Chapter 50

THE INFLUENCE OF ECONOMICS, POLITICS AND ENVIRONMENT ON ROAD ECOLOGY IN SOUTH AMERICA

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SUMMARY

Rapid economic growth in several South American countries combined with high species diversity in tropical regions has raised great concern among ecologists on the future of wildlife in those areas. One of the consequences and drivers of economic growth is widespread infrastructure development. The economic and social development of most countries in South America is a higher priority than biodiversity conservation, especially when compared with transport infrastructure. Over the past decade, several research groups have focussed on the impacts of roads on wildlife in South America.

50.1 The economic development of some countries in South America has strongly influenced the expansion of road networks.

50.2 Although there are numerous organisations involved in planning, development and administration of highways, only few of them evaluate the impacts on biodiversity.

50.3 Numerous protected areas in South America are directly and indirectly affected by roads.

50.4 Road ecology is an emerging discipline in South America, and Brazil and Argentina are leading the field.

There are enormous challenges to effectively incorporate ecological considerations into the planning, design, construction and operation of roads in South America. While much of the current practise has been adapted from international experience, the time has come to invest in local experts and improve the quality of the scientific knowledge generated from within South America. Government policies must also support the development of an ecologically sustainable transportation network.

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INTRODUCTION

South America comprises 12 countries across 18.4 million km^2, each with diverse geographic, economic and social characteristics. South America is largely a developing continent, with its countries ranked between the 44th and 117th positions (out of 187 countries) by the Human Development Index (HDI), a statistic that measures life expectancy, education and income. The inequality in HDI amongst South American countries is reflected in the level of the development of national transportation networks, with road densities ranging from 0.015 km/km^2 in Bolivia to 0.049 km/km^2 in Uruguay, and a railroad density of 0.00009 km/km^2 in Paraguay and of 0.014 km/km^2 in Argentina (IIRSA 2010).

South America is physiographically, biologically and culturally diverse, including extreme environments, such as the permanent snow-covered mountains in the high Andes, dry deserts (e.g. the Atacama) and the wettest tropical forests (e.g. the Amazon). Biologically, South America includes 5 of the 17 countries considered megadiverse (Mittermeier et al. 1997). South American countries also vary culturally, economically and socially and, consequently, exhibit different environmental protection perspectives. The planning and construction of infrastructure, including road, rail and air transport, is a priority because it contributes to economic development. Measures to protect the environment or support sustainable development are often neglected and usually inadequate.

LESSONS

50.1 The economic development of some countries in South America has strongly influenced the expansion of road networks

The development of the road network is heterogeneous in South America. Brazil, the largest country and one of the most developed in South America, has been described as an emerging economy and is currently the seventh largest economy in the world. The gross domestic product (GDP) in Brazil was worth US$2.3 trillion in 2012 (4% of the global economy), a value similar to the GDP of the United Kingdom. To support and drive this economic growth, the Brazilian Federal Government has prioritised the construction of highways and railroads. Between 2007 and 2010, an additional 4731 km of highways and 356 km of railroads was added to the network, and by 2014, approximately 7000 km of highway and 3000 km of railroads will be built, duplicated or repaired. In addition to these works, the Brazilian Government will allocate US$39 billion to highways and railroads over the next 5 years and US$26 billion in the following 25 years. This will result in 7,500 km of new highways and 10,000 km of new railroads, an increase of nearly 20% of paved roads. To achieve this, the Brazilian Government has systematically reduced the environmental licensing requirements for the construction of highways and railways, preferring to fast-track construction at the cost of adequate environmental impact assessments (EIA). While other countries are also planning to expand their transport networks, their growth rate is slower than in Brazil. Bager (unpublished data) estimated that over 400 million vertebrates are killed on Brazilian highways each year. If the road network increased 20%, Brazil will cause the loss of half a billion vertebrates annually.

Another country that is rapidly expanding its road network is Colombia; paving and building new roads and planning to increase its network of paved roads by nearly 8000 km in the next 5 years. Furthermore, the government of Venezuela has a National Railway Development Plan, aiming to expand the country's railway network to 13,665 km of railroads by the year 2030, more than a 10-fold increase over its current system. Economic development requires adequate connections among countries and between coasts to ensure efficient regional and intercontinental trading.

In this context, the Initiative for the Integration of Regional Infrastructure of South America (IIRSA, a joint program of governments of 12 countries) was established in 2000 with the goal of promoting the sustainable and equitable development of transport, energy and telecommunication infrastructure through the integration of all South American countries. The IIRSA projects are organized around 10 hubs spread around South America, which were established according to their productive economic activities and potential for development. In the first 10 years (2000–2010), 474 integration projects were executed, of which 225 were highways (valued at US$49.28 billion), and 61 were railroads (US$14.16 billion) (IIRSA 2010). The program is continuing and transportation projects remain a priority (see www.iirsa.org).

The approach to highway construction across South America is changing, with several governments awarding highway concession contracts to private companies, with varying consequences for biodiversity. Brazilian private companies with concessions are controlled by regulatory agencies that establish more rigid environmental controls than those imposed on highways built and managed by the state or federal governments. These companies usually charge tolls for the use of the highway and in return must commit to making infrastructure improvements and maintaining the highway for a period of time, including environmental requirements. However, this is not consistent among all South American countries, for example private companies in Argentina have lower environmental standards than that of government road agencies.

50.2 Although there are numerous organisations involved in planning, development and administration of highways, only few of them evaluate the impacts on biodiversity

Poor quality EIA are a serious problem in South America (see also Chapters 5, 51, 53, 54 and 56). Minimal controls during the road planning and construction phase and poor quality environmental monitoring programmes produce inefficient mitigation measures. The only organisation that exclusively addresses ecological impacts of roads in South America is the Brazilian Center for Road Ecology Research (CBEE) (http://cbee.ufla.br). CBEE was established in 2011 and is affiliated with the Federal University of Lavras. Its main goal is to undertake research, train specialists, develop technology related to the mitigation of road effects, and contribute to the development of public policies. Currently, the CBEE produces a monthly newsletter and organises the biannual Road Ecology Brazil Congress, which started in 2010 with more than 200 participants. Because most road ecology studies being conducted in Brazil include monitoring wildlife road-kills (either by highway concessionaires or researchers), a primary task of the CBEE is to develop a standardised national protocol to collect road-kill data and a unified database (Textbox 50.1).

In addition to the CBEE, there are a range of other research groups in South America working on road ecology. In 2008, INTERBIODES, an Argentine research group was formed; associated with the National Council for Scientific Investigation and the National University of San Juan. This group conducts research and also advises the Federal Highway Administration on road ecology issues. Additionally, in the province of Misiones, an NGO (Conservation Argentina) and the highway planning body have a research group collaborating on road planning. Currently in Brazil, there are at least four research groups focussed on road ecology and many others that informally study the topic. These groups collaborate with research and other activities that contribute to the growth of the road ecology discipline in the country. Although we are not aware of the existence of formal research groups in Ecuador, some studies have been undertaken on different groups of fauna (Tanner & Perry 2007; Gottdenker et al. 2008; Carpio et al. 2009) and road ecology topics (Byg et al. 2007; Suárez et al. 2009; Suárez et al. 2012).

Textbox 50.1 Brazilian National Wildlife Roadkill Database.

The CBEE, together with the federal Brazilian Institute for Biodiversity Conservation (*Instituto Chico Mendes de Conservação da Biodiversidade*), are developing a wildlife roadkill database that will compile data from a wide array of sources, such as scientific research projects, drivers, and surveys conducted during the planning of highways and railroads http://cbee.ufla.br/portal/sistema_urubu/. This database will integrate roadkill data with a web-based geographical platform, modules of data analysis and reports. Mobile phone applications (Fig. 50.1) have been developed to collect WVC data in the field, including for the general public to record opportunistic sightings; and scientists, with capacity for systematic sampling, control of the monitored distance and images of the highway and surrounding landscape (http://goo.gl/zy9VCF and http://goo.gl/x2h6Sx). The database will be connected to the Brazilian Biodiversity Information System (SIB-Br), thereby allowing the use of the data in the development of state and federal public policies, both for biodiversity protection and the planning of highways and railroads. This database is linked to the development of the standardized national protocol to collect roadkill data (Lesson 50.2). We believe that if a collection tool is available to store and analyse data, various research bodies and institutions will adopt it as their protocol, and Brazil will have spatially and temporally comparable data from every region of the country. This system can also be adapted for other regions in South America.

Figure 50.1 The welcome page of the Urubu System to collect and analyse wildlife road-kill data in Brazil. Source: Alex Bager.

50.3 Numerous protected areas in South America are directly and indirectly affected by roads

More than half (62%) of the federally protected conservation areas in Brazil are intersected by highways and 72% are indirectly affected by highways, accounting for 5.6% of the total park area (Botelho et al. 2012). Many of the most affected areas are in the Atlantic Rainforest (*Mata Atlântica*) biome, which is close to the coastal region and the major urban centers. No similar studies for other South American countries have been published.

In Brazil, the managers of 300 state and federal conservation reserves were interviewed and most identified conflicts between roads and wildlife as a significant issue in their reserve (A. Bager, unpublished data). The managers also reported that 10% of the protected areas contained roads constructed within the previous 5 years, and 25% will have new roads within the next 5 years. Sixty percent of the protected areas had public roads, including major highways, running through them. Managers of 74 % of the protected areas reported wildlife-vehicle collisions (WVC) in their parks, with 41% reporting occasional collisions, 36% constant but at a low frequency, 14% constant and daily and 1% had high roadkill rates; 8% didn't quantify the rate of WVC. This study also demonstrated that mortality from WVC was a significant cause of mortality in the protected areas for 23 of the 29 species of medium and large mammals that are officially threatened with extinction in Brazil. Park managers identified native feline, canine and arboreal species as most affected.

Recent surveys within 11 conservation reserves of Argentina found 12 species under threat (including the jaguar and the Andean condor), which are directly impacted by WVC (C. Borghi, unpublished data; Speziale et al. 2008; Chapter 36).

50.4 Road ecology is an emerging discipline in South America, and Brazil and Argentina are leading the field

Despite the rapid growth of road ecology in Brazil since 2004, most studies have focused on rates of roadkill (e.g. Bager et al. 2007; Dornas et al. 2012) (Figs 50.2 and 50.3) and were published in regional portuguese language journals (e.g. Cherem et al. 2007; Kunz & Ghizoni Jr. 2009; Zaleski et al. 2009). However, sampling effort was usually not documented

Figure 50.2 Capybara, the largest rodent in the world (weighing up to 50–60 kg), are common in most countries in South America and suffer high rates of mortality from WVC, especially where roads cross wetlands. Source: Photograph by Alex Bager.

Figure 50.3 Secondary mortality, where scavengers feeding on carcasses become roadkill themselves, is a major problem for raptors in South America as the rate of WVC continues to increase. Source: Photograph by Alex Bager.

in these studies, making it difficult to evaluate the effect of mortality on population persistence. There was a significant increase in publications in international journals after 2010 (e.g. Bager & Rosa 2010, 2011; Caceres 2011; Hartmann et al. 2011; Oliveira Jr. et al. 2011; Coelho et al. 2012; Freitas et al. 2012; Rosa & Bager 2012; Bager & Fontoura 2013; Teixeira et al. 2013; D'Anunciação; Ratton et al. 2014; Secco et al. 2014). In 2012, the first book on the road ecology of South America (Bager 2012) was published, which addresses political and methodological topics. From this perspective, it was possible to identify major knowledge gaps in road ecology after the analysis of 41 articles published by Brazilian researchers (Table 50.1).

In 2008, Argentina was the first country in South America to install overpasses for wildlife, near Iguaçu National Park in the northern part of the country. In Brazil, wildlife underpasses and fences are routinely

Table 50.1 Summary of Brazilian studies in road ecology.

Knowledge level	Road ecology topic	Number of publications
No information, anecdotal at best	Physical disturbance	0
	Chemical pollution	0
	Exotic species invasions	0
Incipient level	Barrier effects	1
	Edge effects	2
Low level	Human invasions	3
	Fragmentation	3
	Spatial planning and mitigation	5
Medium level	Wildlife roadkill	27

used to mitigate the fragmentation caused by roads, although no rigorous monitoring programs have assessed effectiveness. The inclusion of fencing and underpasses in the design of new roads is positive; however, the use of standard-size underpasses for drainage (both culverts and bridges) and calling them wildlife crossing structures appears to be a justification to approve all new road projects. More detailed evaluation of effectiveness is required to ensure that new roads do not further endanger wildlife and ensure that damaging roads avoid high quality conservation areas.

CONCLUSIONS

To advance the study of road ecology in South America, we need stronger government legislation, expanded road ecology research programmes to increase the number and quality of investigative studies, and the creation of new course curriculums and training opportunities at the academic and technical levels. Our main challenge is to integrate these sectors and normalise the mitigation hierarchy: avoid impacts first, minimise second, mitigate third and compensate or offset any remaining impacts. The road and rail network across South America is rapidly expanding and there is an urgent need to better understand their effects on biodiversity to guide the growth of the transport sector.

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FURTHER READING

Bager (2011 and 2014): Annals of second and third Brazilian conference of road ecology, available at http://cbee.ufla.br.

Bager (2012): First book about road ecology in Portuguese, with three sections: politics, methods and study cases.

Bager and Rosa (2011): This article proposes different sampling efforts to measure rates of road kill, depending on the objectives of the study target group of wildlife.

Laurance et al. (2009): This article summarizes all types of negative effects caused by roads in tropical areas.

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