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Diversity

Roads as a Threat to the Serengeti Ecosystem

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Introduction

In an opinion letter to *Nature* (September 2010), Dobson et al. (2010) oppose the planned road through northern Tanzania that crosses Serengeti National Park (SNP) (Fig. 1). They contend that the road will jeopardize the Serengeti ecosystem by interrupting the wildebeest (*Connochaetes taurinus*) migratory corridor. This opinion is supported by other scientists using mathematical models (Holdo et al. 2011). However, all arguments presented against the project have been questioned (Homewood et al. 2010). As has often been the case in the conservation of African natural resources, some scientists present views that do not account for other key components of conservation: economic growth, reduction of poverty, improvement of quality of life, and social well-being. As scientists working in Serengeti, we believe that the published reports about the Serengeti road mislead the world about its potential effects on the ecosystem.

We concur with Homewood et al. (2010) that any road has environmental and social effects. However, negative effects probably have been overstated and positive effects of the road unappreciated. The proposed road aims to improve access by local people from Mto-wa-Mbu to Loliondo (Maasai) in Arusha region and Makutano-Natta to Mugumu (multiethnic agro-pastoral communities) in Mara region, linking the northeastern and northwestern regions of Tanzania. Presently, SNP acts as a barrier to local communities in eastern and western Serengeti.

Level of Threat from Proposed Serengeti Road

Claims that a single threat—an improved road—in Serengeti will lead to the demise of this World Heritage site (Dobson et al. 2010) are incorrect. In our opinion, climate change is a more serious threat than the road. A range of threats may synergistically jeopardize the sustainability of the Serengeti ecosystem. For example, opponents of the road disregard the reality that poor roads alone may be equally detrimental to this ecosystem because they exacerbate poverty, which in turn promotes illegal harvest of natural resources. Results of previous studies indicate that limited development opportunities and lack of alternative livelihood strategies prompt local people to pursue economic options that are ecologically destructive (Kideghesho et al. 2005).

The Serengeti ecosystem has many critical issues and challenges that are the underlying causes of threats that for decades have received inadequate attention. In a workshop convened in SNP in 2011, potential threats to biological diversity in the Serengeti ecosystem were identified: human population growth, destruction of the Mau Forest catchment area of Mara River, climate change, poverty, and other infrastructure development such as roads and hotels. We discuss these threats here as they relate to the effects of the proposed Serengeti road.

Human Population Growth

Annual human population growth in western Serengeti is >3% (Estes et al. 2012), which is greater than the national

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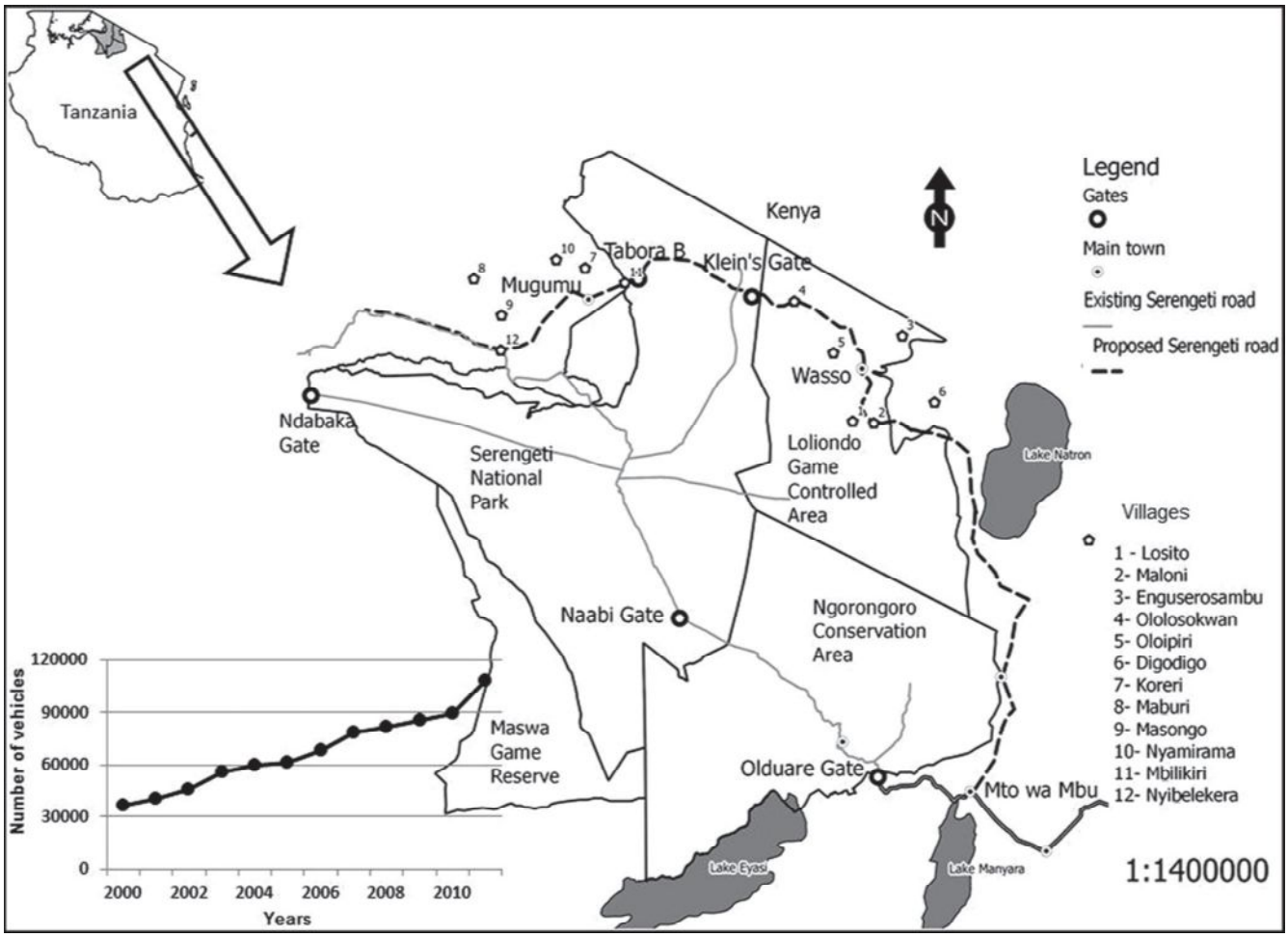


Figure 1. Map of the Serengeti ecosystem showing main roads, park entrance gates, and villages in which interviews were conducted on villagers attitudes towards the planned road. The graph shows the number of vehicles going through the Loduare gate (main gate to Serengeti) from 2000 to 2011. The relation between proportion of vehicles that are small (<2 tons) and large (>2 tons) has been relatively stable at 86.4% (SD 3.3) ($r = 0.822$, $n = 12$, $p < 0.001$). Thus, an alternative road in the north will mostly attract smaller (tourist) vehicles.

average (URT 2003). This population growth increases demand for land and natural resources (Nyahongo et al. 2009). As a result, resources are obtained unsustainably and in most cases illegally. Such extraction of resources intensifies human–wildlife conflicts. Law enforcement efforts to stop illegal harvest of natural resources (Mfunda & Røskaft 2011) have been ineffective (Loibooki et al. 2002). Even without a new road in place, the ecosystem may continue to be affected negatively unless all potential threats, including rapid population growth, are adequately addressed.

Destruction of the Mau Forest Catchment Area of Mara River

The Mau Forest catchment area of Mara River is threatened by increasing deforestation (Baldyga et al. 2008). River flow is crucial for the survival of species that migrate to the Maasai-Mara National Reserve during the dry season. If deforestation continues unabated, the Mara River will dry up in a few years (Mnaya et al. 2011), and migratory species will be exposed to harsh environmental conditions that will result in extremely high mortality (Dore 2005). Threats to the Mau Forest and Mara River could be substantially more important to the future sustainable conservation of the Serengeti ecosystem than other threats, including the road.

Climate Change

Earth is subjected to many human-induced and natural pressures, collectively referred to as global change. Climate change constitutes an additional pressure on ecosystems, the biological diversity within, and the goods and services they provide (McMichael 2001). One of the major effects of climate change in the Serengeti ecosystem may be increased variability and irregularity of rainfall (Dore 2005). The ecosystem is experiencing a drier wet season and a wetter dry season, especially in the western

Table 1. Attitudes of respondents to the question "What is your overall opinion as regards to proposed road improvement?" (i.e., the road planned between Makutano [Mara] and Mto-wa-mbu [Arusha]).*

	Districts		*Districts*		*Major ethnic groups*		*Gender*	
Response	*Overall (n = 422)*	*Ngorongoro (n = 227)*	*Serengeti (n = 195)*	*Maasai (n = 145)*	*Sonjo (n = 43)*	*Kurya (n = 129)*	*male (n = 265)*	*female (n = 157)*
Positive (%)	81.3	75.8	87.7	71.0	86.0	85.3	82.3	79.6
Positive & negative (%)	17.0	22.0	11.3	25.5	14.0	14.0	15.8	19.1
Negative (%)	1.7	2.2	1.0	3.5	0	0.7	1.9	1.3
Total (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

**Interviews were conducted in 12 villages (6 in each district) in Serengeti and Loliondo Districts. In each district, a set of 3 villages located 0, 10, and 20 km from the proposed highway (Fig. 1) were systematically selected, whereas one set of villages in each district was located in the area where the road will be tarmacked and another set in the area not to be tarmacked. In each village, 30 households were randomly selected from the list of households found in the village executive office. Within the household, heads or any adult persons of the age 18 or above who have been living in the village for 12 consecutive months were interviewed. The included sampled villages are shown in Fig. 1.*

Serengeti (Walling 2007). Thus, it can be hypothesized that migratory species will spend more time in western Serengeti than usual and will spend less time in northern Serengeti, where the proposed road traverses the SNP.

Poverty

Poverty threatens the survival of Serengeti. Lack of employment opportunities, low productivity of land, limited opportunities to own land, low levels of government support for social services, and poor infrastructure limits socio-economic opportunities and livelihood improvements and hence furthers unsustainable and illegal use of natural resources (Mfunda 2010). In a meeting with a World Bank official in Loliondo in November 2011, villagers held placards that read, "We are good conservationists; but the poverty caused by poor roads is forcing us to kill the animals in order to survive." This statement contradicts claims that the proposed road is the foremost threat to the Serengeti ecosystem.

Roads through SNP and Other Infrastructure Development

The main entrance point to SNP from Arusha is through the Ngorongoro Conservation Area (NCA). This road goes through areas where wildebeest are calving and other migratory species spend most of the year. The traffic through this area has increased annually by 10.5% (Fig. 1), but minimal attention has been paid to its effects. Calving areas deserve the highest conservation priority. It is our opinion that per unit distance, the road planned to cross the northern Serengeti (53 km), where the wildebeest spend much less time, is much less of a threat than the park's main entrance road, which has a high density of traffic throughout the year over the 220 km from Ikoma Gate in SNP to Loduare in NCA. Likewise, the soil in northern Serengeti, where the proposed road will cross, is poor in nutrients compared with short-grass plains, where the current road traverses the ecosystem (McNaughton 1990). As such, wildebeests and small antelopes seeking high-quality forage spend less time in the proposed road corridor during migration (i.e., about 3 months during September–November). We are convinced that the new road will reduce road traffic in the ecologically important area of the Ngorongoro–Naabi Gate road and thus reduce negative ecological effects on SNP.

Discussion

Over the past decade, an interest in conservation issues has grown among Tanzanian scientists and students (Kideghesho et al. 2007). It is, therefore, imperative that international scientists collaborate with local scientists to come up with more realistic and homemade solutions to conservation problems. This would establish a strategy for biological diversity conservation and allow policy makers and relevant authorities to make informed decisions that will enhance conservation of natural resources and socioeconomic development in Tanzania.

Parts of the proposed road would go through a World Heritage Site. This means that the world's people have the right to speak their minds about possible threats to the ecosystem. However, the world's people should also share the costs associated with conserving such a beautiful site in a developing country. It is unfortunate that opponents of the road put less emphasis on local communities as a key component of the Serengeti ecosystem.

The negative effects from the proposed road can be reduced through proper planning and design, coupled with appropriate studies before, during, and after the road construction. The initial impression is that local people look at the proposed Serengeti road as a new gate to development and therefore have a positive attitude toward it (Table 1). It is important to follow up road development in the north with research focused on its effects as well as the effects of other major roads in the ecosystem. Research will provide robust baseline information, so that, as the case is now, speculation is

not relied on. A multi-institutional team of scientists from Tanzania and Norway are currently studying the effects of the proposed Serengeti road on conservation. Their study focuses on socio-economic trade-offs, changes in human and wildlife populations, climate change, challenges of natural resources management, and governance.

The facts that the road will be unpaved in a 53-km stretch through the park and that it will be of the same standard as other tourist circuit roads in SNP are not mentioned by those who oppose the road. Actually, the road is unlikely to be a barrier to animal movement.

We are of the opinion that the proposed road may reduce disturbance to wildlife along the existing Ngorongoro–Serengeti road to Musoma (220 km). A large stretch of the proposed road will pass outside the park on the eastern side (250 km), leaving a core conservation area with moderate disturbance. Ecosystem sustainability, community development, and livelihoods should be the priorities in conservation activities, which are the main aims of the proposed road.

Literature Cited

Baldyga, T. J., S. N. Miller, K. L. Driese, and C. M. Gichaba. 2008. Assessing land cover change in Kenya's Mau Forest region using remotely sensed data. African Journal of Ecology **46:**46–54.

Dobson, A., M. Borner, and T. Sinclair. 2010. Road will ruin Serengeti. Nature **467:**272–273.

Dore, M. H. I. 2005. Climate change and changes in global precipitation patterns. What do we know? Environment International **31:**1167–1181.

Estes, A. B., T. Kuemmerle, H. Kushnir, V. C. Radeloff, and H. H. Shugart. 2012. Land-cover change and human population trends in the greater Serengeti ecosystem from 1984–2003. Biological Conservation **147:**255–263.

Holdo, R. M., J. M. Fryxell, A. R. E. Sinclair, A. Dobson, and R. D. Holt. 2011. Predicted impact of barriers to migration on the Serengeti wildebeest population. PLoS ONE **6** DOI: 10.1371/journal.pone.0016370.

Homewood, K., D. Brockington, and S. Sullivan. 2010. Alternative view of Serengeti road. Nature **467:**788–789.

Kideghesho, J., J. W. Nyahongo, and T. Holmern. 2007. Wildlife research in Tanzania: capacity building is feasible. Conservation Biology **21:**1385–1386.

Kideghesho, J. R., E. Røskaft, B. P. Kaltenborn, and T. Mokiti. 2005. "Serengeti shall not die": Can the ambition be sustained? International Journal of Biodiversity Science and Management **1:** 150–166.

Loibooki, M., H. Hofer, K. L. I. Campbell, and M. L. East. 2002. Bushmeat hunting by communities adjacent to the Serengeti National Park, Tanzania: the importance of livestock ownership and alternative sources of protein and income. Environmental Conservation **29** DOI:310.1017/S0376892902000279.

McMichael, A. J. 2001. Impact of climatic and other environmental changes on food production and population health in the coming decades. Proceedings of the Nutrition Society **60**:195–201.

McNaughton, S. J. 1990. Mineral nutrition and seasonal movements of African migratory ungulates. Nature **345:**613–615.

Mfunda, I. M. 2010. Wildlife conservation and people livelihoods: lessons learnt and considerations for improvements. The case of Serengeti Ecosystem, Tanzania. PhD dissertation. Department of Biology, Norwegian University of Science and Technology, Trondheim.

Mfunda, I. M., and E. Røskaft. 2011. Participatory wildlife management in Serengeti, Tanzania: lessons and challenges from community based conservation outreach project. International Journal of Biodiversity and Conservation **3:**676–685.

Mnaya, B., Y. Kiwango, E. Gereta, and E. Wolanski. 2011. Ecohydrology-based planning as a solution to address an emerging water crisis in the Serengeti ecosystem and Lake Victoria. Pages 233–258 in H. S. Elliot and L. E. Martin, editors. River ecosystems: dynamics, management and conservation. Science Publishers, Hauppauge, New York.

Nyahongo, J. W., T. Holmern, B. P. Kaltenborn, and E. Røskaft. 2009. Spatial and temporal variation in meat and fish consumption among people in the western Serengeti, Tanzania: the importance of migratory herbivores. Oryx **43:**258–266.

URT (United Republic of Tanzania). 2003. 2002 Population and housing census. Bureau of Statistics, General Report. Government Printers. Dar es Salaam. 203pp.

Walling, D. E. 2007. Global change and the sediment loads of the world's rivers. Pages 112–130 in Proceedings of the 10th International Symposium on River Sedimentation, Moscow, Russia.