Introduction

The detrimental effects of roads and subsequent frontier development in the Brazilian Amazon is well documented, with approximately 75% of deforestation occurring within 50 km on each side of major roadways. In fact, roads are “the single most robust predictor” of deforestation in tropical forest regions. Numerous studies have demonstrated the huge direct and indirect influence of paved roads on deforestation by:

- providing easier access to untouched land by both settlers and commercial interests;
- promoting extractive industries, such as logging and mining, thus influencing deforestation rates;
- creation of economic enterprises, such as soybean cropping and cattle raising, which were previously not viable;
- increased risk of land speculation and other illegal activities; and
- contributing to forest fragmentation, increased risk of fire, and impacting spatial patterns of biodiversity loss.

Understanding the effects of roads on land use change in the Brazilian Amazon is crucial in developing policies to combat forest destruction. Here we examine one relevant case study: the proposal to pave BR-319 (Figure 1).

Specifically, we analyze land within 50 km on either side of BR-319 using Multi-Criteria Analysis (MCA) to identify areas particularly vulnerable to deforestation.

BR-319

Our study area measures approximately 1000 km north to south, stretching from Manaus in the state of Amazonas to Porto Velho in the state of Rondônia. It extends 50 km on each side of the highway, which is one suggested distance of clearing active ties related to road networks. BR-319 was originally constructed in the 1970s as part of a widespread effort by the Brazilian government to develop the Amazon. Unlike other roads built during this time, BR-319 had little traffic, in part because industrial production in Manaus was exported by ship and air—both cheaper alternatives than road transport. As a result, BR-319 went basically unused, degrading to the point of becoming impassible.

Parts of BR-319 were repaved in 2001, but road conditions remain poor. Two factors contribute to this: the use of the Madeira River,
parallel to the highway, and the high cost of highway maintenance in a region with high rainfall (up to 2,200 mm avg. rainfall per year).

**Multi-Criteria Analysis**

MCA is a tool used to evaluate outcomes comprising of several different criteria, which has been widely implemented in IPAM. For this model, we chose five input variables associated with deforestation: (1) distance from BR-319, (2) proximity to urban centers/markets, (3) density of existing secondary roads, (4) terrain "roughness" and (5) location of protected areas. By combining these weighted inputs, we created a map identifying the areas most vulnerable to deforestation if BR-319 is repaved (Figure 2).

**Results**

Our results are displayed under three distinct scenarios: 20% deforestation, 50% deforestation, and 80% deforestation. Each scenario is intended to represent a different state of reality, spanning from most conservative (20%) to least conservative (80%). Areas identified in red are the most likely to become deforested. Areas in yellow indicate a medium risk of deforestation, and areas in light green and dark green show moderately low and low risk, respectively.

In addition to illustrating the total impact of deforestation under each scenario, the maps on the previous page can also be interpreted as a likely pattern of deforestation over time if policies are not implemented to promote conservation and/or sustainable development.

**Impact on CO₂ emissions + climate**

Historically, land surrounding BR-319 has been largely unaffected by deforestation due to its remote location and poor road conditions. Paving BR-319 would drastically change this, resulting in huge emissions of CO₂ currently stored in the forest. Analysis of above-ground biomass in the buffer area indicates that CO₂ emissions could range from approximately .541 billion metric tons released under the 20% deforestation scenario to approximately 2.164 billion metric tons under the 80% deforestation scenario.

Comparing projected CO₂ emissions from BR-319 with (1) annual total country emissions and (2) Brazil’s Intended Nationally Determined Contributions (INDCs) under the United Nations Framework Convention on Climate Change (UNFCCC) provides a better sense of what deforestation of this scale means for Brazil (Figure 3). Although deforestation in the buffer area and associated emissions would likely occur over a number of years, the emissions from this single project are significant, and should be considered when evaluating the potential outcomes associated with road pavement.

Past emissions trends suggest that Brazil can meet the INDCs in 2025 and 2030 – but only if additional strides are taken to limit CO₂ emissions. As emissions from energy and agricultural sectors rise over the coming years (as projected), emissions from changes in land use must decrease.

In addition, studies evaluating local climactic changes from forest land to pasture and crop have observed significant increases in land surface temperature and reduction in evapotranspiration (ET). Both of these changes could have major impacts on agriculture and water availability in the region.

**Policy Recommendations**

Brazil cannot afford to experience rapid and extensive deforestation – like that which occurred after the pavement of other roads in the Amazon – if the country wishes to meet its CO₂ emissions targets and avoid impacts on local climate. In order to avoid deforestation, we recommend:

- implementing a regional planning process that brings together multiple stakeholders (including local groups and municipal governments) to address unique aspects of the area;
- enhanced monitoring and enforcement of illegal land-grabbing throughout the surrounding area;
- promoting sustainable land uses through technical assistance and credit lines, including programs which promote sustainable development in conservation areas; and
- allocating undesignated forest as sustainable use areas or other land classifications (e.g. low-impact logging, or green settlements), which allow for the continued use of forest resources.

Road development in the Amazon, particularly with respect to paved roadways, does not need to come at the expense of forest cover and biodiversity. Rather, long-term, participatory planning before roads are paved is critical to combating forest loss and other negative consequences.

**Further reading**

