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Amazonian Deforestation Models

Deforestation predictions for Amazonia presented by W. F. Laurance *et al.* in 2001 (1) are based on the assumption that the road infrastructure is the prime factor driving deforestation. Much has already been said by the scientific community about their model--its apocalyptic results are based on simple extrapolation of past patterns, disregarding the region's enormous biophysical and socioeconomic heterogeneity (2, 3)--but recently the authors reinforced their arguable results ("Deforestation in Amazonia," Letters, 21 May 2004, p. 1109), blaming planned infrastructure and the land speculation it provokes for the current high deforestation rates in the Amazon, which we consider an oversimplified view of current deforestation causes (4).

Deforestation rates have increased significantly in the last two years (5), but in spite of the ambitious infrastructure plans announced in the mid-1990s, very few federal investments on roads have been made since the 1980s. Therefore, this overall rate increase cannot be explained by those plans even if land speculation is one of the factors in areas such as BR-163. For instance, the municipality that has had the highest deforestation rates in recent years, São Felix do Xingu, Pará, is not even served by a paved road. São Felix is an entrée to the area between the Xingu and Iriri rivers, a recent deforestation hot spot, where cattle farmers and local municipal governments build unpaved roads themselves (4). The Laurance *et al.* model fails to capture this type of new frontier (see figure in Supporting Online Material) (6, 7).

Although we do not dispute the fact that in the past most of the deforestation has happened along the major highways (8), there is an urgent need to understand the genesis of the new Amazon frontiers, and the hypothesis that they are more localized and much less dependent on federal government infrastructure investments than in the 1970s and 1980s (9). Even in the 1970s and 1980s, the effect of roads was not homogeneous across the region (10), depending on proximity to national markets in the south, climatic restrictions, official settlements sites, agrarian structure differences, and technology access.

Simplistic models such as that of Laurance *et al.* (1) may divert attention from real deforestation causes, being potentially misleading in terms of deforestation control, even if, as proposed in (2), Brazilian infrastructure plans are completely undermined.

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Response

Câmara *et al.* challenge our assertion that the unprecedented, planned expansion of highways and other transportation projects in Amazonia that was originally proposed under the "Avança Brasil" (Advance Brazil) program is likely to lead to a dramatic increase in forest loss and degradation, and they argue that our earlier spatial models (1) were overly simplistic and "apocalyptic" in their projections. Three points about our models merit emphasis.

First, the projections of our models--that 28 to 42% of Brazilian Amazonia would be deforested by 2020 if all the Avança Brasil projects proceed immediately--are in fact very plausible and do not differ greatly from simple extrapolations using the current high rate of forest loss (2). Second, our models incorporated key components of regional heterogeneity in Amazonia, including spatial

variability in forest vulnerability to fire, logging, and mining. Third, independently derived scenarios of future forest loss (3, 4), including a recent model that incorporates much of the region's biophysical and economic heterogeneity (5), also indicate that new and planned highways are likely to play a central role in determining future patterns of Amazon deforestation.

If a new highway penetrates into a large forest tract and promotes spontaneous colonization by farmers, loggers, and ranchers, is the forest loss caused by the highway or the other drivers? Clearly, it is both--but the crucial point is that such transportation projects play a pivotal role in determining where forest destruction occurs. The truly alarming aspect of the *Avança Brasil* program is that it will crisscross the Amazon with some 7500 km of paved highways and many other transportation projects that will penetrate deep into the heart of the basin. The net effect will be not only increased deforestation, but also fragmentation of forests on an unprecedented spatial scale (1). Rather than concentrating development in the vast expanses of land that have already been deforested, the projects that promote frontier expansion will do precisely the opposite.

Contrary to the claim by Câmara *et al.*, the dramatic upsurge in Amazonian deforestation in 2002-03 includes many areas associated with highways and roads, including the notorious Santarém-Cuiabá Highway. Even the deforestation hot spot (São Félix do Xingu) emphasized by Câmara *et al.* is closely associated with privately financed roads (6). The point of our recent Letter is that Brazilian-government efforts to slow rampant Amazon deforestation are unlikely to succeed if the government proceeds with its most environmentally damaging transportation projects. We stand by this assessment.

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References and Notes

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