Alternative Routes for a Proposed Nigerian Superhighway to Limit Damage to Rare Ecosystems and Wildlife

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Alternative Routes for a Proposed Nigerian Superhighway to Limit Damage to Rare Ecosystems and Wildlife

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Abstract

The Cross River State Government in Nigeria is proposing to construct a "Cross River Superhighway" that would bisect critical remaining areas of tropical rainforest in south eastern Nigeria. We offer and evaluate two alternative routes to the superhighway that would be less damaging to forests, protected areas, and biological diversity. The first alternative we identified avoids intact forests entirely while seeking to benefit agriculture and existing settlements. The second alternative also avoids intact forests while incorporating existing paved and unpaved roads to limit construction costs. As currently proposed, the superhighway would be 260 km long, would intersect 115 km of intact forests or protected areas, and would cost an estimated ~US$2.5 billion to construct. Alternative Routes 1 and 2 are only slightly longer (~290 and ~353 km, respectively) and have markedly lower estimated construction costs (~US$0.92 billion). Furthermore, the alternative routes would have negligible impacts on forests and protected areas and would be better aligned to benefit local communities and agriculture. We argue that alternative routings such as those we examined here could markedly reduce the economic and environmental costs, and potentially increase the socioeconomic benefits, for the proposed Cross River Superhighway.

Keywords

Cross River National Park, Cross River State, equatorial Africa, habitat fragmentation, highway, Nigeria, protected areas, superhighway, tropical rainforest

Introduction

We are presently living in the most dramatic era of road and infrastructure expansion in human history. Globally, approximately12 million km of paved roads have been built since 2000 and another 25 million km are projected to be built by 2050 (Dulac, 2013). Africa has extensive plans for road expansion, with high concentrations of road building projects slated to occur in environmentally sensitive areas (The African Development Bank, the African Union & the United Nations Economic Commission for Africa, 2016; Laurance et al., 2015; Sloan, Bertzky, & Laurance, 2016).

New road development projects can be beneficial to the economic well-being of a region but effectively mitigating their environmental costs requires careful planning (Edwards et al., 2014; Weng et al., 2013). Poorly planned and implemented road development can impose substantial environmental costs (Edwards et al., 2014; Laurance, Sloan, Weng, & Sayer, 2015; Sloan et al., 2016). New roads into wilderness areas typically increase biodiversity loss, habitat modification, deforestation, legal and illegal logging, forest conversion, hunting, and forest fires

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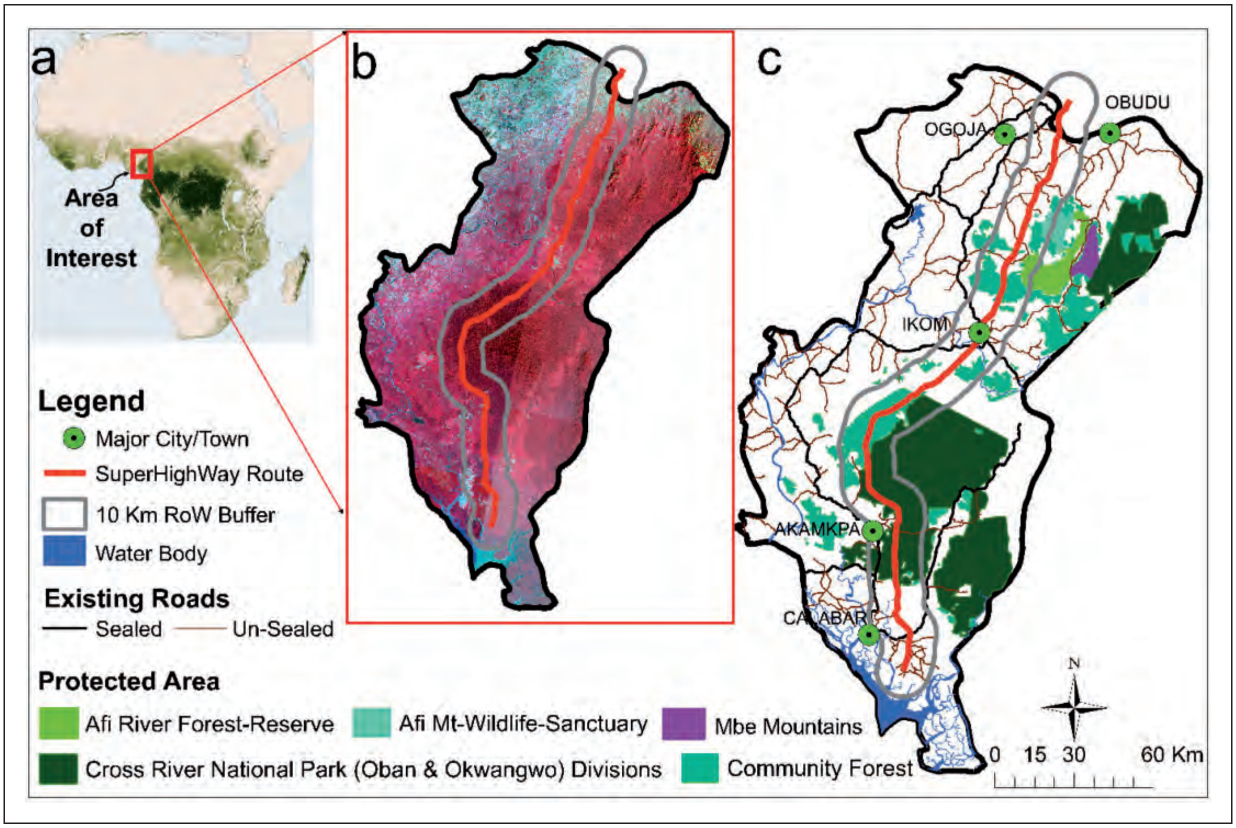

Figure 1. (a) Study area inset on the African continent; (b) Landsat-8 False Color Composite satellite image of Cross River State depicting various landscape features (vegetation in red, water bodies in blue, exposed soil or built-up areas in brown and cyan), as well as the proposed superhighway showing a proposed land-use buffer of 10 km on either side of the highway, in which land rights of local peoples would be resumed by the state government; (c) the proposed superhighway in relation to conservation landscapes and protected areas.

(Clements et al., 2014; Laurance et al., 2002; Laurance, Goosem, & Laurance, 2009). These detrimental impacts occur more frequently in developing countries, such as Nigeria (Figure 1), where road development projects are often subject to weak environmental impact assessments that can be biased by strong vested interests (Appiah-Opoku, 2001). Poor project planning can similarly impose economic costs by incurring large financial debts that must be serviced by governments and the public (Collier, Kirchberger, & Söderbom, 2016; Messick, 2011).

Many of the proposed "development corridors" in Africa would disproportionately affect protected areas with high conservation values (Laurance et al., 2015; Sloan et al., 2016). For instance, the Cross River State Government recently proposed the Cross River Calabar-Ikom-Kastina Ala Superhighway (hereafter "Cross River Superhighway"), which would connect the country's far south-eastern coast to areas in south-central Nigeria (ALERT, 2016). This superhighway (Figure 2) would cost an estimated US$2.5 billion (Anonymous, 2016) and has raised widespread environmental concerns both internationally and nationally. If constructed as planned, it would penetrate the Cross River National Park and surrounding high-conservation value forests along with sustainable community forestry areas (ALERT, 2016; Cannon, 2015). Cross River National Park is one of the most important conservation landscapes and protected areas in Africa, sustaining two thirds of Nigeria's tropical rainforest and providing critical habitat for 18 species of primates including the globally endangered and locally endemic Cross River Gorilla (*Gorilla gorilla diehli*; Effiom, Nuñez-Iturri, Smith, Ottosson, & Olsson, 2013; Oates, Bergl, & Linder, 2004; Oates et al., 2007).

While strategically designed roads can facilitate socio-economic development with minimal environmental degradation (Balmford et al., 2016; Laurance & Balmford, 2013; Laurance et al., 2015, 2014), the current proposed route for the Cross River Superhighway is very unlikely to achieve this aim (ALERT, 2016; Cannon, 2015). However, no alternative to the Cross River Superhighway has been put forward to date. We evaluate the ecological and financial implications of the proposed superhighway route and compare them objectively with those of two potential alternative routes designed to minimize ecological impact and cost. These alternatives

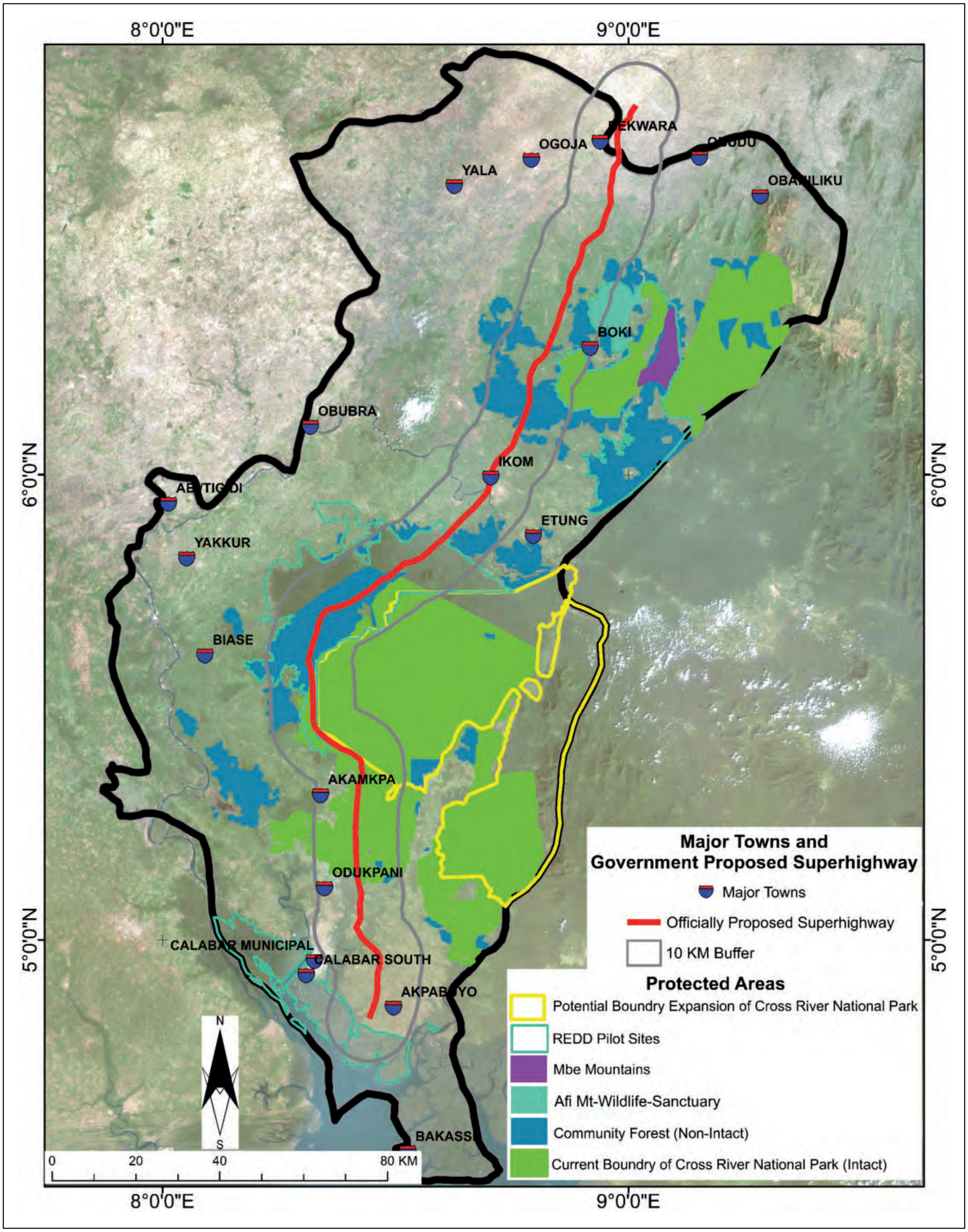

Figure 2. Proposed route for the superhighway in Cross River state, Nigeria, in relation to key habitat features and protected areas. The black solid line represents the state boundary.

reveal some environmental and economic shortcomings of the proposed superhighway route and call into question its underlying rationale.

Methods

Study Area

Our study area covers the state of Cross River (Figure 1) in south-eastern Nigeria, which shares a border with the Republic of Cameroon. Within Nigeria, the state has long been a recognized center of forest conservation and agricultural production, including forest plantations. By the 1980s, the biological significance of the forest reserves had attracted interest from the International Union for Conservation of Nature, the World Wide Fund for Nature (Jacob, Nelson, Udoakpan, & Etuk, 2015), and Wildlife Conservation Society, all of whom identified the need for the conservation of these forests, leading to the designation of the current protected areas. Cross River State also harbors both locally endemic species and globally important migratory species. For instance, the endangered Cross River Gorilla, Chimpanzee (*Pan troglogytes ellioti*; Gonder et al., 1997), African Forest Elephant (*Loxodonta cyclotis*), and Leopard (*Panthera pardus*) are also found in certain forested areas.

Study Overview

We defined two alternative routes to the proposed superhighway. The first alternative (Figure 3) favors locations deemed suitable because they are distant from conservation landscapes and protected areas, and predominantly characterized by flatter agricultural lands whose residents may benefit from the superhighway's proximity. The second alternative route (Figure 4) comprises construction along existing roads wherever possible so long as these also avoid conservation landscapes and protected areas. The proposed route and both alternative routes were then compared in terms of their potential construction costs, total lengths, and intersections of forested landscapes.

Cost Calculation

The costs of road construction vary greatly according to underlying terrain and the presence of existing road infrastructure (Collier et al., 2016). Per-kilometer costs of superhighway construction were estimated from relevant technical literature and differentiated for new road development versus upgrades to existing roads. Cost estimates were further differentiated based on whether new roads occurred in forested terrain (the sole mode for the proposed superhighway) or followed cleared, flatter lands, as well as whether road upgrades overlaid paved or unpaved roads, because both terrain and existing road surface are also known to influence road construction costs (Collier et al., 2016). All cost estimates were expressed in U.S. dollars because exchange rates for the Naira, Nigeria's national currency, has fluctutated markedly over time. Values in Naira from technical reports were converted to U.S. dollars at the time of publication of the report.

On a per-kilometer basis, estimated costs ranged from \$2.0 to \$4.8 million for new highway construction in forested land (African Roads Evolution, 2016), \$950,000 for upgrading an existing paved road (Gwilliam et al., 2008), \$1.3. million for upgrading an existing unpaved road (Gwilliam & Bofinger, 2011), and \$1.3 to \$3.2 million for new highway construction in non-forested lands (African Roads Evolution, 2016). Road-surface types were derived for Cross River State based from the government road-mapping project by Nigeria's National Space Research and Development Agency (National Space Research and Development Agency, 2008). Bridge construction was not considered in our analyses but is undeniably expensive on a per-kilometer basis, and so the upper bounds of projected road costs were used for making comparisons among road routes. When viewed in combination, the resulting cost estimates should be considered as broad "first-order" estimates.

Forest Definition

We delineated forested landscapes as either fully intact or partially intact forest landscapes. Intact forest landscapes were defined as forest patches of >500 km^2 in area without clear signs of human activity such as infrastructure or agriculture according to visual interpretation of Landsat satellite imagery (Potapov et al., 2008). Cross River National Park totals $\sim$4,000 km^2 in area and has two separate components, Oban Hills ($\sim$2,800 km^2) and Okwangwo ($\sim$1,200 km^2), both of which satisfy these criteria (Bergl, Oates, & Fotso, 2007; Ite, 1996). All other forest patches were defined as partially forested landscapes, typically having moderate to substantial levels of human activity, such as selective logging and agriculture, and being $<$500 km^2 in area (Potapov et al., 2008); in Cross River State, such forests are typically community-managed forests. We further identified those community forests (partially forested) that currently host REDD+ projects supporting sustainable forest management or carbon sequestration and forest rehabilitation efforts.

Alternate Route 1

Alternate 1 (Figure 3) relies primarily on development of new paved roads but follows a route that largely avoids forested landscapes (Table 1). This alternative is entirely

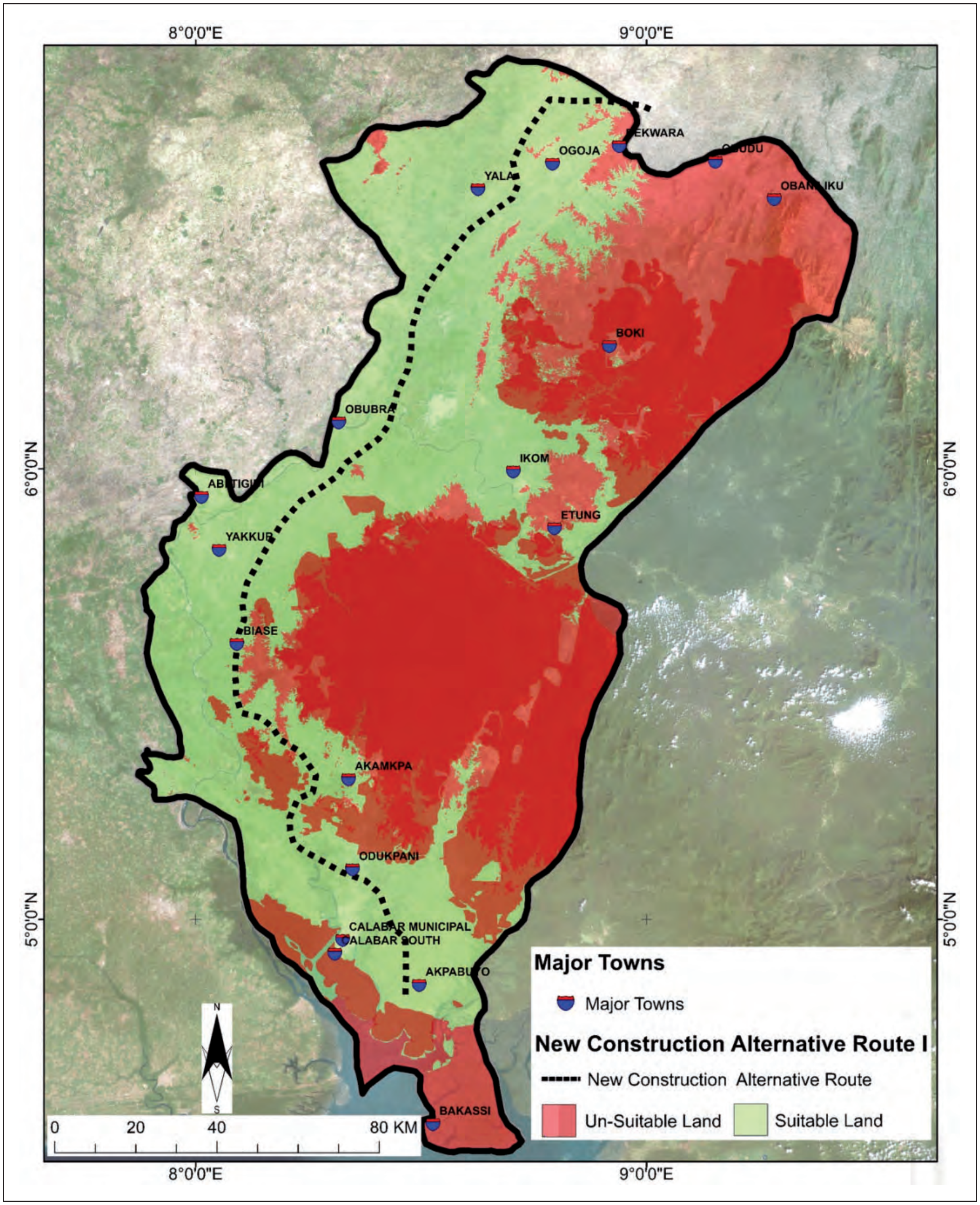

Figure 3. Alternate 1 for the Cross River state superhighway, which exclusively traverses undeveloped terrain. Red-shaded areas represents conservation landscapes and protected areas deemed unsuitable for road construction.

confined to what we describe as "suitable" lands, defined as those without conservation landscapes and protected areas (intact and partially forested) as well as with slopes of <5% and elevations of 0 to 120 m. Within suitable lands, Alternate 1 traverses through or near major towns (>20,000 inhabitants) and surrounding agricultural landscapes and is near to existing roads. This proximity of Alternative 1 to settled areas suggests it could

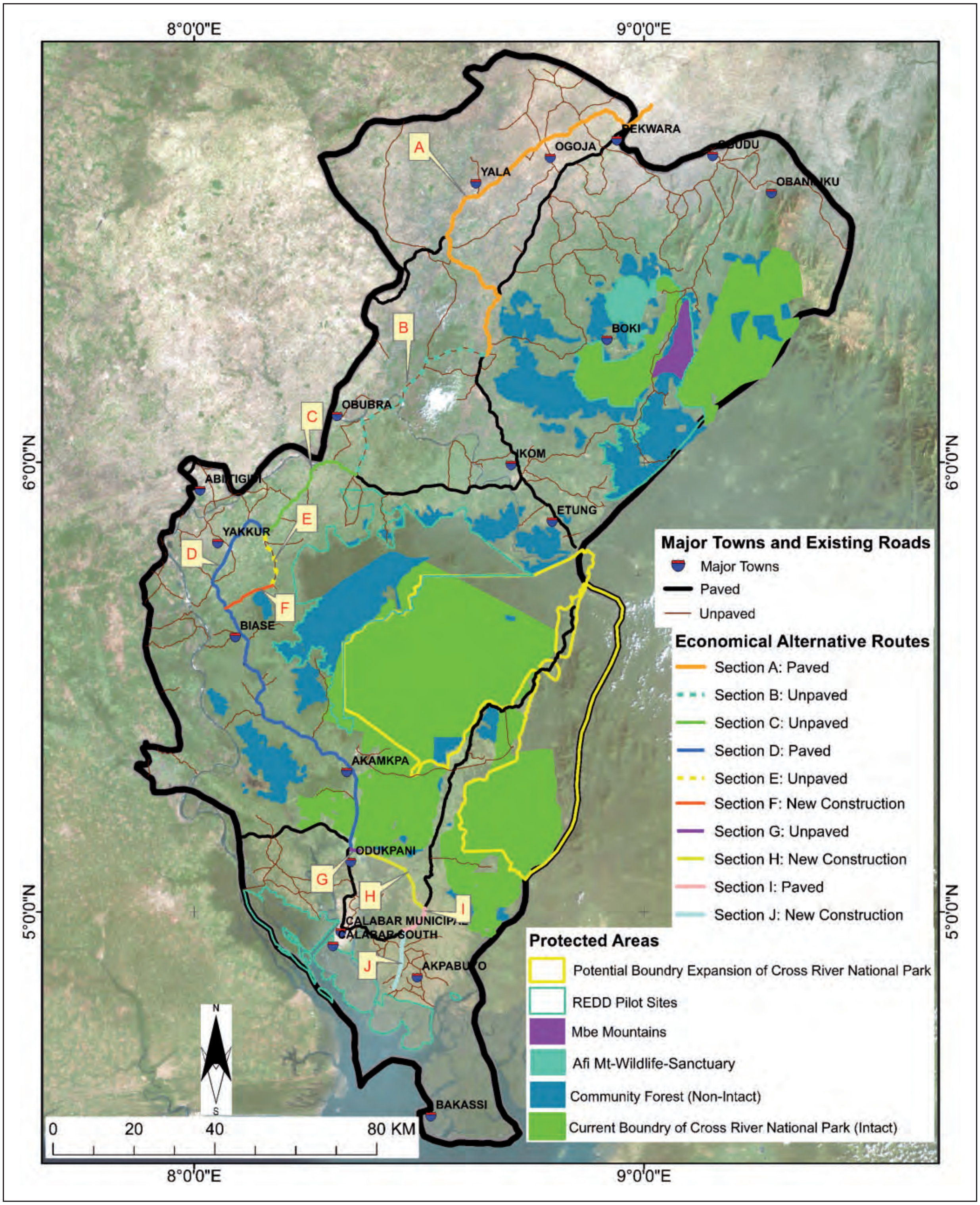

Figure 4. Alternate Route 2 for the Cross River state superhighway, which predominantly uses the existing road network. Shading represents conservation landscapes and protected areas. The road length is divided into sections between larger towns or geographic features. REDD Pilot Sites are predominantly community-managed forests where forest-carbon-storage projects are being developed.

Table 1. Cumulative and Sectional Road-Length Distances for the Proposed Nigerian Superhighway and Alternates Routes, Including Lengths of Different Road Surfaces and Construction Types.[a]

Name	Total (km)	Sectional distances (km) and route types									
		A	B	C	D	E	F	G	H	I	J
Alternate 1	290	NR									
Alternate 2A	353	107 P	53.5 UN	33.3 P	110.4 P	–	–	2.8 UN	23.1 NR	8.4 P	14.5 NR
Alternate 2B	347	107 P	53.5 UN	33.3 P	78.1 P	14 UN	12.3 NR	2.8 UN	23.1 NR	8.4 P	14.5 NR
Proposed Superhighway	260	NR									

[a]P = Paved-road upgrade; UN = Unpaved-road upgrade; NR = new road construction.

also facilitate locally beneficial economic activities, such as access to nearby towns or urban markets.

Alternate Route 2

Alternate 2 (Figure 4) connected the same origin and terminus as the proposed route but, to the extent possible, followed existing paved roads or existing unpaved roads where the former were not present (Table 1). If neither road type was present, it traversed unroaded land. The route minimally affected intact and partially forested areas; minimized its total length; and avoided towns that may cause traffic flow obstructions, in that approximate order of priority. Alternate 2 (Table 1) improved upon the proposed route by requiring little new road development, particularly in forested landscapes. All paved and unpaved roads comprising the route would be upgraded to superhighway conditions.

Trade-offs among the criteria for routing Alternate Route 2 were not immediately resolvable through cost-benefit analysis or similar optimization approaches (Hopcraft, Bigurube, Lembeli, & Borner, 2015). Therefore, two versions for Alternate 2 (2A and 2B) were produced (see Segments D, E, and F; Figure 4). However, their differences are so minor that we consider them as one route within our analyses.

Alternate Route 2 commenced at Bekwara (northern origin of the proposed superhighway) and tracked southward toward Akpabuyo (proposed terminus) along existing paved roads making up Segment A (Figure 4). Segment B would continue southwards by upgrading existing unpaved road rather than following a paved but longer road that passes through Ikom township. From there, Segment C would continue southward along the only available paved road until the junction leading to Yakur Local Government Area. From Yakur, Segment D would continue southward to Biase Local Government Area either along the sole paved road available or by bypassing Yakur via a combination of upgrades to existing unpaved and paved roads as well as new road development (Segments E and F; Figure 4). From slightly north of Biase, Segment D would continue along the existing paved road and connect to Akamkpa. Segment G would continue from Akamkpa along paved roads to Odukpani. At this point, Segment H would deviate from the paved road that leads to the congested city of Calabar and instead entail new or unpaved roads to the east of the city (Segment I). Finally, Segment J would reach the terminal seaport via another construction of new road. In total, 10 distinct segments of Alternate Route 2 are defined (Figure 4). In no instance does any segment intersect intact or partially forested areas except along Section D, which tracks an existing paved road already bisecting an intact forest landscape.

Results

The proposed superhighway route would entail significantly more environmental degradation and a greater total cost than either alternative route (Table 2), while not being appreciably more direct in terms of its total length. The officially proposed route would intersect significantly more intact and partially forested areas than either of our alternate routes. In total, the proposed superhighway would intersect 115 km of intact and partially forest. Of this, 53 km is in the Oban Division of Cross River National Park, 52 km is in the Ekuri Community Forest, and a further 10 km is in the partially intact forest around Orimekpang (Figure 2). In contrast, the two alternate routes we propose do not intersect any intact or partially intact forest landscapes, with the exception of limited parts of Alternate 2, which tracks the existing paved road already intersecting 52 km of the Oban Division of Cross River National Park (Figure 4).

Because the officially proposed superhighway would exclusively entail new road development in forested terrain (Figure 2), its estimated construction costs would be much greater, ~US$2.5 billion (Anonymous, 2016), than our two alternate routes (Figures 3 and 4). Alternate 2

Table 2. Estimated Costs for Alternate Highway Routes 1, 2A, and 2B, Based on Distances of Road-Segment and Terrain Types Defined in Table 1.

Name	Road type and length (km)	Total length (km)	Cost per km (US$ million)	US$ (billion)	
				Lower limit	Upper limit
Alternate 1	New paved road = 290	290	1.3–3.2	0.365	0.922
Alternate 2A	Paved upgrade = 259	353	0.95–2.5		
	Unpaved upgrade = 56		1.3–2.5		
	New paved road = 38		1.3–3.2		
Total				0.366	0.922
Alternate 2B	Paved upgrade = 227	347	0.95–2.5		
	Unpaved upgrade = 70		1.3–2.5		
	New paved road = 50		1.3–3.2		
Total				0.369	0.915

would cost only US$366 to US$922 million, depending on whether new roads were developed along Segment D of its route. For Alternate 2, some 72% to 73% of its total length would entail upgrades of exisiting paved roads, and another 9% to 15% upgrades of existing unpaved roads (Table 2). The cost of Alternate 1 would be comparable to that for Alternate 2, ranging from US$365 million to US$922 million. Even at their upper ends, the estimated costs of the two alternative routes are still markedly lower than that of the officially proposed superhighway route.

The calculated cost differences were not due to marked differences in the length of the routes. The proposed superhighway route is 260 km, and the two alternates are only 30 km and 63 km longer, respectively (Table 2). Considering the marked differences among the proposed and official routes in terms of potential environmental degradation and construction costs, such minor differences in length (and thus travel time) appear modest by comparison.

Discussion

In Nigeria, as in Africa generally, socioeconomic development is desperately needed to alleviate chronic wealth and health disparities and road development is espoused as a means of obtaining these outcomes. However, road development needs to be well planned to avoid critical and threatened remnant ecosystems (Edwards et al., 2014; Laurance et al., 2015, 2009, 2014). At present, across Africa, such planning often appears to be sorely lacking (Sloan et al., 2016; Edwards et al., 2014; Laurance et al., 2015). Our study illustrates that well-planned road development need not conflict heavily with environmental conservation in Nigeria's Cross River State. We have provided two, of potentially many, feasible alternate routes to the proposed Calabar-Ikom-Katsina Ala superhighway that would be significantly less costly, entail far less environmental degradation and, we believe, provide greater local economic benefit by improving highway access for many existing villages, local government areas, and agricultural lands.

The proposed superhighway would bisect some of Nigeria's last remaining intact and partially intact forests, including the iconic Cross River National Park (Laurance & Mahmoud, 2017; Laurance, Mahmoud, & Kleinschroth, 2017). These forests comprise an important hotspot for both nationally and globally significant biodiversity, sustaining critically endangered fauna such as one of the last surviving populations of the Cross River Gorilla (Laurance et al., 2017; Oates et al., 2007). Moreover, Cross River National Park has been proposed as a UNESCO World Heritage site, underscoring its international as well as national importance. That this development is being considered within such high-priority areas for conservation and cultural values reflects a broader and alarming trend across Nigeria and Africa as a whole, whereby natural-resource extraction and related transportation-infrastructure development are often seen as the priority land use, regardless of other factors (Laurance & Mahmoud, 2017; Sloan et al., 2016). In fact, many African parks have been degazetted in the interest of resource extraction or infrastructure expansion (Edwards et al., 2014). The current proposed superhighway has been repeatedly forwarded in various forms and iterations, and to date has failed three times to satisfy the arguably weak federal Environmental Impact Assessments (EIA) required for such projects in Nigeria (Akpan, 2017). This is worrisome given that current EIA assessments for large-scale road projects are seldom sufficient for appropriate risk assessment, especially at broader spatial scales and over long time periods (Jaeger, 2015). Despite this trend of recurring failures and in disregard of federally suggested alteratives, the superhighway proponents at the state level simply continue to revise and resubmit what is essentially the same project under a variety of different guises.

By providing two (of potentially many) feasible alternate superhighway routes that would have lower costs, far lesser environmental impacts, and potentially greater local socioeconomic benefits, our study reinforces major doubts (ALERT, 2016) about the current rationale for the proposed superhighway route. We believe that more in-depth analyses are urgently needed before large sums of public funding or foreign debt are committed to a project that would have such large potential environmental, economic, social, and reputational risks for Cross River State and for Nigeria.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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