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Review Article

'Serengeti shall not die': transforming an ambition into a reality

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Abstract

The slogan "Serengeti shall not die" (German: *Serengeti darf nicht sterben*) is widely credited for alerting the global community to the urgency of conserving the Serengeti and its biological values for the benefit of local and global communities. The slogan has become popular since 1960 when Bernhard and Michael Grzimek authored a book, *Serengeti Shall Not Die*. However, despite this commitment the management challenges in Serengeti are growing, causing skepticism about the potential for realizing such a goal. These challenges include illegal hunting, habitat loss, and human-wildlife conflicts aggravated by human population growth and poverty. In addressing these challenges and therefore transforming the ambition "Serengeti shall not die" into reality, the multiple strategies required are presented in this paper. The paper starts by reviewing the challenges contradicting the ambition.

Keywords: Serengeti; Tanzania; ecosystem; wildlife; National Park; challenges; Grzimek; conservation

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Introduction

The creation of Serengeti National Park in 1940 was a milestone in the preservation of wildlife species and habitats in Tanzania. Serengeti is one of the earliest established national parks in sub-Saharan Africa along with the Democratic Republic of Congo's Albert (1925), South Africa's Kruger (1926), Kenya's Nairobi (1946) and Tsavo (1948), and Uganda's Murchison Falls (1951) National Parks. A strong advocacy for the idea of national parks in Africa emanated from the politically powerful personalities in England, spearheaded by the Society for the Preservation of the Flora and Fauna of the Empire (SPFFE) [1,2]. Major Richard Hingston, who was sent to Tanganyika by the society in 1930 to investigate the needs and potential for developing a nature protection program, recommended for urgency of creating national parks, Serengeti being one of the three parks in Tanzania, along with Selous and Kilimanjaro, at that time. The most important criteria in judging the suitability of an area as a national park were interests and priorities of the Europeans. The Serengeti was rated as suitable for creation of a national park, because its insignificant mineral deposits, presence of the tsetse fly, and scant rainfall made the land unattractive to European miners and farmers [3].

The idea of creating national parks, however, was opposed by administrators in Tanganyika, who felt that the strategy was infringing on natives' rights and thus was posing a risk to the political stability of the colony [1,2]. A. E. Kitching, a District Officer and later Provincial Commissioner, was one of the most outspoken personalities on this issue. He criticized Hingston's recommendation by arguing:

"Hingston's recommendation (of creating national parks)...pays no regard to native interests. They involve the alienation in perpetuity of thousands of square miles of the land of the Territory...to create the finest Nature Park in the Empire. The recommendations appear to me to be so wrong in principle as to make any detailed examination unnecessary" [1].

Despite strong opposition from the colonies, Hingston's recommendation was reinforced by the 1933 London Convention on Flora and Fauna of Africa. The convention required all signatories (including Tanganyika) to investigate the possibility of creating a system of national parks. Powerful individuals in London consistently overstated the problem of what they termed "destructive behavior of Africans to wildlife" as a way of pressing the colonial government to act [2]. In 1940 the first game ordinance that gave the governor a mandate to declare any area a national park was enacted. Serengeti was upgraded from a game reserve to a national park in that year. However, it remained a "park on paper" (i.e., without effective enforcement of the laws and regulations governing the national parks) for almost a decade, a delay which can be attributed to World War II (1939 – 1945).

The gazettelement of the Serengeti as a national park precipitated conflicts and opposition from the natives. This was a consequence of conservationists' placing more value on wild animals than on human beings. For example, one of the former park managers of Serengeti stated blatantly: "The interests of fauna and flora must come first, those of man and belongings being of secondary importance" [1]. In the eastern part of Serengeti, the Maasai resisted the proposed park boundaries through violence and sabotage/vandalism. They speared the rhinos, set fires with malicious intent, and terrorized civil servants [1]. The Ikoma hunters in western Serengeti contravened the colonial conservation laws which barred them from hunting, while swearing to use poisoned arrows against any wildlife ranger who would interfere with their hunting activities [4].

The late 1950s idea of excising Ngorongoro from Serengeti National Park, proposed as a measure to accommodate the interests of the Maasai pastoralists, made Professor Bernhard Grzimek one of the most prominent conservationists who laid the groundwork for modern nature conservation work in Serengeti. Grzimek, the former president of the Frankfurt Zoological Society for over 40 years, was invited by the Board of Trustees of Tanganyika National Parks to carry out an aerial count of the plain animals in the Serengeti and plot their main migration routes. Findings of this work were considered essential in advising the government on the proposed park boundaries following the hot debate over the idea of excising the park. Raymond Bonner, an author of the book *At the Hand of Man*, describes Grzimek as a man who “has done more than anyone else to dramatize the plight of African wildlife” [5].

In 1959, Grzimek and his son co-authored a book, *Serengeti Shall Not Die*, in which the importance of wildlife preservation in Serengeti was underscored [6]. The book stressed conservation of the Serengeti and its wildlife at all costs – even if that would compromise the interests of local people. The title of the book is the clarion call to keep the Serengeti pristine against human-induced threats. Almost five decades have elapsed since the book was authored. However, given the growing management challenges and threats facing the Serengeti, the relevancy of this title has increased. The main challenges/threats facing the Serengeti include poaching of wildlife, habitat destruction, human-wildlife conflicts, population growth, poverty, and unsustainable development projects. These threats have prompted some scholars, including Professor Grzimek himself, to challenge the validity of the ambition that “Serengeti shall not die” [7, 8]. This paper highlights these challenges and proposes some strategies that can be employed to transform this ambition into a reality.

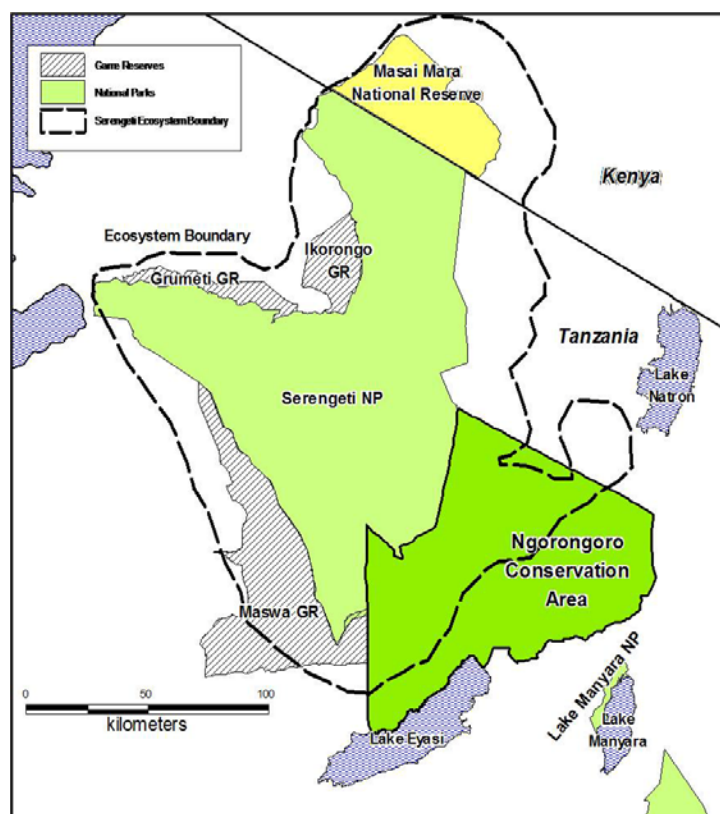


Fig. 1 Serengeti National Park and surrounded protected areas

Serengeti ecosystem: Location, ethnography, livelihoods, ecological value, and protected areas

Location, ethnography, and major livelihoods strategies

The Serengeti ecosystem, which covers about 25,000 km², is located in the northern part of Tanzania (Fig. 1). It lies in the west of the Rift Valley, in a highland savanna region with plains and woodlands ranging from 900 to 1,500 meters above sea level. Its western part extends close to Lake Victoria. Its northern boundary follows the border between Tanzania and Kenya. It lies within the administrative regions of Mara, Mwanza, Shinyanga, and Arusha. The location of this park makes it the cornerstone of the Serengeti ecosystem. It is surrounded by several protected areas: the Ngorongoro Conservation Area, four Game Reserves (Maswa, Ikorongo, Grumeti, and Kijereshi), Loliondo Game Controlled Area (all in Tanzania), and Maasai Mara National Reserve in Kenya (Figure 1).

Serengeti is a multi-ethnic area, composed of over 30 tribes, each claiming its own unique identity and history. Examples of these tribes are: Ikoma, Nata, Kurya, Ishenyi, Sukuma, Ngoreme, Kisii, Jita, Ikizu and Zanaki (living in the western part) and Maasai in the eastern part. While the Maasai in the eastern part are pure pastoralists, the tribes in the western Serengeti are typically agropastoralists (i.e., relying on livestock-keeping and crop cultivation for 80% of their livelihoods). All tribes keep cattle, goats, pigs, donkeys, and poultry. The main food crops grown include maize, cassava, millet, and sorghum, while cotton is grown for cash. Off-farm activities such as hunting, charcoal-making, local brewing, and formal employment contribute the remaining 20% [9, 10].

Ecological value

Serengeti is one of the flagship conservation areas of the world due to its high diversity and abundance of wildlife species. The annual migration involving some 1.4 million wildebeest (*Connochaetes taurinus*), 0.2 million zebra (*Equus burchelli*), and 0.7 million Thompson's gazelle (*Gazella thompsoni*) between the Serengeti and Kenya's Maasai Mara National Reserve [11] is a unique biological phenomena recognized worldwide. In addition to migratory species, Serengeti is also home to resident herbivores such as warthog (*Phacochoerus aethiopicus*), eland (*Tragelaphus oryx*), impala (*Aepyceros melampus*), giraffe (*Giraffa camelopardalis*), topi (*Damaliscus korrigum*), hartebeest (*Alcelaphus buselaphus*), waterbuck (*Kobus ellipsiprymnus*), and Grant's gazelle (*Gazella grantii*) [11]. Elephants (*Loxodonta africana*) and hippo (*Hippopotamus amphibius*) are both charismatic and keystone species in this ecosystem.

Along with herbivores, the Serengeti supports one of the highest populations of carnivores in the African savanna. The major carnivores include lion (*Panthera leo*), leopard (*Panthera pardus*), spotted hyena (*Crocuta crocuta*), cheetah (*Acinonyx jubatus*), black-backed jackal (*Canis mesomelas*), and three species of Mongoose – banded (*Mungos mungo*), dwarf mongoose (*Helogale parvula*), and slender mongoose (*Herpestes sanguineus*) [11 - 15].

Serengeti is also rich in avifauna, estimated at 500 species. Of these, some are of restricted range. Examples are rufous-tailed weaver (*Histurgops ruficauda*) (monotypic genus), Usambiro barbet (*Trachyphonus usambiro*), gray-crested helmet shrike (*Prionops poliophus*), gray-breasted francolin (*Francolinus rufopictus*), Fischer's lovebird (*Agapornis fischeri*), and Karamoja apalis (*Apalis karamojae*) [16].



Fig.2. Four of the charismatic wildlife species found in the Serengeti ecosystem: From top left, elephant (*Loxodonta africana*), cheetah (*Acynonix jubatus*), zebra (*Equus burchelli*), and lion (*Panthera leo*). Photos of elephants, zebras and lion by V.G. Ndibalema. Photo of Cheetah by Rhett Butler.

Challenges facing the Serengeti ecosystem

Like several other tropical ecosystems, Serengeti is facing unprecedented pressures threatening its ecological integrity. Illegal hunting of wild animals and unsustainable activities leading to habitat destruction are major challenges confronting the ecosystem (Fig. 3). The underlying factors behind these challenges are rapid human population growth, poverty, and failure of conservation authorities to offer compensation for losses that local people suffer as a result of conservation. Another challenge is the emerging of large-scale development projects with potential negative impacts on wildlife species and habitats. These challenges and underlying factors are discussed below.

Illegal hunting

Illegal hunting is one of the important off-farm activities for rural communities living around the Serengeti ecosystem. The activity, more prominent in the western part of the ecosystem, has long been a major management challenge for conservation authorities. Both economic and cultural reasons motivate this activity. According to Holmern *et al.* [17] people of the Ikoma tribe contribute the highest number of poachers (accounting for about 40% of all poachers). Illegal hunting has historically served as a major coping and adaptive strategy against poverty and the increased demand for resources caused by rapid human population growth. The activity is essentially done for household consumption and commercial purposes. Holmern *et al.* [18] estimated that about 61% of illegal hunters hunt for their own

consumption, 8.5% for cash, and 31% for both purposes. The activity earns the hunters an annual income of US\$ 200, a value close to or equivalent to average on-farm income.

Illegal trophy hunting emerged during the 1970s and 1980s but was terminated in the beginning of 1990s following a nationwide operation – popularized as *Operation Uhai* (*uhai* is the Swahili word for life). The operation involved the wildlife staff, army, and police forces. The emergence of illegal hunting for trophies was mainly attributed to government failure in funding the law enforcement operations due to the economic recession that affected many African countries. The natural resources sector was one of the least funded. For example, between 1976 and 1981 the entire sector (i.e., wildlife, land, forestry, and fisheries) received only 1.2% from the national development budget [19]. The individual protected areas thus were being allocated very minimal funds. In 1987, for example, the annual budget allocated for the Selous Game Reserve was only US\$3/km² [20] while the amount required for effective control of commercial poaching per annum ranged from US\$200 to \$400/km² [3, 21].

Although it lasted for a relatively short period (almost a decade), trophy hunting had an immense detrimental impact on the Serengeti, affecting its charismatic and keystone species. The black rhinoceros (*Diceros bicornis*) was driven to the verge of extinction while the elephant (*Loxodonta africana*) population plummeted to 20% [22]. A similar trend was also observed for buffalo (*Syncerus caffer*) whose population dropped from 63,144 in 1970 to 15,144 in 1998 [23].

The problem of trophy hunting is now virtually eliminated in the Serengeti. However, hunting for meat has remained a major challenge. The 1991 aerial survey showed that 75,000 resident and 135,000 migratory herbivores were being hunted illegally per annum within the 45 km wildlife demand zone west of the protected areas [9]. Of these, two-thirds of the number of hunted individuals came from a single species, wildebeest. Heavy hunting pressure also affected the following seven herbivores (% annual reduction off-takes in parentheses): waterbuck (94.3%), eland (30.9%), giraffe (29.6%), impala (28.7%), warthog (24.4%), topi (20.5%), and buffalo (19.5%). Although populations for these species are still viable, poaching along with other pressures such as habitat destruction and diseases may considerably change this scenario and make these species vulnerable to extirpation. For example, some scientific predictions have already rung the warning bells for the wildebeest. Mduma *et al.* [24] indicated that a harvest of 80,000 wildebeest per year is unsustainable and may cause a collapse of total population by the year 2018. Given the current annual off-take of about 119,000 individuals per year [9], along with increasing loss of habitats, it is apparent that this species is facing a gloomy future if Mduma *et al.*'s predictions are correct.

Destruction of wildlife habitats

The ecological integrity and long-term survival of any ecosystem depends greatly on the quality of wildlife habitats. In the Serengeti ecosystem, human population growth and poverty are the underlying factors leading to loss of wildlife habitats. Population growth increases demand for land (required for cultivation, livestock grazing, and settlements), wood fuel, building poles, and medicinal plants). On the other hand, poverty affects habitat quality by limiting people's access to modern agricultural technologies and inputs, thus leaving expansion to new lands (including critical wildlife habitats) the most feasible strategy of increasing agricultural outputs. Furthermore, extensive use of fuel wood at the expense of wildlife habitats is common among the poor, since the use of alternative sources of energy, such as electricity, which are environmentally friendly is economically unfeasible [25].

Human activities – notably agriculture (Fig. 3), unplanned fires, settlements, overgrazing, and mining – have degraded the habitats within and outside the boundaries of the protected areas [7, 26]. In 1910, some 30,000 km² of the Serengeti ecosystem were intact with natural vegetation. Assessment in the

1990s showed that human impacts, which had become more prominent since the 1960s, had reduced this area to about 18,000 km² [26]. Despite the protection status and research activities directed to Serengeti National Park, the loss was accelerating within its legal boundaries [26]. No assessment has been conducted to quantify the amount of habitat that has been lost in the past 15 years. However, since the major drivers behind habitat loss are poverty and human population growth, and these factors are increasing, we can argue with conviction that further destruction and loss has occurred within this period. Ecological impacts of habitat destruction in Serengeti are well documented (Box 1).

Box 1. Some examples of ecological impacts of habitat destruction in the western Serengeti

- Reduced population of the browsers in the northern part of Serengeti due to conversion of once wooded vegetation to open grasslands [26].
- Extirpation of roan antelope (*Hippotragus equines*) in many areas of the ecosystem due to loss of its *Combretum*-dominated habitats [11, 27].
- A 50% loss of bird species outside of the Serengeti due to reduced insect diversity following human disturbance of their systems [28].
- Disappearance of the previously healthy populations of trogons and large-casqued hornbills from the riverine forests following the loss of tree cover [29].
- Reduction of the wildebeest population by 75% in Maasai Mara (Kenyan part of the Serengeti ecosystem) following destruction of the core breeding and calving grounds caused by mechanized agriculture from 1977 to 1997 [30].
- The risk of reducing the wildebeest population below a minimal viable population size due to destruction of the Mara River, if the three proposed projects are approved. These projects are degazettement of the Mau forest, development of an irrigation scheme for mechanized farming, and the development of Amala Weir Hydropower projects [31].
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Demographic factors

Over the last four decades, areas adjoining Serengeti National Park have experienced a huge population growth. The highest rate of increase (i.e., 10% per annum) was observed in a period of 10 years between 1957 and 1967. Natural increase contributed 3.4% of the increase and the rest was caused by immigration [7]. The current human population in the seven districts west of the park is over two million with the annual growth rate surpassing the national average of 2.9% [32]. Good agricultural land, wildlife (as a source of protein), water bodies (rivers and Lake Victoria for fishing), and gold deposits have featured as the major factors pulling immigrants from within Tanzania and even from neighboring countries [7, 33].

Several studies have demonstrated the role of human demography in dictating the magnitudes of ecological pressures in the Serengeti ecosystem [7, 9, 10, 33, 34]. On the basis of 1978 and 1988 national census data, Campbell and Hofer [9] estimated the number of illegal hunters within 45 km of the Park boundary and associated protected areas to be 23,294 and 31,655, respectively. The annual rate of increase was 3.11%. More recent estimates of illegal hunters ranges between 52,000 and 60,000 [10, 30], an increase of 90% between 1988 and 1998.

In Maswa Game Reserve, the western part of the Serengeti ecosystem, the problems of high human population in close proximity to protected areas have been exposed. Pressures from the local

communities have forced the government to realign the boundaries of the reserve three times, leading to reduction of the original area by 15% [8]. Expansion of arable land and settlements in the Serengeti has led to shrinkage of the grazing land for livestock, which is increasing with the growing human population. Statistics obtained from the Serengeti District, indicated a 52% increase of livestock units from 175,680.5 in 1990 to 266,624.5 in 2002. This raised land requirements for livestock, which increased from 2108.1 to 3199.5 km² and lowered carrying capacity, which had already been exceeded a decade before [35].

The livestock confined within the small areas causes overgrazing, soil erosion, and siltation of water bodies (Kideghesho, pers. observation, 2005). Inadequate (see Table 1) and poor-quality pastures in these lands prompted serious demands from the livestock owners to the government of Tanzania seeking degazettement of the protected areas or authorize legal-access to critical grazing lands and watering points in Grumeti, Ikorongo, and Kijereshi Game Reserves [7]. Villagers in these areas, however, are continuing to use the resources inside the protected areas illegally 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 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: [7]. *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

Poverty

The majority of the people around Serengeti National Park and adjacent protected areas are poverty-stricken, a situation which is widespread in rural Tanzania. The performance of the agriculture and livestock sectors, on which they rely, is not impressive due to land scarcity, drought, diseases and pests, poor soil fertility, and lack of agricultural inputs [36 - 38]. The gross annual income from these sectors has remained extremely low. For instance, in 2002 an average household income for the Bunda and Serengeti districts was estimated at US\$ 150 per annum [38]. This puts an average expenditure per individual below US\$1 per day. The mean number of persons per household in both districts was six [32].

Correlation between poverty and ecological problems in the Serengeti is widely cited in the peer-reviewed literature. For instance, limited means of sustenance among the local people has made poaching of wildlife species and encroachment on their habitats (including foraging grounds, breeding sites, migratory corridors, and dispersal areas) important coping strategies [7, 10, 30, 38]. Poaching is primarily motivated by the need for food and for improving the household budget along with paying government levies and other contributions [7, 10, 38]. Research has indicated that over three-quarters of illegal hunters in Serengeti have limited sources of income and virtually no livestock [10, 30]. Modern technology and agricultural inputs are economically unaffordable to local people. Because of this, crop outputs are increased through opening of new lands for agriculture in critical and sensitive wildlife areas.

Deforestation is also driven by the reality that alternative sources of energy, other than wood fuel, are exorbitantly expensive and lacking in most of the areas of Serengeti [25].

Human-wildlife conflicts

Human-wildlife conflicts in the Serengeti are a historical phenomenon. There is a common agreement that most of these conflicts emerge as a result of wild animals being accorded a higher priority than human beings. For example, one of the former Serengeti park managers was once quoted as saying openly: "The interests of fauna and flora must come first, those of man and belongings being of secondary importance" [1]. The late Professor Benhard Grzimek made it clear that he was ready to forge a friendship with Adolf Hitler and Joseph Stalin, if that could serve his wildlife [5]. Hitler and Stalin are regarded as the worst dictators in the history of the world. This mind-set among conservationists, in which wild animals were more valued than people, fomented the conflicts between conservation agencies and local communities.

The higher priority accorded to wild animals has often inflicted costs on humans. Conservation efforts, including establishment of wildlife protected areas, have therefore been blamed for causing poverty among the local people through land alienation, crop damage, livestock depredation, and diseases transmission to livestock [37, 39, 40]. This, to a large extent, has contributed to a negative attitude and, therefore, minimal support to conservation efforts [41]. Emerton and Mfunda [37] estimated an annual loss from wildlife crop damage in Western Serengeti at US\$ 155 per household. For livestock depredation, Holmern *et al.* [40] reported about a 70% loss of local income per household. Over 80% of villagers interviewed in Western Serengeti (n = 280) cited diseases transmission from wildlife to livestock as one of the key problems constraining livestock production in the area. The most often transmitted diseases cited were rabies, anthrax, tuberculosis, malignant catarrhal fever, and East Coast fever (Kideghesho, unpublished data, 2004). The great migration of wildebeest from Serengeti to Maasai-Mara in Kenya was said to worsen the situation.

Inadequate concern over local people's livelihoods, such as unfair compensation for damage caused by wild animals, reduces the willingness to support conservation efforts. Deprived people can, therefore, barely refrain from economic activities which are illegal and ecologically damaging, since these activities remain an important strategy for survival. Sometimes these activities are pursued as a revenge and self-compensation for losses caused by wildlife.

Failure to address the costs induced by wildlife

The benefit-based approaches, which were adopted in the Serengeti in 1990s as a strategy of promoting a positive conservation attitude and therefore motivating people to support conservation efforts [42] have failed to meet expectations. This is mainly because the benefits granted to local communities have been too minimal to offset the costs caused by prohibitive conservation policies (opportunity costs of conservation) and damage inflicted by wildlife on property such as crops and livestock. The cost-benefit analyses conducted in the Serengeti have shown that the ratio of wildlife-induced costs to benefits received by local communities was 250:1 [37, 39]. Furthermore, these benefits have often been realized indirectly through community development projects although the costs are localized to individuals.

The opportunity cost of forgoing the economic activities which are ecologically damaging is often very high, thus making these activities inevitable. For example, illegal hunting in the Serengeti has been flourishing, despite stringent law enforcement, because its returns were 45 times greater compared to those provided legally through the Serengeti Regional Conservation Projects community cropping scheme [18]. Destruction of the breeding and calving grounds for wildebeest in the Maasai Mara

(Kenyan part of the Serengeti ecosystem) between 1977 and 1997 and, consequently, reduction of the wildebeest population by 75%, was mainly caused by the high opportunity cost that landowners would incur by opting for wildlife conservation instead of pursuing mechanized agriculture. The latter was ecologically destructive but economically more attractive to farmers. Its profit was 15 times greater [43]. Furthermore, by virtue of being too minimal, conservation benefits do not contribute adequately to poverty reduction. People's direct dependence on natural resources has therefore remained inevitable.



Fig 3: Human Factors in Serengeti: From Left: Effects of illegal hunting - wire snare around the neck of an elephant (Photo: B. Kaltenborn) and Wildlife habitats destroyed for agricultural expansion (Photo: J.R. Kideghesho),

The anticipated threats

In the recent years the Government of Tanzania has allowed and has intended to implement large-scale projects aiming at promoting its social and economic development. However, there is high potential for these projects to detrimentally impact conservation and therefore lower the ecological value of Serengeti. One such projects is the proposed road that would link Arusha with Musoma, cutting directly through a narrow section of the northern Serengeti, which is a critical corridor for the annual migration of wildebeests, Thompson gazelle, and zebra. This road would endanger this migration – a global biological phenomenon that outstandingly reinforces Serengeti's value. In addition to blockage of the migration, other potential negative impacts include loss of habitats, introduction of invasive species, and increasing illegal hunting due to improved accessibility. Improved accessibility will also increase the human population in the area and thus increase demand for resources such as land, fuel wood, and bush meat. Another likely impact of the road would be the killing of the resident and migratory wild animals crossing the road.

Other controversial projects with potential risk to ecological integrity of the Serengeti include unsustainable growth of tourism and associated developments. Construction of five-star hotels inside the park and the airport in the western Serengeti by a U.S.-based game hunting firm, Grumeti Reserves Ltd., is one such project. Ostensibly, these projects are aimed at attracting more tourists to the park.

However, by being so close to or within the park and migratory corridor, they will affect wildlife through habitat loss, noise, odor, and pollution. Other projects with similar impacts include construction of a soda ash plant in the Loliondo area, the establishing of wheat plantations in Lobo, Kenya's Mau forest degazettement, irrigation of large-scale farms, and the development of the Amala Weir Hydropower project in the Mara River. Gereta *et al.* [31] associate the latter project with undesirable effects on the utility of the area. Mara River is "a dry season refuge" for a million wildebeest and zebra. Using the ecohydrology model, the study showed that severe drought resulting from the reduction of water quantity in the Mara River would reduce the wildebeest population to 20% – a proportion that can barely allow population recovery. According to the model, population recovery might take 20 years if the die-off is 50%.

The projects cited above will not only destroy the critical habitats and other sensitive areas for wildlife, but will also act as major population pull-factors to the area, thus increasing pressure on the available resources. The employment opportunities created by these investments, the improved accessibility, and social amenities will attract more people and, consequently, increase demand for resources and land.

"Serengeti shall not die": Transforming an ambition into a reality

The ambition that "Serengeti shall not die" could inspire the necessary interventions to ensure apt conservation of Serengeti and its values. However, numerous challenges are contradicting this ambition, thus making it unsound. Therefore, these challenges should be addressed if this ambition is to be transformed into reality. This section recommends the strategies that can be pursued to this end.

Promoting factors inducing positive attitudes toward wildlife conservation

An attitude-based survey in Serengeti [41] identified four factors that influence conservation attitudes among the local people in Serengeti: (1) people experiencing more wildlife-induced costs are less likely to support conservation; (2) people with access to conservation-related benefits are more supportive of conservation; (3) a higher level of education influences a person's attitude. and (4) those employed in different sectors other than agriculture are more positive and therefore more supportive to conservation. In developing strategies for promoting the positive conservation attitude these factors should be considered as important entry points. The following measures can be espoused to this end:

- Balancing the costs of wildlife conservation with benefits by ensuring that the benefits are adequate enough to offset the conservation-induced costs and contribute notably to poverty reduction;
- Enhancing conservation education to provide people with basic knowledge and clear understanding of the long-term consequences of their actions on species and habitats and the legal and policy aspects pertaining to wildlife conservation;
- Enhancing regular contacts with communities in order to avoid conflicts (between the conservation authorities and local communities) that may result due to poorly communicated development and conservation policies. Experience has shown that increased personal contact carried out in good faith is a critical factor to the development of understanding and trust between wildlife staff and local residents [44].

Adopt livelihoods and production strategies that are ecologically friendly

Many environmental studies in the Serengeti have demonstrated that where poverty is widespread, conservation can seldom excel (7, 10, 45). It is unlikely for people to accept a scenario where biodiversity conservation implies starvation. This is the case even if the level of conservation awareness

is high. This reality prompts a need to secure alternative livelihood and production strategies that are ecologically less damaging. One way of doing this is to overcome the problem of land scarcity – the problem felt to be behind encroachment into wildlife habitats and poaching. This can involve putting land that is already under cultivation to a more efficient use. The government and conservation agencies can intervene by supporting local people in improving agricultural production through provision of extension services, agricultural inputs, and other technologies (at subsidized rates), soft loans, and access to markets. With proper and adequate support, food security can be guaranteed, and therefore pressure on species and habitats can be reduced. Furthermore, alternative livelihood strategies such as small business enterprises, ecotourism, poultry production, and beekeeping can be secured to complement the existing conservation-friendly livelihood strategies.

On addressing the issue of the fuel energy crisis, the solution hinges not only on the communities but largely on the government and its agencies. The alternative sources of energy other than wood fuel (e.g., gas, solar, and electricity) are exorbitantly expensive and the solution is far from the reach of the majority of the people. It is, therefore, imperative that the government support people to secure these environmentally friendly sources. This may include subsidizing the costs involved in accessing these sources. At the local level agroforestry/aforestation programs should be encouraged in the village lands to enable the villagers have their own woodlots. Energy-saving stoves can also be introduced in the villages.

Make human population growth an agenda of priority

Population growth, despite being the major underlying cause of pressures on conservation areas, has barely been accorded adequate attention in the conservation policies. This factor is often neglected, thus making dealing with conservation problems similar to treating the symptoms rather than the real cause of the disease. Furthermore, due to the pressures it exerts on wildlife species and habitats, population increase may also dilute the effectiveness of other conservation strategies. 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 the challenge of population growth may include:

- Developing and implementing the active policies aiming at reducing immigration from other areas by limiting the population-pull factors;
- Adopting family-planning measures (to minimize the problem of natural increase). These measures, among others, include promoting education for girls, funding clinics or traveling nurses/outreach workers to educate people about nutrition and child care, providing adequate materials and staff for family planning, and reducing regulatory obstacles for non-profit organizations that provide resources for such measures;
- Formulating special policies to depopulate the area (e.g., by obligating all administrative regions in Tanzania to absorb and employ the youth from the Serengeti area);
- Increasing awareness of the need to stabilize population and resource consumption.

Ensure adequate conservation status to critical wildlife areas

Over 80% of the Serengeti ecosystem enjoys legal protection as a national park, game reserves and Ngorongoro Conservation Area. However, some other critical areas are either not or inadequately protected. Nyatwali is example of such areas, among others. The area is a migratory corridor utilized by wildlife populations as they leave Serengeti National Park for water in Lake Victoria. However, as human

settlements and economic activities are growing within this corridor, its ecological value is being reduced. Fishing and hunting opportunities (offered by the lake and park, respectively), and proximity and good accessibility to big cities and towns such as Bunda, Magu, Mwanza, and Musoma are key population-pull factors that have made the area highly populated.

Creation of new wildlife protected areas, annexing critical areas to the already existing protected areas, and/or upgrading the existing protected areas to higher categories could be among the important measures. To make these measures effective, however, observance of human interests is imperative. Experience has shown that such measures often engender conflict by interfering with local livelihoods [1, 2, 17, 37, 44, 45]. A recent plan to establish Wildlife Management Areas (WMAs) in the buffer zones surrounding Serengeti National Park is a good stride. Numerous advantages can be envisaged from WMA initiative (e.g., Box 2). However, the measure may exacerbate economic and social costs to local communities. More effective and larger conservation areas, increased wildlife populations, and their proximity to human assets would mean increased crop damage, livestock depredation, and reduced human safety. The suitable policies to minimize the likely costs should, therefore, be formulated along with this strategy. For example, the government and its conservation agencies can adopt the problem-animal control program and develop effective mechanisms to compensate the victims for wildlife-induced damages.

Box 2. Anticipated economic benefits from the WMA initiative

- i) Increased village revenues through hunting by tourists
- ii) Increased household income from nature-based and cultural tourism
- iii) Access to protein and household income through fishing and resident hunting
- iv) Improved beekeeping activity and, therefore, increased household income through selling the bee products
- v) Increased employment opportunities as a result of increased investment opportunities
- vi) Increased authority and efficiency in dealing with problem animals locally
- vii) Guaranteed sustainable utilization of natural resources as a result of improved management regimes.
- viii) The possibility of the participating villages benefitting from the REDD initiative – a special global fund aimed at compensating people's conservation efforts that contribute significantly to Reducing Emissions
- ix) from forest Degradation and Deforestation

Adopted from: Kideghesho et al. [46].

Discourage policies, land uses, and projects likely to cause adverse impacts on wildlife species and habitats

In safeguarding the ecological integrity of Serengeti, Tanzania can capitalize on lessons from other parts of the country or ecosystem and abandon all projects or policies that have proved undesirable. For example, the land-tenure system around the Kenyan part of the Serengeti ecosystem, which allowed unrestricted use of private lands (e.g., mechanization) and associated detrimental impact on wildebeest population [30], is an important lesson against implementing similar policies in other parts of the

ecosystem. The current state/communal land tenure and policies restricting commercial and mechanized agriculture on the Tanzanian side should be maintained. Furthermore, both countries sharing the ecosystem should develop and implement practical ways to harmonize the development policies around the ecosystem. Similarly, several years of bitter Tanzanian experience with road kills in Mikumi National Park in the Southern circuit suffices to ring a warning bell that the Serengeti road project is ecologically undesirable. The rehabilitation of the Tanzania-Zambia highway, which crosses Mikumi National Park over a stretch of 50km, in the 1990s increased the problem of road kill, making it the most serious management issue facing the park. If one of the feasible and long-term solutions proposed for avoiding the problem of road kill in Mikumi is to construct an alternative road (which would pass outside the park), it would be contradictory for the government to approve the road project passing through Serengeti.

More importantly, all projects should be subjected to a thorough Environmental Impact Assessment (EIA) before implementation, and those with detrimental impacts on wildlife species and habitats should be rejected outright. This measure is of particular importance in recent times as trade liberalization and investment policies are gaining prominence.

Conduct applied research and ensure effective utilization of the findings to guide management interventions

Serengeti is one of the most extensively researched areas in the world. Unfortunately, the research findings have seldom been used to guide management decisions and solve the problems facing the ecosystem. Most of the findings have instead been used to meet academic ambitions through publications in international journals. An official from the Tanzania Wildlife Research Institute (TAWIRI) put it correctly by observing that, despite the enormous research publications with useful recommendations for improving the management of the protected areas, the willingness to access this information by the conservation authorities is often lacking. This deficiency necessitates the conservation authorities to work closely with researchers so that the findings from a variety of studies are used for sound decision-making and policy implementation, along with the provision of practical solutions to different problems facing the ecosystem.

Furthermore, in order to provide rational solutions to challenges facing Serengeti, it is important that the setting of research priorities be guided by the existing challenges, i.e., problem-oriented research. For example, the current focus should include the following topics, among others:

- Establishing the reasons that make local people exhibit particular unsustainable behaviors toward wildlife;
- Identifying alternative livelihood strategies with minimal impact on wildlife species and habitats;
- Evaluating the potential and limitations of different management interventions;
- Quantifying impacts of environmental change and human use on wildlife species and habitats;
- Analyzing the contribution of traditional practices and indigenous knowledge in management of wildlife species and their habitats.

Ensure adequate and active participation of local communities in natural resources management

For decades, conservation has been pursued against the wishes of local people and therefore has caused hostility, loss of trust, and local resentment towards conservation. Recently, some efforts to involve local people have been pursued. However, these efforts are inadequate and passive. Essentially, genuine

participation is lacking because the involvement of local people in designing, planning, decision-making, implementation, benefit-sharing, monitoring, and evaluation of the programs targeting them is minimal. Local people are, therefore, still skeptical about these programs. This situation should prompt the government, its agencies, and donors to prove to people that, unlike in the past, their current intentions are credible and trustworthy. Sensitization is required to change people's mindset and instill in them the feeling that they are important partners rather than potential enemies of conservation. Another important area requiring inputs from 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.

On benefit-sharing, new modalities are required to ensure equitable distribution, sustainability, and adequate benefits that can offset the conservation-induced costs and outweigh the returns generated by ecologically destructive land uses. Although the issue of compensation is hotly debated, with its feasibility being challenged by conservation agencies, there is a need to reconsider it and adopt it as one of the regulatory factors against land uses and behaviors undermining conservation goals. Fair compensation should be given for the direct costs caused by wildlife and lost opportunities from alternative uses of the land. One way of realizing effective participation is by adopting co-management approaches, a popular paradigm in natural resources management in Africa. The approach allows for the sharing of power, responsibilities, rights, and duties between the government and local resource users [47, 48]. Co-management approaches have immense potential in unraveling the conservation challenges facing the Serengeti. They can complement law enforcement strategy, which despite huge investments has not ended the problems of poor relationships with local communities, poaching, and destruction of habitats. The co-management approaches are premised on the reality that local communities have a long history of association with resources and a high degree of dependence on them, and are assumed to have acquired the ability to manage resources sustainably [49].

Promote the traditional practices and systems that enhance sustainable use and conservation of wildlife resources

The lives of many rural African societies are often regulated by informal traditional institutions. These institutions command high loyalty among the communities due to strongly held beliefs that failure to respect them can cause misfortunes. Unfortunately, the conventional conservation policies regarded these institutions as inferior and incompetent for managing wildlife resources. However, recently these institutions have gained recognition in literature as an important complement to existing conservation institutions [50 - 56]. Their importance is derived from the reality that "culture conditions individuals' perceptions of the world, influences what they consider important, and suggests courses of action that are appropriate and inappropriate" [57]. Cultural factors, for example, can influence and regulate people's behaviors toward the consumption patterns of species and their habitats and, therefore, act as an important driver of environmental change.

Although they are not as robust as in the previous decades, the need to revive and strengthen the traditional cultural practices by according them full policy recognition and necessary support is imperative. A recent study in the Serengeti has uncovered four potential roles that the traditional cultural practices can play in enhancing sustainable use and conservation of wildlife resources. These roles include: mitigating the over-exploitation of resources and habitat loss; minimizing the costs incurred for law enforcement; complementing modern scientific knowledge with a view to providing communities with political incentive (empowerment) for strengthening conservation approaches; and enabling the indigenous resource users to critically evaluate the scientific predictions on their own terms and test sustainability using their own forms of adaptive management [55].

Implement sustainable tourism policies

Tourism is increasingly being acknowledged as a potential gateway towards poverty alleviation and economic prosperity in many developing countries. In Tanzania, Serengeti is eyed as one of the flagship destinations for realizing this potential. However, as observed earlier, increased demand for infrastructure, transportation networks, and hotels/lodges, threatens the quality and integrity of the area through destruction of the scenic amenities, changes in animal behavior, blockage of migratory routes and critical habitats, depletion of natural resources, and increased health risks to wild animals. In order to mitigate these tourism-related impacts, a form of tourism that is sustainable should be adopted. Sustainable tourism implies a form of tourism that observes a balance between the needs of the visitor, the destination (i.e., resource base), the host community, and other tourism stakeholders (i.e., the industry). In other words, this form of tourism enhances the management of all resources in a way that optimizes the economic, social, and aesthetic needs while maintaining cultural integrity, biodiversity, essential ecological processes, and life-support systems. Sustainable tourism, therefore, seeks to meet the needs of tourists and host regions while protecting and enhancing opportunities for the future. The following strategies can be implemented to ensure the sustainability of the tourism industry in Serengeti:

- Subjecting all tourism development projects to rigorous Environmental Impact Assessments (EIAs). The developments likely to pose detrimental impacts to the environment and resources should be rejected regardless of their promising economic potential;
- Employing effective visitor management strategies such as soft and hard measures to mitigate the adverse impacts that are likely to emanate from tourism activities. The soft measures may involve improving marketing, interpretation, planning, and visitor coordination. Hard measures may include placing extensive and permanent restrictions on visitor activities such as limiting the number of visitors and imposing heavy fines on anybody contravening the regulations of the protected areas by feeding the wild animals, off-road driving, and speeding.

Increase support for conservation of the Serengeti

The Serengeti is a World Heritage Site and is regarded as a global asset. Therefore, the global community has a role to play in sustaining the goal that *Serengeti shall not die*. The question of who benefits and who compensates for conservation of Serengeti is very relevant in this regard. The global community can intervene by:

- Supporting the local communities through income-generating projects (IGPs) and providing alternative livelihood options that will inspire people to refrain from ecologically destructive activities;
- Supporting research programs that will provide practical solutions to problems facing the ecosystem;
- Supporting training programs that will improve the management of the ecosystem;
- Supporting the infrastructure;
- Funding family planning and HIV/AIDS control programs.

The need for support to wildlife protected areas (including Serengeti) from the global community is recognized and underscored in the book *Serengeti Shall Not Die* where the following conclusion is given:

"The National Parks of Tanzania are a common heritage, not only of the people of Tanzania but of mankind as a whole...Therefore I venture to ask those who are concerned as I am to preserve these last wonders of free nature in Africa, to come to the help of the wonderful work now being done in the National Parks of Tanzania..." [6].

Implications for conservation

The slogan "Serengeti shall not die" has for five decades featured both as a means and an end for the survival of Serengeti. It has inspired conservation commitment and served as a legendary marketing catch-phrase for Serengeti's terrific tourism attractions. However, the ecosystem has remained endangered with numerous challenges. Illegal hunting and habitat destruction emanating from the rapid human population increase, poverty and unfair compensation of local communities for losses associated with wildlife conservation, and unsustainable development policies are compromising the ambition for a healthy ecosystem. This scenario suggests that the current conservation efforts are inadequate in sustaining the ambition. Realistic efforts and strategies for transforming this ambition into reality can be derived from the challenges facing the ecosystem. Therefore, meticulous understanding of these challenges is imperative. The multiple strategies proposed in this paper, if adopted and executed on time (along with the current strategies such as law enforcement and anti-poaching), can contribute immensely to realizing this ambition. The reality that the threats undermining Serengeti are continuing to grow and that they cannot wait for our interventions inspires the need for promptness in serving this global and unique asset.

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