Projecting Future Amazonian Landscapes: An Econometric Approach

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IMAZON

NASA: “A Basin Scale Model for Projecting Amazonian Landscapes”
LBA questions....

How does the Amazon function
.......as an ecological-hydrological system?

What does the future hold for the Amazon?
Question 1:

SCIENCE

Question 2:

crystal ball
tarot cards
GIS
CA models
econometrics
### Earlier Answers to Question 2

<table>
<thead>
<tr>
<th>Author</th>
<th>Deforestation Percentage</th>
<th>Scenarios</th>
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</thead>
<tbody>
<tr>
<td>Laurance et al.</td>
<td>42% by 2020</td>
<td>De forested or heavily degraded (<em>Optimistic Scenario</em>)</td>
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<tr>
<td></td>
<td>42% by 2020</td>
<td>De forested or heavily degraded (<em>Non-Optimistic Scenario</em>)</td>
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<tr>
<td>Soares-Filho et al.</td>
<td>28% by 2050</td>
<td>De forested (<em>Governance Scenario</em>)</td>
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<tr>
<td>Andersen et al.</td>
<td>28% by 2020</td>
<td>De forested</td>
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<td>47% by 2050</td>
<td>De forested (<em>Business As Usual Scenario</em>)</td>
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<td>441,550 Km² in 10 years</td>
<td>Accumulated cleared land (<em>No Road Investments</em>)</td>
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<tr>
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<td>425,970 Km² in 10 years</td>
<td>Accumulated cleared land (<em>Road Investments (AB) -3.6%</em>)</td>
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Our Approach

1) Econometric model (Reis, Pfaff, Andersen et. al)
   NOT A BUFFERING FUNCTION……..NOT A “CA” approach

2) Data rich
   # observations........Data used
   3 time steps for deforestation, 3 “lags” in roads

3) Focused just on Closed Forest area
   versus “urbanized” or heavily cerrado tracts

4) Treatment of demographics in projections
   use of 2000 micro-data from the census
The Model

The Data
deforestation, roads

The Scenarios
roads, demography, governance

The Projections
The Data

DEFORESTATION

1976-1987 – Antropismo map, Diagnóstico Ambiental (IBGE), 1:2,500,000 scale

1986-1992 – TRFIC-MSU Land Cover (pixel size reduced to 200m)


ROADS

IBGE Instituto Brasileiro de Geografia e Estatística. 2004. Mapas interactivos de Transportes

DNER Department Nacional de Estradas de Rodagem (DNER). Mapa Rodoviario. Republica Federativa do Brazil, Ministerio dos Transportes
The Model

1) First, fit the regression model, \( Y_t = f(X, X_t X_{t-1} \ldots) \), where \( Y \) in the estimation is % yearly deforestation.

2) Project to 2010, using scenario data.

3) Update forest and scenario data, as necessary.

4) Project to 2020.
Scenarios, to date........

1) AB - Expected Pop growth - No Governance

2) AB - Expected Pop growth - Partial Governance

3) No AB – Expected Pop growth - Partial Governance

4) No AB - Increased Out-migration - Hi Governance
Demographic Scenarios

Microdata files of Brazil's 2000 demographic census

- Age structures for males and females
- In- and out-migration 1995-2000 (yielding net migration)
- Fertility rates and child survival figures for life expectancies

Population projections, from 2000 to 2020
(with moderate fertility declines and slight increases in life expectancy)

Two demographic scenarios:

"Expected population growth"

"Increased out-migration"

Two “city” population scenarios for every Amazon municipality
The Aggregate Story

population in 2000: \textbf{21,073,967} 68\% urban, leaving \textbf{\sim 6,700,000} in rural areas

Fertility: \textbf{5.26}
Life expectancy: \textbf{70} for men, \textbf{71} for women

High birth rate, low death rate

Out-migration, but low: \textbf{-2595} per year between 1995 and 2000

PROJECTED AMAZONIAN POPULATION

Expected Population growth: \textbf{35,409,282}
Increased Out-migration: \textbf{32,678,238}

The Amazon has NOT gone through a demographic transition
Out-migration is not compensating natural increase of the regional population
Population in 2020
Expected Growth

Legend
- < 5,000
- 5,001 - 60,000
- 60,001 - 99,999
- >100,000
Governance Scenarios

Low governance
No protection in PA’s, no control on private holdings

Partial governance
Indigenous areas and Fed Protected: 100%
Fed Sustainable Use and State Protected: 75%
State Sustainable Use: 50%
Private Holdings: 50% rule

High Governance
100% protection in all PA’s
Private Holdings: 20% rule
Scenarios enable us to consider.....

Governance effects
  controlling for pop growth & investment (1 & 2)

Road Investment effects
  controlling for pop growth & governance (2 & 3)

Best and Worst conservation cases (1 & 4)
Expected Population Growth, Road Investments, and Low Governance

2020
31% Deforestation

Note:
Population growth with historical levels of regional out-migration
Avança Brasil projects implemented (2000-2010)
No enforcement of codes in protected areas
No enforcement of limits to deforestation on private holdings
Preliminary Findings

Partial Governance effects  31% vs. 19%

Road Investment effects  19% vs. 19%

Worst vs Best  31% vs 16%
Where to from here?

- Model improvements and refinements
- Further work on the demographics
- Infrastructure effects