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Research Article

Roads through national parks: a successful case study

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Abstract
Roads through protected areas are generally believed to have many adverse environmental effects but there are few examples of road building being halted for environmental reasons. In Katavi National Park, western Tanzania, plans to upgrade a murram road connecting regional capitals have been stopped in favour of retaining the sanctity of the protected area. Despite empirical evidence suggesting upgrading would damage trees, increase traffic, adversely affect large mammals, and result in more litter, the decision not to upgrade was likely made for general environmental and sociopolitical reasons rather than on consideration of ecological data per se. This suggests that conservation scientists, while remaining independent, need to work with politicians to achieve environmentally friendly outcomes regarding tropical highways.

Key words: protected areas, roads, Katavi, Tanzania

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Introduction

Numerous warnings have recently appeared about the environmental dangers of building roads through wilderness and protected areas [1], and especially in the tropics [2-5]. The concern is that relatively undisturbed areas are being increasingly impacted by human activities and UNESCO recommends that existing commercial roads should be relocated outside national parks and that new roads be routed *around* park boundaries for nine principal reasons. These are (i) destruction of habitat during road building, (ii) modification of the environment next to roads, (iii) increased road traffic resulting in animal mortalities, (iv) increased road speed resulting in animal mortalities, (v) greater frequency of fires, (vi) litter, (vii) impediment of wildlife movement between two sides of the road and, outside of reserves there is (viii) increased accessibility of natural resources leading to increased exploitation, and (ix) increased settlement of people into areas traversed by roads.

Despite this litany of potential adverse influences, there are few case histories of road building actually being stopped through reserves in the tropics. Normally plans are made and then carried out without independent environmental impact assessment and without seriously considering long term ecological consequences. Economic considerations nearly always trump environmental concerns. Here I describe a case study in which a murram road passing through a Tanzanian national park that was slated for upgrading to tarmac has not occurred, and that this decision was jointly taken by national and local politicians, the Tanzania roads authority (TANROADS) and Tanzania National Parks (TANAPA) ostensibly for environmental reasons. During the decision-making process, I collected information about the environmental effects of upgrading this road to tarmac.

Methods

Study area

Katavi National Park lies in Katavi Region in western Tanzania and at 4471 km^2 is the third largest national park in the country (Figure 1). It consists of miombo woodland within which there are at least three large seasonal floodplains (Lake Katavi, the Katisunga floodplain and Lake Chada) where large mammals collect during the dry season. It is particularly famous for its large hippopotamus (*Hippopotamus amphibius*) and crocodile (*Crocodylus niloticus*) populations [6]. The Park lies between Sumbawanga (the Regional capital of Rukwa Region) and Mpanda (the Regional capital of Katavi Region). The former Prime Minister of Tanzania lives in Kibaoni, Mlele District, a small village 11km south of the Park, and he has been instrumental in facilitating the upgrading of the murram road to tarmac from both Mpanda and Sumbawanga to Mlele District, an upgrade that is still under construction. Between Sitalike, where the national park headquarters is located, and Kibaoni there is a murram road (75km in total), 45.7 km of which passes through Katavi National Park (Figure 1). Buses and commercial lorries use this road to get from Mpanda to an area called Mpimbwe (approximately 20 villages) in Mlele District. In addition, however, there is another westerly murram road from Sitalike passing through the Park to Kisi (100km), and then on to Sumbawanga (a total of 208km). The eastern Sitalike-Kibaoni road joins this western road at Kisi 28km away (see Figure 1).

Assessing the potential impact of a road upgrade on trees

Katavi National Park protects miombo woodland with many species of trees [7]. To determine the potential effect of road building on this woodland, I estimated the number of trees that would be killed in the course of tarmacking the road. Typically tarmac roads in Tanzania are 30m wide but during construction road builders need a 10 m wide feeder road at the side. Adding piles of earth for road construction along the other side, this totals a 50m wide strip of disturbance. I counted and measured

trees every 2.5km at 19 points along the road within the Park. At each point, I counted all forms of woody vegetation in a quadrat 20m wide by 50m broad (25m from either side of the center of the road). Trees were divided into five size categories: <2cm DBH (diameter at breast height), 2-5cm DBH, 6-10cm DBH, 11-50cm DBH, and >50cm DBH and were not identified to species.

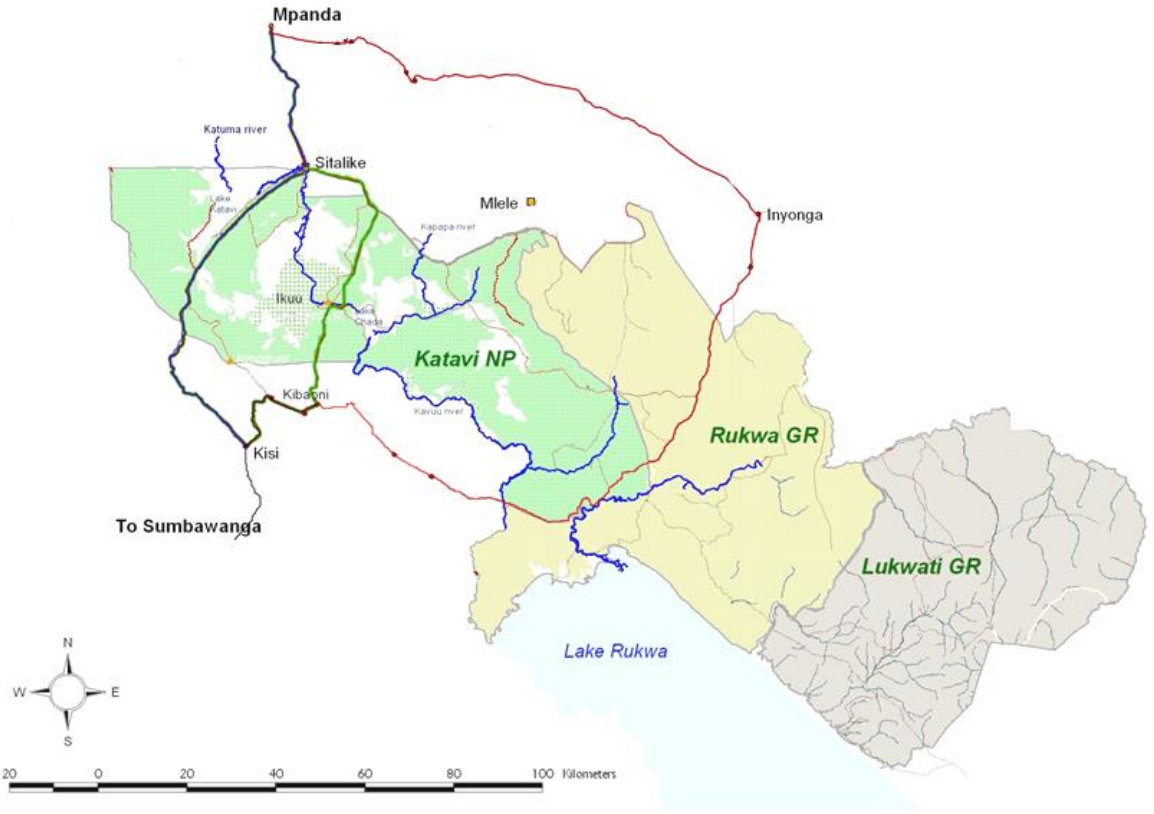

Fig. 1. Map of Katavi National Park, Rukwa and Lukwati Game Reserves depicting major roads and rivers, three of which are marked: Katuma, Kapapa and Kavuu rivers (adapted from Katavi-Rukwa Conservation and Development Project). Within Katavi NP, miombo woodland is shown in green, floodplains in white. Sitalike is the Katavi National Park HQ and Mlele is the Rukwa Game Reserve HQ. Roads: the westerly road linking Mpanda to Kisi via Sitalike (138 km) is shown in blue. Mpanda to Sitalike (38km) is currently being upgraded to tarmac. The easterly road linking Sitalike to Kibaoni (75km) is shown in green. Kibaoni to Kisi (28km red and blue) is currently being upgraded to tarmac. Future plans include upgrading the easterly road from Sitalike to the park boundary (18km) and from Kibaoni to the park boundary (11km). The red circular road to the far east may be upgraded in the distant future (369km). Note where the Sitalike to Kibaoni portion of the road in green crosses the river midway through the Park at Ikuu bridge.

Assessing the potential impact of a road upgrade on large mammals

To estimate the extent to which road upgrading might affect large mammals, I used ground transect data taken from seven transects within the Park driven in 1995-1996 [6]. Transects were driven along minor tracks once a month for 14 months over an 18 month period, were conducted between dawn

and 10.30am, and all individual mammals >1kg seen up to 500m on each side of the track were counted. Species' densities were assessed by dividing total numbers of each species by the area visible, and averaged across months [6,8]. Locations of these transects allowed me to assess where concentrations of large mammals were principally found in the Park [6].

Traffic volume

Studies of road use across the world show that road deaths increase with traffic volume and with vehicle speed [9]. Being optimistic, one can limit vehicle speeds with road bumps. For example, TANROADS has tried to do this through Mikumi National Park and it is assumed to have some effect. To estimate traffic volume, the numbers of different sorts of vehicle passing to and from Sitalike to Kisi and from Sitalike to Kibaoni were counted day and night over three consecutive weekdays in August 2013. Vehicles were divided into motorbikes, cars, small lorries, large lorries and buses.

Litter

I counted all forms of litter that could be seen on both sides of the side the 45.7km stretch of Sitalike to Kibaoni road that runs through the national park, on a single day in July 2013.

Results

At 19 points along the road, each an area of 1000m^2, I counted a total of 1560 trees (N = 19 locations, X = 82.1 trees, range 15-157) most of which were saplings. Extrapolating from this sample of 380m total width up to 45.7 km gives the following estimate of woody vegetation that might be cut if the road was upgraded and hence widened: 51,352 small saplings (<2 cm DBH), 65,904 saplings (2-5cm DBH), 40,649 small trees (6-10 cm DBH), 27,901 trees (11-50 cm DBH), and 1,804 large trees (>50 cm DBH). This is an estimated total of 187,610 trees that might be removed from the Park.

Numbers of vehicles passing along the two roads through the Park are shown in Table 1. The number of motorbikes using the western route is few as most people do not travel between distant regional capitals by motorbike. Most of the large lorries use the direct regional capital to capital route. I assumed that if the easterly road was to be converted to tarmac, most traffic would use the tarmac road since it is approximately the same distance using either route from Sitalike to Kisi. Thus, using these traffic volume figures (Table 1), traffic volume along the easterly tarmacked road would potentially increase as follows: motorbike: 11%, cars 296%, small lorries 65%, large lorries 386% and buses 95%.

Table 1. Number of vehicles using the two murram roads through Katavi National Park per 24-hour period. Data were collected on three days and nights in August 2013.

	Westerly route Sitalike to Kisi	Easterly route Sitalike to Kibaoni
Motorbike	0.7	6.3
Car	22.7	7.7
Small lorry	4.3	6.7
Large lorry	18.0	4.7
Bus	6.0	6.3

The easterly road passes through areas of high large mammal concentrations because they collect along the Katuma River connecting the Katisunga flooplain and Lake Chada in the dry season (June to November). My 1995-96 transects 1 and 2 passed through this area [6, Figure 1]. Zebra (*Equus burchelli*), lion (*Panthera leo*), topi (*Damaliscus korrigum*), impala (*Aepyceros melampus*) and vervet monkey (*Cercopithecus aethiops*) densities were higher along Transect 1 than any other of the six transects, and hippopotamus, giraffe (*Giraffa camelopardalis*), waterbuck (*Kobus ellipsiprymnus*) and mongoose densities were highest along Transect 2 [6, Table 1]. A particular concern is that hippopotamus concentrate in large numbers near the Ikuu Bridge in the dry season. At night they move away from the Katuma River to graze (up to 6 km from water) and on one side of the river have to cross the murram road since it runs for 3 km parallel and very close to the Katuma River south of Ikuu Bridge (Figure 2). Hippopotamus mortality at night may therefore be expected to be high if the road was tarmacked and collisions with this species can be very detrimental to people.

Fig. 2. Google Earth map of part of the easterly murram road (green road in Figure 1) where it crosses the Katuma River at the Ikuu bridge coming from the north (center-left). The road then turns west following the river closely for 3 km before veering south. The river contains very large hippopotamus concentrations during the dry season.

The total amount of litter counted on July 29th 2013 along 45.7 km of the easterly road through the park, was 773 bottles, tin cans, plastic bags, pieces of rubber, shoes, and wrapping papers combined. This amounted to 16.9 pieces of litter/km. It approximates the amount of litter normally seen on this stretch of road (pers. obs.). Assuming buses are principally responsible for this (they carry many people any of whom may litter), and the number of buses may double along an upgraded road, we may expect roughly 34 pieces of litter/km.

Discussion

Basic ecological data collected in this study show that upgrading of a murram road in this Tanzanian national park would result in the loss of approximately 188,000 trees. It would very likely result in an increase in road traffic, particularly large lorries, cars and also buses. Since it would pass through areas with high large mammal concentrations, animal road deaths would likely increase, particularly because traffic volumes and road speeds would increase on tarmac. This might be particularly worrisome for hippopotamus grazing at night. Finally, litter might be expected to double along this section of road.

Does this matter? We are likely to lose a number of hippopotamus, lions, artiodactyls and other species [see 10] to road traffic but for herbivores this will have likely little effect on the Park populations that are relatively high [11]. Instead, the environmental effect is more likely to be indirect through the loss of economic revenue from tourism. The reason for this is that the four tented camps operating in Katavi National Park principally advertise themselves as a wilderness experience. For example, Nomad Chada Camps' website states: "Katavi National Park in the far west of Tanzania is somewhere that even today, few people have been lucky enough to visit. Perhaps because of this, it feels untouched, almost like traveling back in time." (www.nomad-tanzania.com/west/chada-katavi/katavi/). Likewise, Foxes Wildlife Camp website states: "The park is for the connoisseur of Africa travelers who like to visit the most remote places, away from the crowds." (www.tanzaniasafaris.info/Katavi/background/htm). Heavy traffic, road kills and litter are the antithesis of a wilderness experience and are likely to adversely impact tourists' satisfaction leading to declining visitors and park entrance fees, and as a consequence less money for antipoaching and TANAPA community conservation activities in a park where poaching pressure is high [12]. The tented camps (now semi-permanent structures) will be reticent to move location because they are situated in areas where large mammals collect along the Katuma River, Katisunga floodplain and Lake Chada as my data have shown.

Fortunately, the decision has been made *not* to upgrade this 45.7 km section of murram road running through the Park, *nor* the westerly inter-regional capital road. Instead a tarmac road may eventually be built in the distant future from Kisi to Kibaoni (28km and partially upgraded at the time of writing), then from Kibaoni to Maji Moto to the southeast (a rapidly growing town in Mlele Division) and then further east to the far east of the Park (68km). Then it would run for 25km through the Park and for 35 km through the adjacent Rukwa Game Reserve, eventually reaching Inyonga (the current District capital of Mlele Division) after 42km of passing outside protected areas. These areas contain far lower concentrations of large mammals than along the Sitalike to Kibaoni route. Finally it would connect to Mpanda 138km away (369km total red route in Figure 1). The long route is not seen as an alternative to not upgrading the two roads leaving Sitalike but is simply a future option.

Possible reasons not to upgrade the road

What prompted this environmentally sensible decision not to upgrade? Perhaps an important consideration is that there is a tarmac road running from Dar es Salaam to Mbeya through Mikumi National Park which is widely recognized as killing many large mammals [13,14]. Speed bumps in Mikumi have been in place for several years – 11 sets in a 48km stretch – but they have limited success in slowing larger lorries and buses that can drive over them fast. Indeed, traffic still moves at 80-100 kph, faster than the 70kph mandated by TANAPA. Litter is found as far as 50m on either side of the road in Mikumi NP (pers. obs). Signs listing hefty fines for hitting different species of mammals have been erected but infringements are rarely prosecuted.

Another factor may be the sharp debate [15-18] and the adverse publicity [19] that a proposed road through the Serengeti National Park has generated where there are serious concerns about severing the wildebeest (*Connochaetes taurinus*) and zebra migrations. No one wants international pressure or political and polarized arguments arising in another part of the country.

Last, I prepared an unsolicited report about roads through Katavi National Park that I distributed widely (150 copies) to regional and district officials as well as to national authorities [20] but I am dubious that this had an effect on decision makers. Rather, I suspect that original plans to upgrade the road were quashed principally by the Prime Minister who wanted to please constituents on all sides. He suggested tarmac be built to Katavi National Park borders (from Sitalike and from Kibaoni, Figure 1) to satisfy local transport and businesses, but not through the Park to pay respect to TANAPA officials who have been keen to keep the road as murram and let the two gravel roads share the traffic burden.

Implications for conservation

In short, this environmentally friendly decision was probably socially and politically motivated rather than driven by ecological data and it suggests that conservation biologists and researchers need to initiate and maintain links with national and local politicians to have an effect on the ground. Furthermore, positive achievements are likely to occur on a case-by-case basis in this fashion and not necessarily through large scale continental or global analyses that rarely get read by local decision makers.

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