Analysis of the Socio-Environmental Impacts of the Sierra del Divisor transportation infrastructure in Peru and Brazil

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Association of American Geographers; Los Angeles, California; April 9-13, 2013

Introduction

Located in the remote southwestern Amazon, the Sierra del Divisor mountain range divides the Ucayali and Jurua Watersheds and separates the urban centers of Pucallpa, Peru and Cruzeiro do Sul, Brazil. Both Pucallpa and Cruzeiro do Sul serve as economic hubs for their region, but are each the end of the road, as beyond them rivers remain the main means of transportation (figure 1). The Sierra del Divisor region includes indigenous territories, forestry and mining concessions, a reserve for the "uncontacted" Isconahua people, the Serra do Divisor national park in Brazil, and a proposed Peruvian national park, currently the Sierra del Divisor reserved zone: a transitional category (figure 1). The Brazilian Park embraces the Peruvian border and hosts a "spectacular" number of rare and endemic species (Vriesendorp et al. 2006), including jaguar, white-lipped peccaries and the red Uakari monkey (Salisbury et al. 2013). In addition to fauna and flora, the region also holds cultural diversity with descendants of the Asheninka, Nawa people, rubber tappers, and the "uncontacted" Isconahua people. Indigenous communities and small villages line the rivers. In the last decade, loggers, miners, and drug traffickers have become more visible, even as populations in both cities continues to grow (Salisbury et al. 2013). Simultaneously, plans to bridge the ecologically and culturally diverse region between the cities with transportation infrastructure continue to coalesce.

Background

Since 1943, there has been pressure by various political figures to create a road to link Pucallpa to Cruzeiro do Sul (Salisbury et al. 2013). In 2003, the Initiative for the Integration of the Regional Infrastructure of South America (IIRSA) project portfolio included a plan to connect Pucallpa and Cruzeiro do Sul. In 2009 the Peruvian Ministry of Transportation and Communication commissioned a consultant report to analyze the spectrum of various positive and negative impacts the road could bring. The resulting report by the Pucallpa Road Consortium compared several different routes for the road, but ultimately decided the road would be best placed along the Abujao River (figure 1) (Ministerio de Transportes y Comunicaciones 2012). Meanwhile, in Brazil, an alternate transportation corridor is developing. A 2012 IIRSA report plans to connect Cruzeiro do Sul to the Peruvian border via railroad (IIRSA 2012). However, the railroad would end 32 km north of the Peruvian planned road.

Disconnect

Although IIRSA seeks to integrate South American countries, our analysis of official documents shows Peru and Brazil currently contemplate two different routes and two different means (road and rail). If the two countries carried out the plans currently articulated by their official documents, there would be two different corridors ending at the other's border, an action likely to exacerbate socio-environmental impacts (Laurance et al. 2009; Carpenter 1994) with none of the transboundary economic or political advantages articulated by political authorities. A railroad destined to end at the border and in a National Park promises to transport few people or goods. Even if the road and railroad met, transitioning between the two would be logistically challenging. At the border, goods and people would need to be transported from rail to road or vice versa, which would necessitate significant infrastructure and resources. The existence of both routes might also motivate locals and outsiders to build unofficial roads to connect the two. However, the route to connect the current end point of these two projects would penetrate at least one of the following: San Mateo indigenous reserve, Serra do Divisor national park or Isconahua Territorial reserve. This disconnect highlights the challenges of transboundary infrastructure projects: where two countries seeking to advance towards a common goal fail to coordinate planning across the border.

Impacts of Roads and Railroads in Amazonia

An extensive body of existing research concludes road building has myriad adverse environmental impacts in the tropical rainforest (Laurance et al. 2009, Alves 2002, Nepstad et al. 2001). The greatest socio-environmental impact is road associated deforestation given that in the Brazilian Amazon over two-thirds of deforestation occurred within 50 kilometers of a major paved road (Nepstad et al. 2001), and almost 90 percent of deforestation can be found within 100 kilometers of government build roads (Alves 2002). Additional impacts include:

- Many rainforest species are incapable of traversing even narrow forest clearings (Develey and Stouffer 2001, Laurence et al. 2004, Laurence and Gomez 2005, Goosem 2001) and/or many species suffer higher mortality near roads from vehicle road kill (Goosem 1997, Novelli et al. 1988, Vijayakumar et al. 2001).
- Many rare species are apex predators and large-bodied mammals that require large home ranges or have low reproductive rates and are thus vulnerable to increased mortality (Bennett and Robinson 2000).
- Chemical pollution and nutrient runoff from roads are detrimental for nearby streams and wetlands with major pulses at the start of the wet season particularly devastating to wildlife (Pratt and Lottermoser 2007).
- Forest clearings facilitate widespread species invasions, including fire ants, non-rainforest vertebrates and many weed species (Goosem and Marsh 1997, Brown et al. 2006, Walsh et al. 2004, Dawson and Weste 1985, Gascon et al. 1999, Goosem and Turton 2006, Goosem 2008).
- Amazon forests penetrated by roads from selective logging operations are ~400% more likely to be deforested than non-logged forests (Asner 2006).
- Roads facilitate the spread of outside diseases to uncontacted tribes without immunities (Napolitano 2007).
- Roads encourage illegal cultivation of drugs (Young 2004).
- Roads facilitate trafficking of drugs, weapons, wild animals, and other contraband (Young 2004; Suarez et al. 2009).
- Roads contribute to the loss of cultural traditions (Sawyer 2005).

Although less extensive, research on the environmental impacts of railroads indicates these linear clearing can also damage ecosystems (Doyle and Havlick 2009). However, a nonstop railroad would avoid many of the unofficial roads stemming off official roads which would likely limit deforestation. Impacts of railroads include:

- Railroads create edge effects which alter forest structure, dynamics and microclimate in the Amazon with elevated tree mortality and a proliferation of disturbance adapted species (Broadbent et al. 2008; Laurence et al. 2002).
- Railroad maintenance can contaminate waterways (Carpenter 1994).
- Railroads pollute waterways by erosion, oils and chemicals (Carpenter 1994).
- Creosote from railroad ties can have significant influence on photochemical ozone creation and human health (Doyle and Havlick 2009).
- Engineering structures required by railroads destroy river banks and alter river courses (Carpenter 1994).

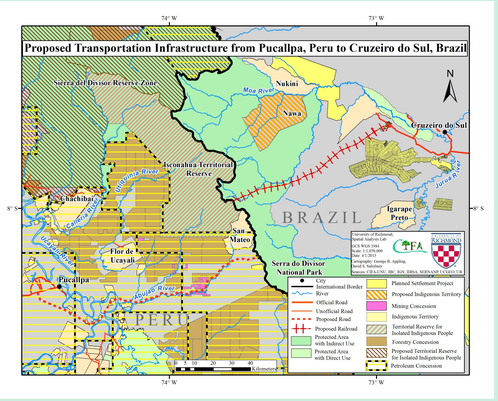


Figure 1. Map of proposed Pucallpa-Cruzeiro do Sul transportation infrastructure in the southwestern Amazon illustrates the disconnect between the Peruvian and Brazilian infrastructure projects.

Administrative Units within 50 km Buffer	
Total Area	**20,912 (km²)**
Buffer within Peru	**17,429**
Conservation Units	2,661
Forestry Concessions	3,869
Titled Indigenous Territories	1,703
TerritoryialReserve For Isolated Populations	1,175
Other Units	8,021
Buffer within Brazil	**3,483**
Conservation Units	2,261
Other Units	1,222

Table 1. The area of the 50 km buffer in Peru and Brazil divided into different land units within each country.

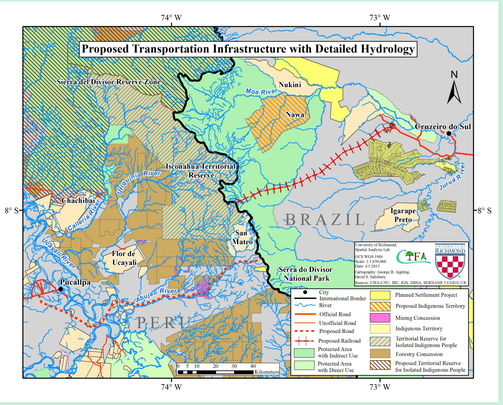
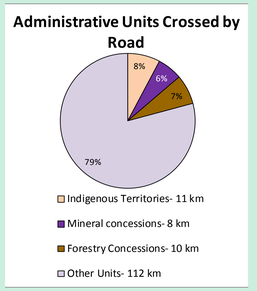


Figure 5. The proposed transportation infrastructure will cross 39 streams and rivers.



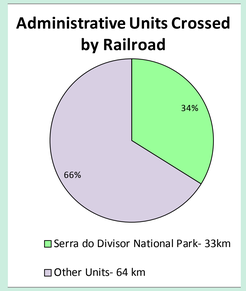


Figure 2. The distribution of different land units the proposed road/rail would travel through.

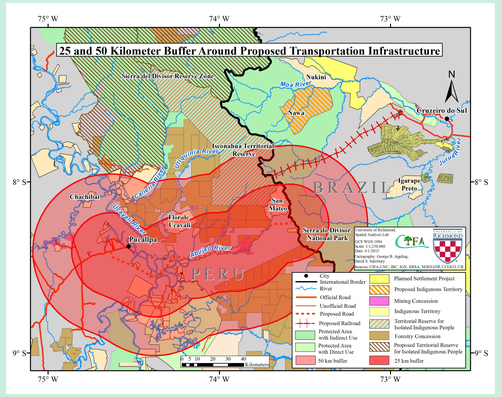


Figure 3. 25 km and 50 km buffer illustrate the potential impacts of the Pucallpa- Cruzeiro do Sul road.

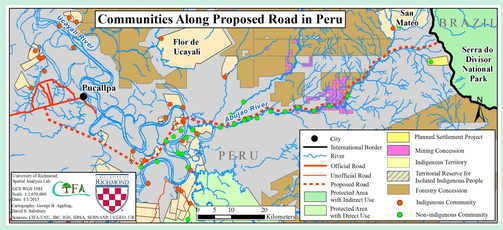


Figure 4. Proposed road would connect resource extraction concessions, communities and coca production zones located north of the Abujao river.

Figure 5. Inset map delineates the researched area.

Methodology

This research uses a mixed methodology including spatial analysis with Geographic Information Systems (GIS) and a literature review of historical accounts, scientific studies, government reports project reports, legal documents and agreements, news articles and existing maps in Spanish and English. In order to assess the social and environmental impacts of the infrastructure project, a map of the Sierra del Divisor region and the proposed infrastructure projects was created using GIS.

Given existing research showing the impact of deforestation, fires, and other impacts within 50 km of roads (Laurance et al. 2009, Alves 2002, Nepstad et al. 2001), the research used a 50 km buffer around the proposed road (Figure 4) to spatially and quantitatively analyze the potential impacts on the administrative units and hydrology in Peru and Brazil. The 50 km buffer reflects a study done in Brazil (Nepstad et al. 2001). Unlike Peru, the Brazilian method of official road building frequently includes a main highway with 6-10 km secondary roads spurring out every 5 km (Simmons 2004). From these roads stem government-built resource extraction roads up to 25 km from the original road (Arima el al. 2001). Additional unofficial roads stem from official secondary roads, creating additional deforestation. With the lack of monitoring in remote Peruvian Amazonia, similar unofficial roads, particularly logging focused ones, will likely stem from the original road. Since significant deforestation occurred within 25 km of the official secondary roads in Brazil, a 25 km buffer around the proposed road illustrates the potential impacts of a Peruvian road without official secondary roads.

Results

The 50 km buffer around the planned road in Peru covers nearly 21,000 km²: roughly 81% lies in Peru and 19% lies in Brazil. The buffer will include 29% of Serra do Divisor National Park, 40% of Isconahua territorial reserve, 7% of Sierra del Divisor Reserve Zone, and 70% of the Imiria regional reserve. In addition, more than 60 titled indigenous (1485 km²) territories fall within the 50 km buffer, including San Mateo and Flor de Ucayali. The 142 km road will cross 29 rivers and streams (figure 5) and follow within 1 km of the Abujao River for 68 km (figure 4). The majority of the road will penetrate undesignated state lands, but the route will also cross indigenous territories (11 km), mining concessions (8 km) and forestry concessions (10 km).

A nonstop railroad will not likely have the same large-scale deforestation associated with paved roads. However, 34% (33 kilometers) of the 97 km railroad will cross the Serra do Divisor National Park. In addition, the railroad will bridge ten Brazilian rivers.

Discussion

The combination of a road and rail terminating at different points along the international border would bring socio-environmental impacts without the transboundary economic and political benefits articulated by policy makers. In addition to the effects described in the Impacts section above, the road would also run parallel to the Abujao River (less than 1 km away) for 68 km causing concentrated pollution even while facilitating access, resource extraction, population growth, and other unforeseen impacts in the riverside villages and indigenous communities, while linking mining, forestry, and petroleum concessions to the aforementioned population centers, coca production zones, and the Brazilian border (Figure 4).

On the other side of the border, an ecological railroad with no planned stops would likely have less socio-environmental impacts. However, while deforestation might be restricted to an area less than 50 meters wide along the railroad, this linear clearing would bisect a national park and end at the Peruvian border, providing easy access to hunters and other illegal foot traffic and allowing additional degradation through edge effects: additional penetration by wind, sun, and fire even as some species avidly avoid forest edges (Murcia 1995; Goosem 1997, 2000, 2007: Laurence et al. 2002: Laurence 2004) and cannot traverse forest clearings (Develey and Stouffer 2001; Laurence et al. 2004; Laurence and Gomez 2005; Goosem 2001).

Additional research on the impacts of railroads on tropical forests is necessary to fully understand the impacts of this infrastructure project. Moreover, this research does not fully recognize the difference between Brazilian and Peruvian road building methods and the difference in the impacts. Although the 25 km and 50 km buffers identify the area of potential impact, other factors, such as physical features and location of resources will also affect the location of impacts. In Peru, the Abujao River would create a barrier to deter deforestation south of the river, while resources north of the road could drive extensive roads beyond 50 km. If the road was located south of the Abujao River, the opposite effect could protect the conservation units located north of the Abujao River. Ultimately, the socio-environmental costs to the integrity of conservation units, indigenous territories, and tropical forest due to the proposed transportation infrastructure, make further research and governmental planning necessary before attempting to connect the Pucallpa and Cruzeiro do Sul.

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