Amazon Deforestation Models: Challenging the *Only-Roads* Approach

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The enormous potential impact of Amazon deforestation calls for qualified and comprehensive assessments of the factors affecting it. Predictions presented by Laurance et al. [4][5] are based on the assumption that the road infrastructure is the prime factor driving deforestation. We consider this an over-simplified view, given the diversity of immediate and subjacent conditions that influence the location and the rates of land use change in a very heterogeneous region. The simple extrapolation of past patterns of change, disregarding the region's biophysical and socio-economic diversity, leads to policy recommendations that are unable to deal with the real factors affecting Amazon deforestation [1].

To assess the immediate factors related to deforestation, we compiled a spatially-explicit database including 80 environmental, demographical, agrarian, and technological variables, as well as accessibility and market connectivity indicators. These variables were interpolated to a cellular space of 100 x 100 km, which allows a detailed comparison of the different factors. The database combines remote sensing derived data, field surveys and data from demographic and agricultural census and allows an unprecedented level of integrated analysis.

Our assessment used linear regression models where the dependent variable is the percentage of agricultural areas (pasture and crop) in each

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cell, obtained from the 1996 census. We built several candidate models, all with high coefficients of multiple determination (R^2 from 0.80 to 0.85). We selected a model that indicates seven factors correlated 84% to the Amazon deforestation patterns:

(a) Agrarian structure: percentage of area occupied by large farms and number of small farms.

(b) Population density.

(c) Biophysical factors: average precipitation and percentage of fertile soils.

(d) Infrastructure: distance to roads.

(e) Government policy: percentage of Indian Reservations.

We conclude that road infrastructure is only one of many factors affecting patterns of land use change in Amazonia. Models such as Laurance et al. [4] fail to capture the diversity and cross-correlation of the physical, demographical, agrarian, governmental and infrastructural factors. We analyzed the negative outliers of the model (areas where the regression model indicates that there is a tendency for deforestation and where there was no measured deforestation in 1996), for instance the south of Amazonas State and the Iriri region (Figure 1). INPE's latest results on the patterns of Amazon deforestation using 2003 LANDSAT data [3] and recent field surveys [2] show these regions to be undergoing rapid land use change. Therefore, our analysis using 1996 data indicates *hot-spots* for future deforestation.

Model 7 - Clima - R^2= .84			Factor category	Variable
	BETA	p-level		
Intercept		0.00		
LOG_DENS	0.35	0.00	**Demography**	Total population density (hab/km2) (log10)
PRECIPIT	-0.32	0.00	**Environmental**	Avarege annual precipitation in the cell (mm)
PORC3_AR	0.28	0.00	**Agrarian Structure**	Percentage of the area of large properties by the total area of rural properties
LOG_NR1	0.27	0.00	**Agrarian Structure**	Proportion number of small properties in relation to total number of rural properties (log10)
DIST_EST	-0.13	0.00	**Accessability**	Distance to raods (km)
PORC1_UC	-0.06	0.00	**Protected areas**	Percentage of cell area covered by Indigenous Lands
LOG2_FER	-0.04	0.05	**Environmental**	Percentagem of cell area covered by medium fertility soils.

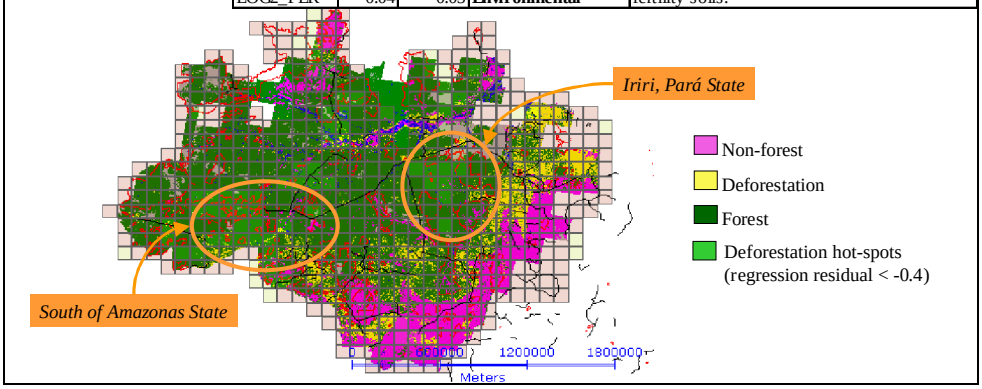

Figure 1: Regression model and *hot-spots* map.

The authors are currently investigating the new Amazon frontiers and the hypotheses that they are less determined by governmental infrastructure investments than in the 70s and 80s, and more by the interplay of local factors, presenting a more localized pattern than before. The fact that the hot-spots maps show areas under current pressure indicate that our models captures some of the spatial dimensions of this new deforestation expansion process, and their potentially high predictive power.

Further tests of this hypothesis require studies at multiple scales and in different spatial partitions to understand sub-regional differences. These results should be combined with projective models of land-use change [6] to obtain alternative policy scenarios. We are currently conducting a multi-institutional research initiative in Brazil (the GEOMA Network Project of the Ministry for Science and Technology) to develop detailed analysis of land use change in Amazonia along these lines.

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