildlife, such as migratory corridors and dispersal areas – therefore, becomes the most feasible strategy to this end. Essentially, land shortage in western Serengeti can be ascribed to poor agricultural practices (Figure 2).

Fuelwood is the main source of energy for cooking and heating in Serengeti and in Tanzania in general. Its demand expands exponentially with population growth (Mwalyosi 1992). This demand exacerbates destruction of the critical wildlife habitats (Figure 2). While electricity could serve as an alternative source of energy, until recently most areas (including some District Headquarters such as Mugumu, Serengeti) lacked access to this service. Further, even in areas with the service, such as Bunda District, high installation and service costs render its affordability practically impossible to majority of the households. Where the few households have access to the service, high tariffs make its use for cooking and heating

economically unfeasible. For most Tanzanians (including some senior government officials), electricity is used for lighting and operating radio and TV sets. On average, a family of five people uses two bags of charcoal weighing between 90 and 100 kilograms per month. The cost of this fuel is between US$10 and US$14 per month compared to US$35 paid for electricity service (personal experience).

3.2 Demographic factors

Over the last four decades, areas periphery to SNP have experienced huge population growth. The period between 1957 and 1967 recorded the highest rate of increase i.e. 10% per annum. Of this, only 3.4% was contributed by natural increase while the rest was due to immigration (MNRT 1985). The current population in the seven districts to the west of the park is over two million (more people than the total population of the Republic of Botswana) with annual growth rate exceeding the national average of 2.9% (URT 2002). Immigration from within and even from neighbouring countries appears to be the major factor stimulated by good agricultural land, wildlife (as a source of protein), water bodies (rivers and Lake Victoria for fishing), and gold deposits (Kideghesho *et al* 2005).

One of the problems of high population in close proximity to the borders of protected areas is growing pressure from local people to open protected lands for community use (Hackel 1999). This scenario is evident in Maswa GR where its boundaries have been realigned three times, causing 15% loss of the original area (MNRT 1985). Expansion of arable land and settlements in Serengeti had led to shrinkage of the grazing land for livestock, which is increasing simultaneously with human population. Statistics obtained from Serengeti District, indicated 52% increase of livestock units from 175,680.5 in 1990 to 266,624.5 in 2002. This had implication on land requirements for livestock, which increased from 2108.1 to 3199.5, respectively. This lowered the carrying capacity, which was already considered to be exceeded a decade ago (Kauzeni and Kiwasila 1994).

The confinement of livestock into small areas causes overgrazing, soil erosion and siltation of water bodies (Kideghesho, pers. observation, 2005). Due to inadequate (see Table 1) and poor quality pasture in these lands, the livestock owners in some villages of Western Serengeti have been pressing for government to degazette or legalize access to critical grazing and watering points in Grumeti, Ikorongo and Kijereshi GR (Kideghesho *et al.* 2005). These villagers, however, are continuing to use the areas illegally on the basis of violation of law in order to survive.

Table 1: The land available and the land required* for livestock grazing in Serengeti and Bunda Districts in 2002

District	Livestock units (as of 2002)	Land available (Km^2)	Land Requirement (Km^2)	% of land exceeded
Serengeti	266 624.5	2456	3199.5	30.3
Bunda	267 090	2408	3205.08	33.1

Source: Kideghesho et al. (2005)

*The land requirement is calculated based on livestock units (LU), where 1 LU = 1 cow/bull = 2 goats or sheep = 5 donkeys. 1 LU requires 1.2 ha

3.3 Inadequate conservation status of some critical habitats

Over 80% of Serengeti ecosystem has been included into protected areas network. However, some areas, which are critically important for survival of wildlife population, have long remained unprotected or partially protected. Recently, there had been some efforts to accord adequate conservation status to these areas. For example, Ikorongo, Grumeti and Kijereshi Game Controlled Area was upgraded to Game Reserve in 1994. However, enforcement has been minimal. Illegal inhabitants continued to remain inside the reserve until 2002, when government authorities forcefully evicted them. Even after eviction, illegal grazing and firewood collection is still going on to date due to inadequate manpower and equipment to patrol the area. The Speke Gulf, a critical corridor for wildlife species migrating between SNP and Lake Victoria where animals get access to water during the dry season, has remained unprotected against incompatible land uses, despite calls from conservationists to safeguard the corridor. Increased permanent human settlements, infrastructure developments and investment facilities such as tourist hotels minimize the chances of securing the corridor (Kideghesho, pers. observation, 2004).

3.4 Land tenure and development policies

The land tenure system, land use policies and market conditions may have detrimental impacts on biodiversity. In Tanzania, the land belongs to the State, although most of it (except PAs) is held in a communal type of tenure - often called the deemed right of occupancy. In Kenya, the privately owned land outside the core PAs has allowed the landowners to respond to market opportunities for mechanized agriculture at the expense of wildlife habitats (Homewood *et al.* 2001; Ottichilo *et al.* 2001b). In both countries wildlife belongs to State. In contrast to private land tenure, State control of land has the advantage that the State can restrict the policies and land uses likely to cause detrimental impact on wildlife.

The recently proposed development policies in the Kenyan side of the Serengeti ecosystem (i.e. Mau forest degazettement, irrigation of mechanized farming and the development of the Amala Weir Hydropower project) suggest further destruction on habitats if implemented (see section on ecological impacts). Similar threat faces the Tanzanian side in the Lobo and Loliondo areas (east of the SNP), earmarked by foreign investors as potential areas for large-scale agricultural schemes (MNRT 1985) if the government errs in its political decisions and allow the project to take off.

3.5 Inadequate economic incentive

Like in many other terrestrial ecosystems, in Serengeti wildlife conservation is pursued along with several other land uses. These uses may be ecologically destructive but economically rewarding. For local people to forgo these uses in favour of conservation, the wildlife-related benefits should be equitably distributed and be able to contribute sufficiently to the local human economy. However, much of the benefits accrue to national or international companies such as Safari firms, tour operators and lodge owners (Leader-Williams *et al.* 1996). The local communities receive too minimal amounts, which can hardly offset the wildlife-induced costs and outweigh the returns from alternative (destructive) land uses. Therefore local people have less incentive to surrender their current livelihood strategies – why should they do so to benefit the government, tourists and foreign investors? Further elaboration is provided by sub-headings below.

(i) Equity in distribution

As stated above, the local communities receive very little benefits from wildlife resource. For example, according to SNP annual reports, tourism earned the park some US$ 31 million

from 1992 to 2003. Of these only US$ 0.5 million (less than 2%) trickled down to local communities in all districts bordering the park indirectly through supporting social services (e.g. construction of dispensaries and classrooms). In the MMNR the adjacent local communities receive less than 1% from tourism revenues generated by the reserve (Emerton 2001).

Worse enough, these scanty benefits are often inequitably distributed, between the households and villages. In western Serengeti it was claimed that the wildlife-related benefits reach neither the victims nor the intended beneficiaries - the claims that were verified by the then Minister for Natural Resources and Tourism during the parliamentary session on July 28, 2005. She criticised the district councils for using their share of revenues from tourist hunting for (paying) sitting allowances instead of directing it to local communities.

Further ambiguity emanates from the fact that all villages in the district are eligible to a share of wildlife related benefits regardless of the costs they incur. This renders the communities unable to differentiate between the conservation-related benefits and other handouts given by the government. One village chairman complained that the benefits were going even to people who do not know how an elephant look like. It was also noted that some local elite in the villages monopolize the benefits thus causing dissatisfaction among the communities (Kideghesho, pers. observation, 2004).

Failure of wildlife-related benefits to offset the costs

Despite the current assertions of making wildlife a positive development factor, there is no evidence on improvement of the local economy, the major reason being failure of the benefits to balance the costs caused by wildlife. Likewise these benefits are received as communal goods and therefore cannot offset the costs borne by individuals or households. Table 2 below shows how wildlife-induced costs incurred by the landholders in western Serengeti exceeds the benefits granted through community conservation initiatives.

Table 2: Estimates of economic benefits and costs for landholders in Western Serengeti

Benefits/costs	Value (USD/year)
TANAPA Support to Community Initiated Projects (SCIP)	+ 15 400
SWCP/WD community hunting	+ 3 500
Wildlife crop damage	-484 000
Agricultural opportunity costs of Grumeti and Ikorongo Game Reserve	-540 000
Total	-1 005 100

Source: Emerton and Mfunda 1999

The cost-benefit estimates in Western Serengeti shows that farmers bordering SNP and Ikorongo-Grumeti GRs incurred the costs amounting to US$ 155 per household through crop damage while eviction from the GRs caused an opportunity cost of over US$ 770 a year per household (Emerton and Mfunda 1999). These costs were extremely high compared to benefits granted to each household i.e. some US$ 2.5 per year. These benefits were indirect as they were granted in form of infrastructure - e.g. construction of classrooms, dispensaries and roads - (ibid), and, therefore, it is not necessary that they addressed people's felt needs and priorities. Yet majority of the villagers could not access the benefits simply because their villages were not included in the project.

Failure to compete effectively with alternative land uses

As Emerton (2001:211) observes, "if there is no domestic economic gain associated with wildlife, then there will be insufficient arguments – as well as insufficient local incentives – either for conserving it or for communities becoming involved in conservation activities."

The choice made by the landowners in the group ranches adjacent to MMNR (a Kenyan side of Serengeti ecosystem) epitomizes this situation. The landowners opted to develop the land into full-fledged agriculture and ranching because the value of this option was 15 times greater than the alternative use for wildlife-based tourism and limited agriculture and livestock (Norton-Griffiths 1995). The higher economic value of the former inspired the conversion of over 50,000 ha of rangelands into large scale mechanized wheat farms (Serneels and Lambin 2001) – the decision that resulted into serious destruction of the core breeding and calving grounds for wildebeest (Ottichilo *et al.* 2001a). This situation is further elaborated by the words of a villager along Grumeti GR, complaining following prohibition of access to pasture and water from the GR.

> "This is a joke! A classroom and two kilogrammes of bush meat we buy from SRCP per year cannot match up to loss of pasture and water sustaining some 70,000 cattle. Nor could they (classroom and meat) be able to restore our dignity, which is overtly being abused by game rangers when they arrest us inside the reserve. What is the use of school if it means loss of cattle giving us food, clothes and school requirements for children who are intended to attend to this school?" (Source: Interview with anonymous villager, April 24, 2004).

4. Ecological impacts

Extensive expansion of arable land, depletion of woody vegetation, reduction of rangelands, soil erosion, siltation of water bodies and loss of soil productivity attributed to factors discussed in the previous section translate into negative impacts on faunal populations.

Roan antelope (*Hippotragus equines*) is reported to be locally extinct in many areas of the ecosystem - due to the loss of its *Combretum*-dominated habitats (Campbell and Borner 1995; Sinclair 1995). Sinclair *et al.* (2002) reported a negative correlation between the intensity of agriculture and bird species diversity and abundance in Western Serengeti. The abundance of bird species found in agricultural areas west of SNP was 28% of that for the same species in the native savannah. They further reported 50% loss of insectivorous and granivorous bird species in agricultural areas. They attributed reduction of insectivorous to a decline of arthropods following disturbance to the grass layer as a consequence of conversion to agriculture. They cited reduced ability to control insect pest outbreak as one of the negative impacts of reduction in insectivorous birds. They further pointed out that, " the lack of raptors in agriculture, particularly the rodent specialists (e.g. black shouldered kite (*Elanus caeruleus*) and long-crested hawk eagle (*Spizaetus ayresii*)) that are abundant in savannah, may be related to the frequent outbreaks of rodents such as *Mastomys natalensis*" (Sinclair *et al.* 2002:269).

Morell (1997) attributed disappearance of the previously healthy populations of trogons and large-casqued hornbills to loss of tree cover in the riverine forests. Some bird species, such as shrikes and thrushes, were said to have moved into the park, while black and white colobus monkeys (*Colobus angolensis*), previously seen along the Grumeti River, moved further west (ibid). Rural communities have also reported the disappearance and reduction of some animal species in areas where they were previously abundant (villagers in Western Serengeti, pers. comm. 2004).

Pits created by mining activities in Park Nyigoti, Serengeti district are associated with accidents and mortality to wildebeest and other species utilizing the area as a migratory route or dispersal area (Kideghesho *et al.* 2005). Also animals have abandoned the highly settled areas which were previously used as migratory routes and dispersal areas (ibid.). Drop in population of browsers in the North of SNP was linked to depletion of the woodland vegetation caused by deforestation and unplanned fires (Sinclair and Arcese 1995b).

Between 1975 and 1995, the Kenyan part of the Serengeti ecosystem experienced higher decrease in vegetation cover than Tanzanian side, a situation attributed to Kenya's private land tenure system and failure of the returns from wildlife to outweigh those from alternative land uses. Fencing and destruction of the wet season dispersal and/or calving grounds for the resident wildlife populations following conversion into wheat farms resulted into a decline of the total non-migratory wildlife population by 58%. Resident population of wildebeest dropped from 119,000 in 1977 to 22,000 in 1997 i.e. 81% decrease (Ottichilo *et al.* 2001a). Populations of giraffe (*Giraffa camelopardalis*), topi, (*Damaliscus korrigum*), buffalo (*Syncerus caffer*) and warthog (*Phacochoerus aethiopicus*) declined by 73 to 88% while populations of waterbuck (*Kobus ellipsiprymnus*), Thompson gazelle (*Gazella thompsonii*), Grant gazelle (*Gazella grantii*), kongoni (*Alcelaphus buselaphus*) and eland (*Tragelaphus oryx*), decreased by about 60% (Ottichilo *et al.* 2001b). Serneels and Lambin (2001) observed that the decline of wildebeest population in the Kenyan side of Serengeti ecosystem over the last decades had little effect on the population found in the Tanzanian side. However, they predict the detrimental impact on the entire ecosystem due to reduction of the dry season range for the Kenyan and Tanzanian population if the current land conversion closer to Maasai Mara National Reserve will continue unabated.

As mentioned earlier, the recently proposed projects in the Kenyan side of the ecosystem (i.e. Mau forest degazettement, irrigation of mechanized farming and the development of the Amala Weir Hydropower project) may adversely affect the utility of the area by affecting the water quantity in Mara River, which is 'a dry season refuge' for over a million wildebeest (*Connochaetes taurinus*) and zebra (*Equus burchelli*). Using the ecohydrology model, Gereta *et al.* (2002) predicted that the resulting severe drought would reduce the wildebeest population by 80%, a situation precluding any possibility of population recovery. The model suggests that, with 50% die-off, it might take 20 years for the population to recover.

The current unsustainable human activities in the PAs, buffer zones and migratory corridors and, subsequently, reduction in the size of effective conservation area, may accelerate the species loss. This may probably occur at a rate above the one estimated in Soule et al's (1979) model of faunal collapse in the Game Reserves in East Africa. The model suggested that SNP would lose about 70% of its species within 1,500 years.

5. The Way forward: Some proposal for action

This section presents some strategies that can be employed to overcome the problem of habitat destruction and other forces threatening Serengeti ecosystem. Although some strategies discussed here are not new (i.e. are already being employed), they have some drawbacks that need to be addressed.

5.1 Adopt the poverty reduction policies/strategies that are conservation-friendly

The agenda of human survival is critical if forces threatening the ecosystem are to be halted. It is illogical for anyone to accept a scenario where preservation of biodiversity implies starvation. To reduce the pressures on natural resources and habitats, alternative strategies capable of reducing the necessity of encroaching into wildlife habitats should be adopted. Since land shortage in Serengeti is ascribed to poor farming practises, more equitable and efficient use of the land already under cultivation should be adopted as one of the strategies. The strategy should entail activities aiming at supporting agricultural sector – e.g. subsidizing inputs, providing credits and access to markets, and controlling problem animals. With an average of 5 ha for most individuals in the villages (Kideghesho, unpublished data, 2005), and with proper and adequate support, food security can be guaranteed. Further, alternative livelihood strategies such as small business enterprises and ecotourism can be secured. In order to reduce heavy dependency on fuelwood the government should subsidize the

alternative sources of energy (e.g. biogas, solar and electricity). The agroforesrty /aforestation programmes should be encouraged in the village lands to provide villagers with their own woodlots.

5.2 Make human population growth a priority agenda

Although population growth is one of the underlying causes of threats facing Serengeti ecosystem, it barely receives adequate attention in the current conservation policies. Overlooking this factor is synonymous to treating the symptoms rather than the causes. Unless proactive intervention policies are sought, it is apparent that pressure on land and resources will increase. Population increase may also dilute the effectiveness of some current strategies and exacerbate the conflicts. For example, population increase may decrease the share of wildlife-related benefits to people and therefore defeat the aim of the strategy i.e. motivating people to refrain from destructive activities.

The possible strategies to address population growth may include developing and implementing the active policies aiming at reducing immigrants from other areas by limiting the population-pull factors; adopting family planning measures (to minimize the problem of natural increase); and formulating special policies to depopulate the area (e.g. by obligating all administrative regions in Tanzania to absorb and employ the youth from Serengeti area).

5.3 Provide adequate conservation status to critical wildlife areas

Over 80% of the Serengeti ecosystem enjoy legal protection as protected areas – e.g. National Park, Game Reserves and Ngorongoro Conservation Area. However, as noted earlier, some critical areas are either not or inadequately protected. Creation of the new wildlife PAs and/or upgrading of the existing PAs from the lower to higher categories can be adopted as one of the measures. To make this measure effective, observance of human interests is imperative. Experience has often shown that the measure engenders conflicts by interfering with local people's livelihood strategies.

Recent plans to establish the Wildlife Management Areas (WMAs) in the buffer zones surrounding SNP is a good stride. However, this measure may exacerbate economic and social costs to local communities since it translates into improved and increased effective conservation areas, increased wildlife populations and their proximity to human assets. The suitable policies to minimize the likely costs should, therefore, be formulated. For example, the government should adopt the vermin control and compensation programmes in case of property damage.

5.4 Discourage policies, land uses and projects likely to have adverse impacts on habitats

The detrimental impact of private land tenure on wildlife around the Kenyan part of Serengeti ecosystem should serve as a precaution against adopting similar policies in other parts of the ecosystem. The current state/communal land tenure and policies restricting commercial and mechanization agriculture in Tanzanian side should be maintained. Further, both countries sharing the ecosystem should develop and implement practical ways to harmonize the development policies around the ecosystem. All projects should be subjected to EIA before taking off and those with detrimental impacts on habitats and wildlife should be discarded.

5.5 Enhance conservation education and research

The basic lack of knowledge contributes to destructive activities on wildlife habitats. This is due to failure of the people to consider the long-term consequences of their actions. Provision of appropriate conservation education is, therefore, important. Emphasis should focus on educating people about the value of wildlife and their habitats, the consequences of habitat destruction/loss and ways of mitigating the problem.

Additionally, the research programme is vital in generating useful information for controlling and reversing the trend of habitat destruction. The research should focus on: establishing the reasons on why local people exhibit a particular unsustainable behaviour; identifying the (alternative) livelihood strategies with minimal impact on habitats; evaluating the efficacy, implementation constraints and social acceptability of the alternative land uses and strategies against those threatening the ecological integrity and; identifying the new wildlife corridors and habitats along with the effects associated with environmental change and human use.

5.6 Involve local communities, institute participatory land use planning and provide adequate conservation incentive

For decades, conservation has been pursued against the interests of local people and, therefore, resulted into loss of trust, hostility and local resentment towards conservation. Of recent, efforts to involve local people are being adopted. However, these efforts have been inadequate and passive. Essentially, genuine participation is lacking. Genuine and effective participation should involve empowering local people to take part in designing, planning, decision making, implementation, benefit sharing, monitoring and evaluation. The government, its agencies and donors have to prove to people that, unlike in the past, they are credible and trustworthy and, therefore, the initiatives or programmes they propose will work. The offensive attitude against the local people should stop. They should instead be viewed as important partners rather than potential enemies in conservation. Sensitization may help. Another important area requiring inputs from the local people is in land use planning. The participatory process is essential in reaching consensus about the appropriate uses in specific zones. Only uses that are compatible with conservation should be allowed in critical wildlife areas such as migratory corridors, calving and dispersal grounds.

New modalities for benefit sharing should be developed to ensure that the benefits are evenly distributed, are adequate enough to offset the conservation-induced costs and can outweigh the returns generated by environmentally destructive land uses. Further, the future access to these benefits should be guaranteed. Although the issue of compensation is highly debated and rarely practised there is a need to reconsider it and adopt it as one of the motivational factors against land uses and behaviours undermining the conservation goals. People should be fairly compensated for costs incurred through wildlife damage and opportunity costs of alternative land uses.

6. Conclusion

A healthy population of wildlife is a function of high quality habitats. Therefore, habitat destruction presents a potential threat to the survival of wildlife species. In Serengeti this threat is generated by numerous factors - a situation calling for a variety of mitigation measures or strategies. This diversity of factors and mitigation measures makes the problem of habitat destruction a multisectoral rather than a single sector issue. Addressing the problem, therefore, calls for involvement of, not only conservationists, but also other stakeholders with different interests on the area and professional background such as lawyers, agriculturists, and business community, demographers, policy makers, community development workers and land use planners. For a comprehensive and long-term solution stakeholder analysis should be done. The following criteria should be used to select the stakeholders: the existing rights to land or other natural resources; historical and cultural relationship with the resources; unique knowledge and skills in managing the resources; losses and damage incurred in the process of managing the resources; degree of economic and social reliance on the land and other resources; compatibility of the interests and

activities (of the stakeholders) with the national conservation and development policies and; the impacts of the activities on the resource base.

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