Tropical Deforestation and the Land-Water Interface

Linking land use and the integrity of freshwater ecosystems

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April 21, 2010
Research goal

To understand how land use change affects the connectivity of streams and explore the implications of these changes for the health of freshwater ecosystems.
Land use intensification

- deforestation
  - 6.3 M ha from 2000-2009 (INPE)

- drivers
  - industrial agriculture
  - cattle production

- land use practices
  - riparian forest removal
  - small dam installation
Catchment scale land use

1996

2007

% agriculture

0-20
20-40
40-60
60-80
80-100

100 km

LU data: Claudia Stickler
Research framework

1. Remote sensing
   - land use history
   - riparian modification
   - impoundments

2. Ecohydrology
   - hydrological flows
   - water quality
   - biotic indicators

3. Ecological function
   - habitat quality
   - disturbance regimes
   - stream fragmentation
1. Remote sensing
   - land use history
   - riparian modification
   - impoundments

2. Ecohydrology
   - hydrological flows
   - water quality
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3. Ecological function
   - habitat quality
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Conservation outcomes:
   - Improved understanding of land use impacts on aquatic ecosystems
   - Scientific basis for improved management
Remote sensing
Multiple scales

Temporal Frequency

- 1-30 days
- 1 Year
- Sporadic

Spatial Resolution

- > 250 m
- 30 m
- MODIS
- Landsat
- ASTER

- phenology
- land use history

- land cover
- riparian forests
- impoundments
- fragmentation
EVI time series

Galford et al., RSE 2008
EVI time series
## Water quality indicators

<table>
<thead>
<tr>
<th></th>
<th>F-Pasture</th>
<th>F-P-Soy</th>
<th>Forest</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>hourly</strong></td>
<td>• T, rainfall, light, turbidity, discharge, RH</td>
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<tr>
<td><strong>monthly</strong></td>
<td>• T, DO, pH, conductivity, nutrients</td>
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<tr>
<td><strong>yearly</strong></td>
<td>• periphyton (production, biomass) • fish community</td>
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</tbody>
</table>

- **n=3**
- **n=5**
- **n=4**
• primary production (chl-a)
• nutrient limitation
• community composition
• discharge ($m^3/s$)
• water level (mbars)
• discharge ($m^3/s$)
• light (lux)
• temperature (C)
• clarity (luxA/luxB)
Maximum daily temperature

Temperature (°C)

- Forest
- Soy
- Pasture

The diagram compares the maximum daily temperature across different land uses: forest, soy, and pasture. The box plots show the distribution of temperatures, with the central line indicating the median temperature.
Modeling stream temperature

Covariates

- light
- riparian cover
- discharge
- rainfall
- watershed area
- LU history
- impoundments
- air temperature

Nepstad et al., 2007
Ecological function
Hydrological connectivity

- fragmentation alters physical variables that determine basic ecological function
- impoundments and riparian forest removal change:
  - flow/sediment transport
  - light/temperature
  - nutrient regimes

Photo: Vania Neu, 2007
Extrapolating to landscape scale

- Develop fragmentation indices
  - impoundments
  - riparian disturbance
  - landscape metrics

- Infer impacts on biota

- Prioritize management

**Diagram:**
- Impoundments
- "Hotspot" (degraded riparian)
Xingu in the news...

Belo Monte Dam May Operate at 40% of Capacity, Estado Says

Amazon Dam Project Pits Economic Benefit Against Protection of Indigenous Lands

Avatar director James Cameron joins Amazon tribe's fight to halt giant dam
Acknowledgments...

- Blue Moon Foundation
- Columbia University, E3B Dept.
- DeFries lab group
- Instituto de Pesquisa Ambiental da Amazônia
- NASA Earth System Science Fellowship
- Packard Foundation
- Universidade Federal de Minas Gerais (UFMG), Dept. of Limnology
- Universidade Estadual de Maringá, NUPELIA
- Universidade Estadual do Mato Grosso, Dept. of Ichthyology
- University of Maryland, Dept. of Geography
- Woods Hole Research Center
Thank you

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