Deforestation Evolution in the Amazon Floodplain

Vivian Fróes Renó
Evlyn Novo
Chieno Suemitsu
Thiago Silva

National Institute for Space Research (INPE), Brazil
9th Intecol June 5, 2012
Differences in vegetation cover

Vegetation map of the Amazon Floodplain (1996)

Mapping of wetlands vegetation and inundation at high-water stage

Differences in vegetation cover

Vegetation map of the Amazon Floodplain (1996)

Natural factors x Human activity

Geographic location
Geomorphology

Agriculture
Cattle ranching
Logging
Hypothesis:
The difference in floodplain vegetation cover pattern between the regions upstream and downstream of Manaus is a result of human activities.

Objective:
Assess the existence and extent of deforestation in the Lower Amazon floodplain (downstream of Manaus), between the late 1970s and 2008.
Study Area

- **Brazil**
- **Santarém**
- **Manaus**
- **Almeirim**
- **Óbidos**
- **Tefe**
- **Parintins**
- **Lower Amazon floodplain**

- **AM**
- **PA**

- **Amazon River**
- **Tapajós River**
- **Xingu River**

110 km
Data and methods

Remote sensing data

MSS – Late 1970s
TM - 2008
Data and methods

Field data

Campaigns: high-water (June 2009) / receding-water (Sept. 2009)

Botanical observations = 68
Community Interviews = 117

GPS Photos = 2,023

110 km
Data and methods

1st stage

MSS

Preprocessing

MSS and TM mosaics

Multidate Segmentation

Nearest Neighbor Classification

Vegetation maps integration

Object-oriented analyze

Deforestation Map

Training data
- 17 field points
- ~30 GPS photos

Vegetation Maps

1970s

Accuracy assessment

Field Data
- 168 field points

Vegetation Maps

2008
Results

Historical vegetation map (1970s)

Recent vegetation map (2008)

LEGEND
- Floodplain forest
- Non-forest vegetation
- Bare soil
- Water surface
- Cloud
- Mainland mask

Kappa = 0.77

Kappa = 0.75
### Results

#### Area (km²)

<table>
<thead>
<tr>
<th>Classes</th>
<th>1970s</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodplain forest</td>
<td>7795</td>
<td>4073</td>
</tr>
<tr>
<td>Non-forest vegetation</td>
<td>9096</td>
<td>9548</td>
</tr>
<tr>
<td>Bare soil</td>
<td>248</td>
<td>600</td>
</tr>
<tr>
<td>Water surface</td>
<td>12691</td>
<td>15032</td>
</tr>
<tr>
<td>Cloud</td>
<td>309</td>
<td>887</td>
</tr>
<tr>
<td><strong>Total area</strong></td>
<td><strong>30140</strong></td>
<td></td>
</tr>
</tbody>
</table>

---

1st stage
Results

Deforestation map (1970s - 2008)

<table>
<thead>
<tr>
<th>Classes</th>
<th>km²</th>
<th>% (- water)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deforestation</td>
<td>4336</td>
<td>27</td>
</tr>
<tr>
<td>Floodplain forest</td>
<td>3992</td>
<td>25</td>
</tr>
<tr>
<td>Non-forest veg.</td>
<td>6040</td>
<td>38</td>
</tr>
<tr>
<td>Bare soil</td>
<td>372</td>
<td>2</td>
</tr>
<tr>
<td>Water surface</td>
<td>14227</td>
<td>-</td>
</tr>
<tr>
<td>Cloud</td>
<td>1173</td>
<td>7</td>
</tr>
<tr>
<td>Total area</td>
<td>30140</td>
<td>100</td>
</tr>
</tbody>
</table>

kappa = 0.75
1. About half of the Lower Amazon floodplain was still covered by forest in the late 1970s. Deforestation reduced this to about a quarter of the land area by 2008, but the process was already in course well before the 1970s.

   The major phase in the expansion of agriculture was between 1950 and 1975.

2. The most affected areas were concentrated in the central portion of the Lower Amazon (Óbidos, Santarém, Alenquer and Monte Alegre).

   Together with field information, these results suggest that floodplain deforestation was mainly due to agriculture and livestock activities.

3. The results support the hypothesis that the differences in floodplain vegetation cover patterns upstream and downstream from the city of Manaus are, to a large degree, a consequence of anthropogenic factors.

   However, a more complete characterization of the floodplain cover changes is needed, especially where agriculture and livestock activities play an important economic role.

In order to accomplish this task, larger time series data (7-8 dates), covering other locations of the Amazon floodplain forest are being integrated into this research for further analysis.
Hypothesis:
The process of forest cover change in the Amazon floodplain is not continuous in space and time, as it is subject to the successive economic cycles and occupation history of each region.

Objective:
Access the spatial and temporal patterns of forest cover changes in different regions along the Amazon floodplain using multi-temporal Landsat image classifications.
1. Belém  
2. Xingu  
3. Santarém  
4. Óbidos  
5. Madeira  
6. RDS Piagaçu  
7. Badajós  
8. RDS Mamirauá  
9. Tabatinga

Same methodology
Landsat time series
Each 5 years since 1973
Preliminary results: Belém

Area (km²)

Years

Forest
Non-forest (Vege + Soil)
Water


Floodplain forest
Non-forest vegetation
Bare soil
Water surface
Cloud
Preliminary results: Belém

- Deforestation (1984)
- Deforestation (1989)
- Deforestation (1994)
- Deforestation (1999)
- Deforestation (2004)
- Deforestation (2008)
- Water surface (1973 - 2008)
- Others

Graph showing area (km²) over years from 1984 to 2008 with deforestation and regrowth data.
Next Steps

- Mapping the other areas
- Evaluate landscape evolution (landscape metrics)
- Integration with floristic information (inventories)
- Integration with social information (interviews)

How different patterns of forest cover change affect the integrity of forest ecosystems and the provision of ecosystems goods and services to the local communities?