

From the Landscape to the Region: Scaling up Approaches in Human and Physical Dimensions of Land-Use and Land-Cover Change in the Amazon

LBA - LC 34



**Mateus Batistella
Embrapa Satellite Monitoring**

Study Areas

1. Yapu, Colombia



2. Marajó, PA



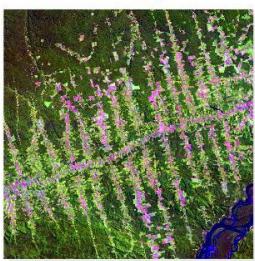
3. Igarapé-açu, PA



4. Tomé-açu, PA



5. Altamira, PA

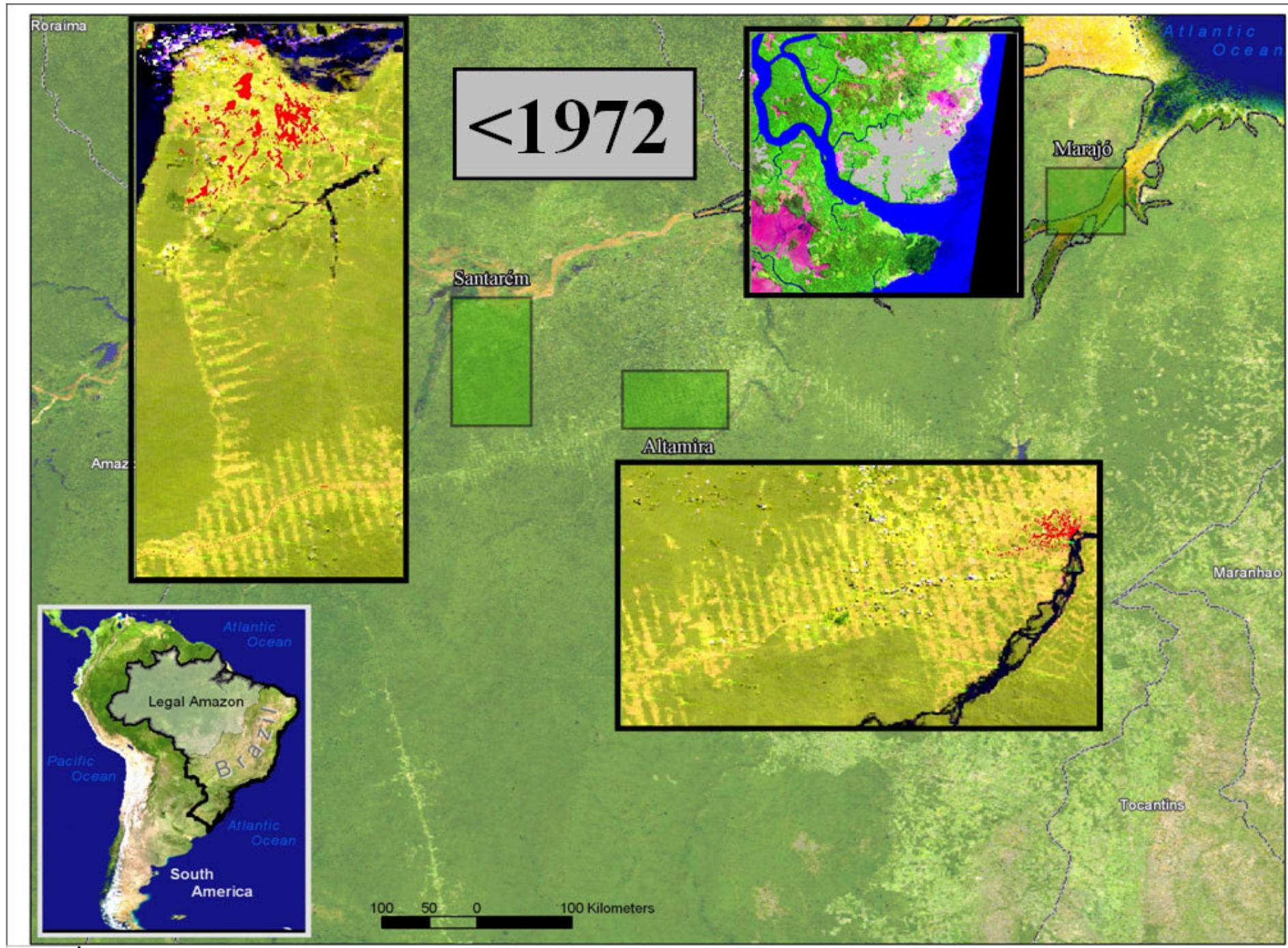


7. Machadinho, RO



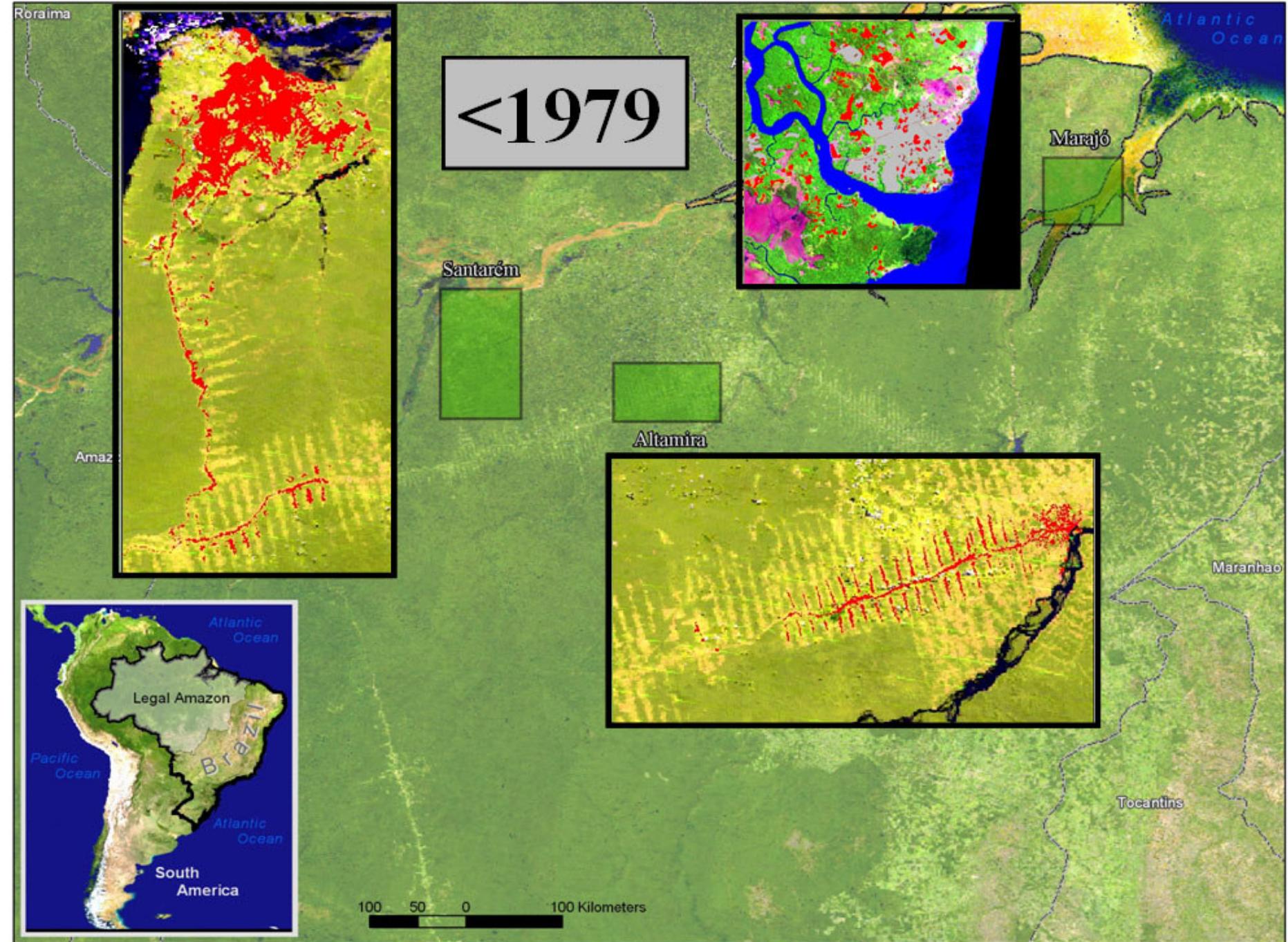
6. Santarém, PA



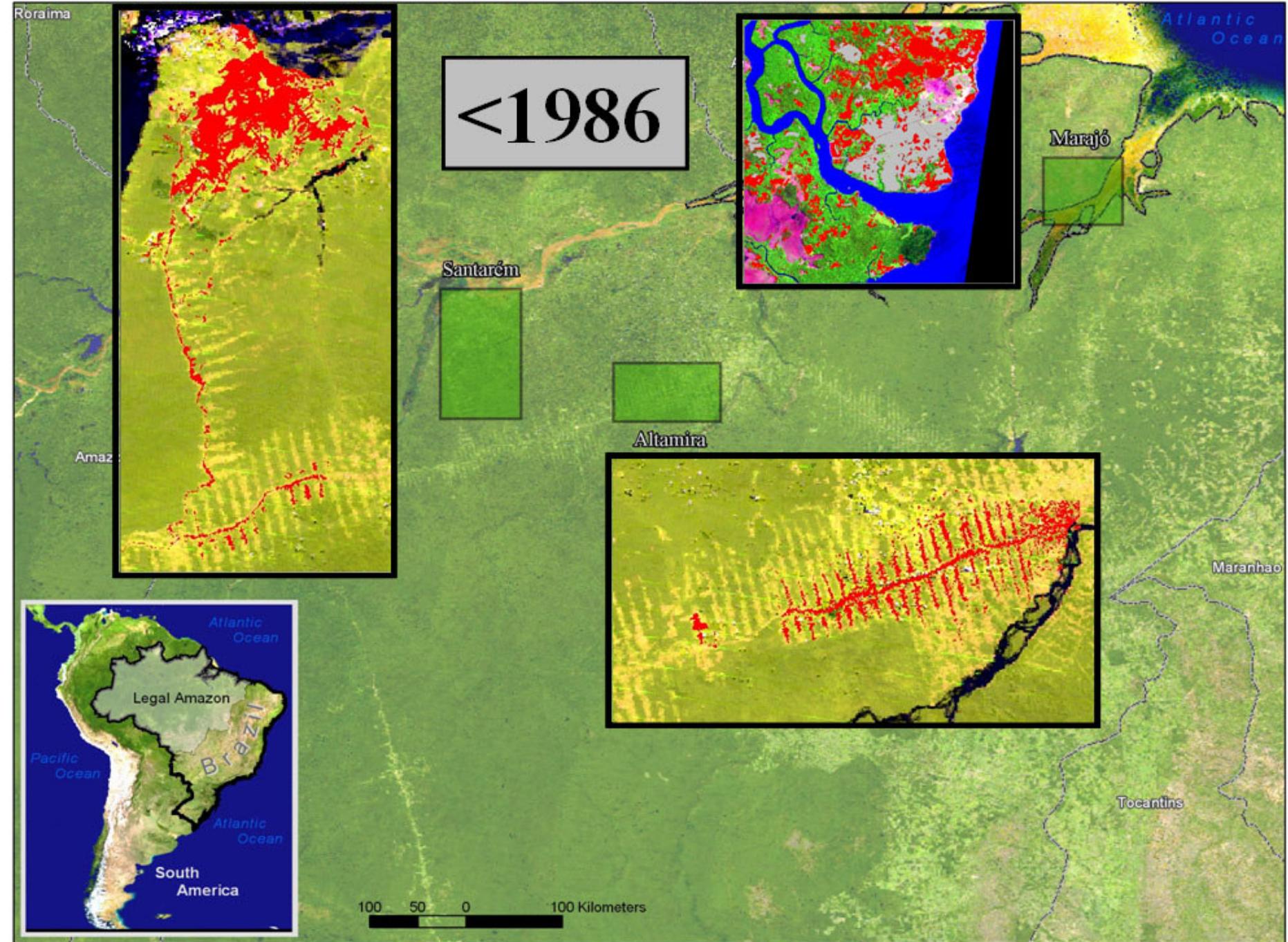


Created by Scott Hetrick 09/04. Data Sources include NASA's Earth Observatory Team, Instituto Nacional de Pesquisas Espaciais (Brazilian Space Agency), Instituto Brasileiro de Geografia e Estatística and ESRI.

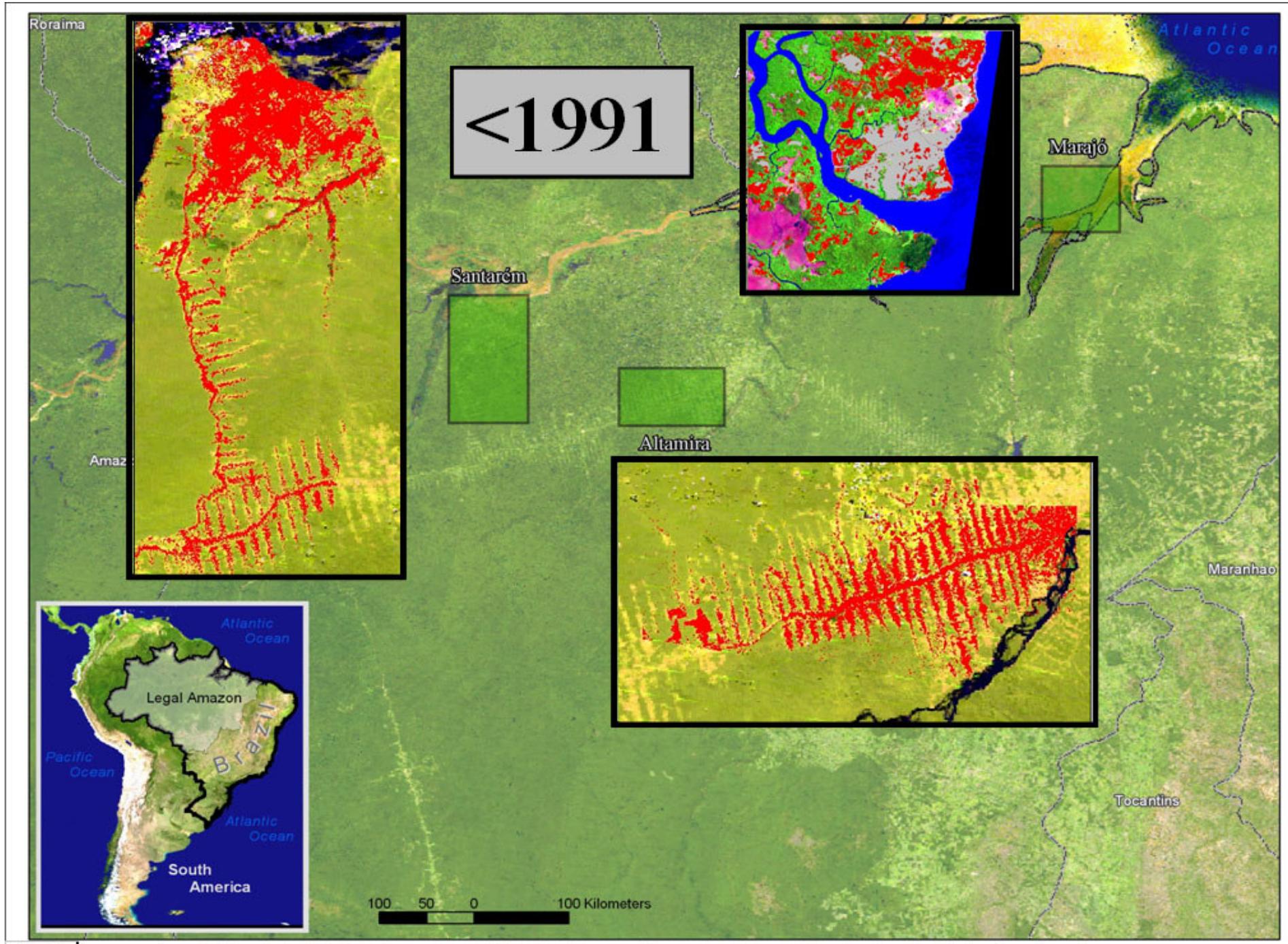




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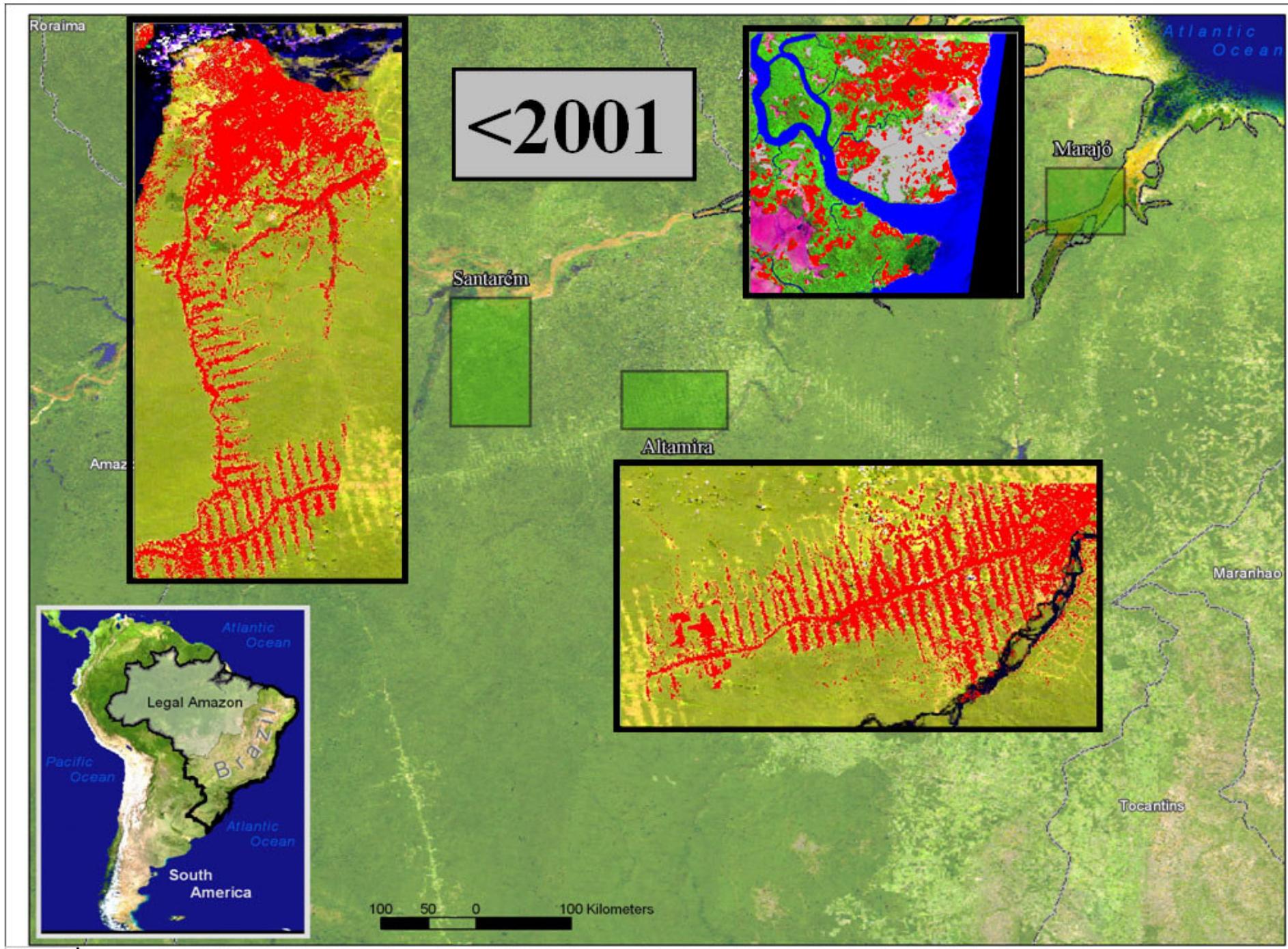


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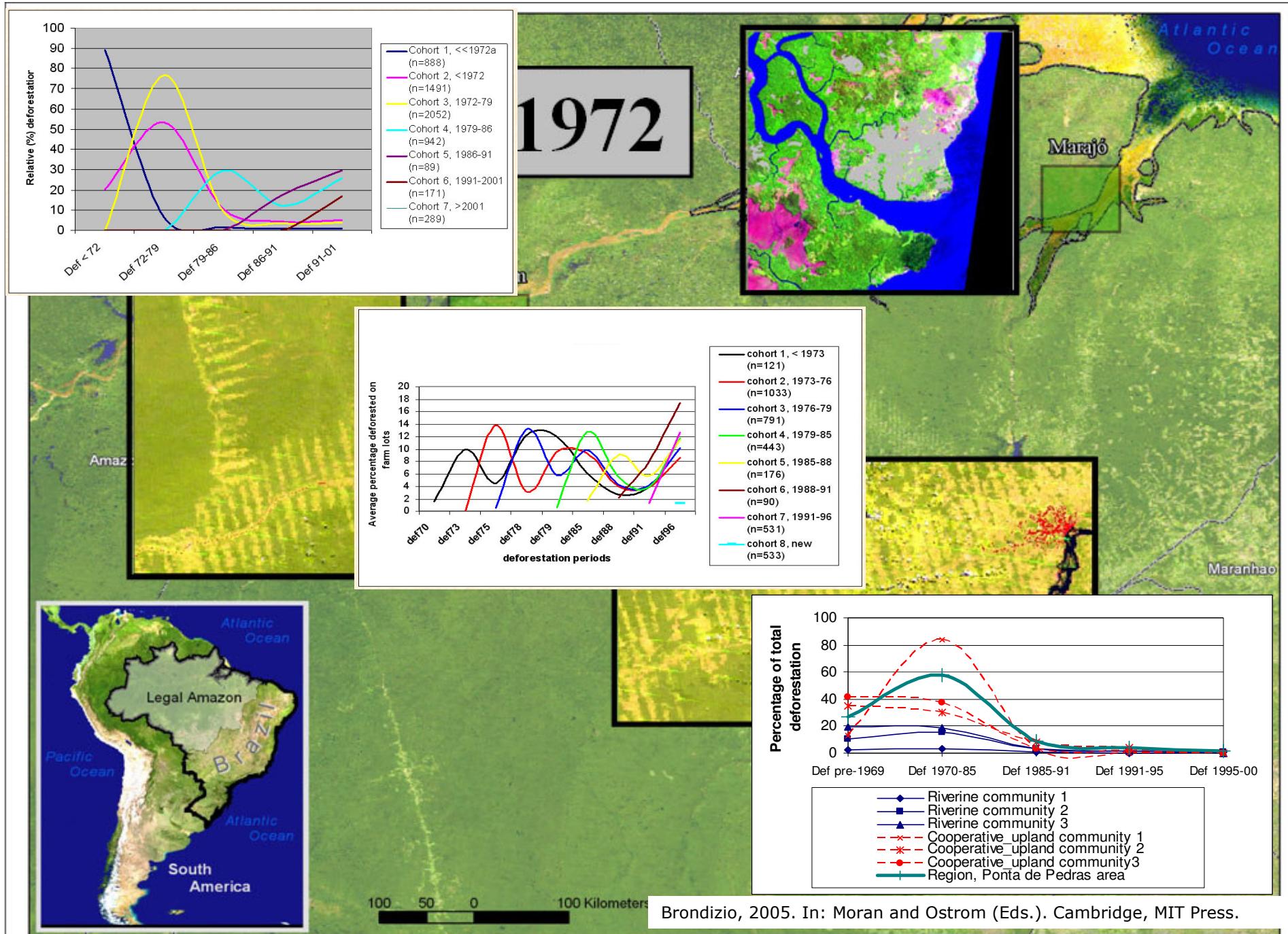


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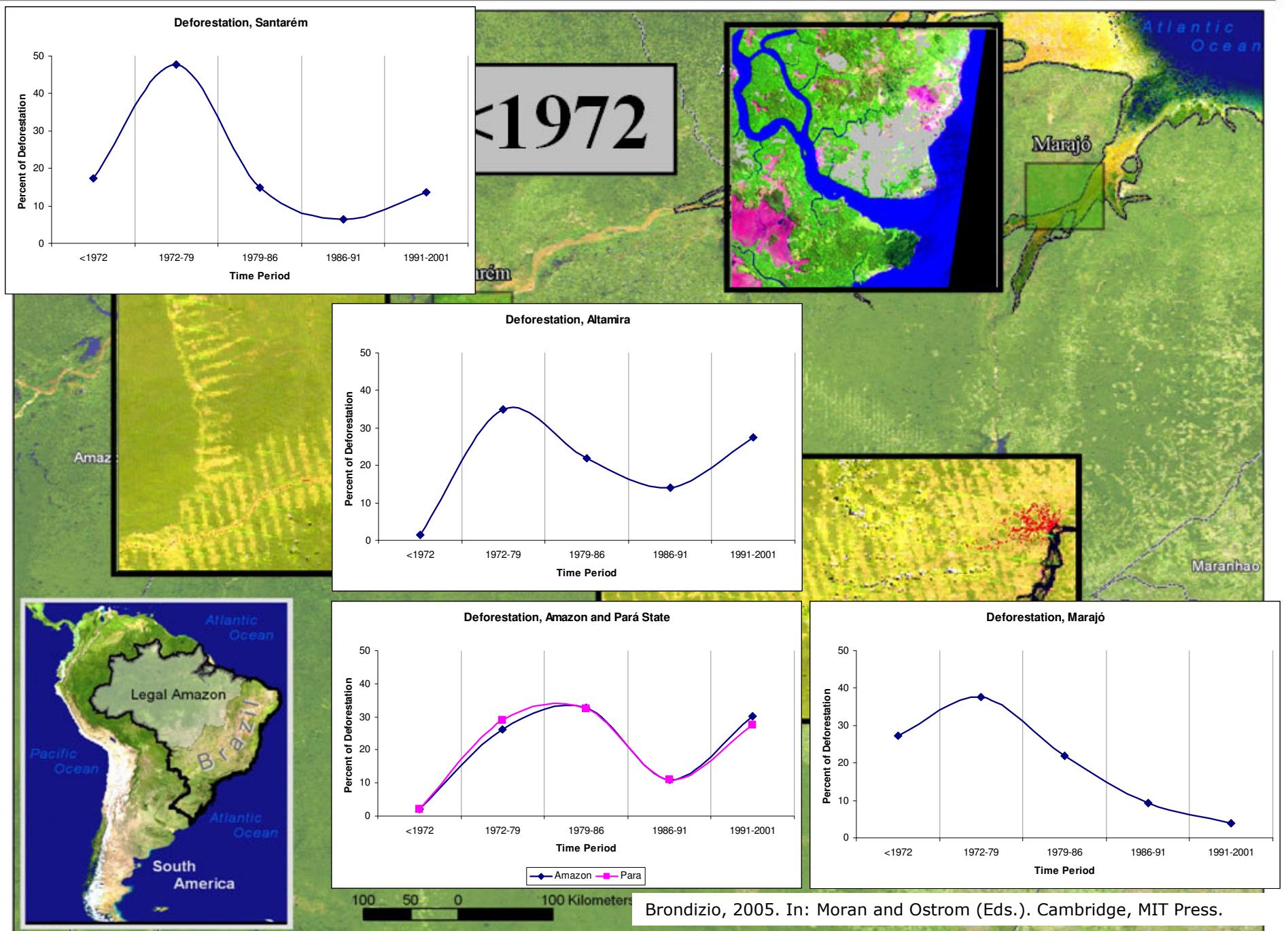




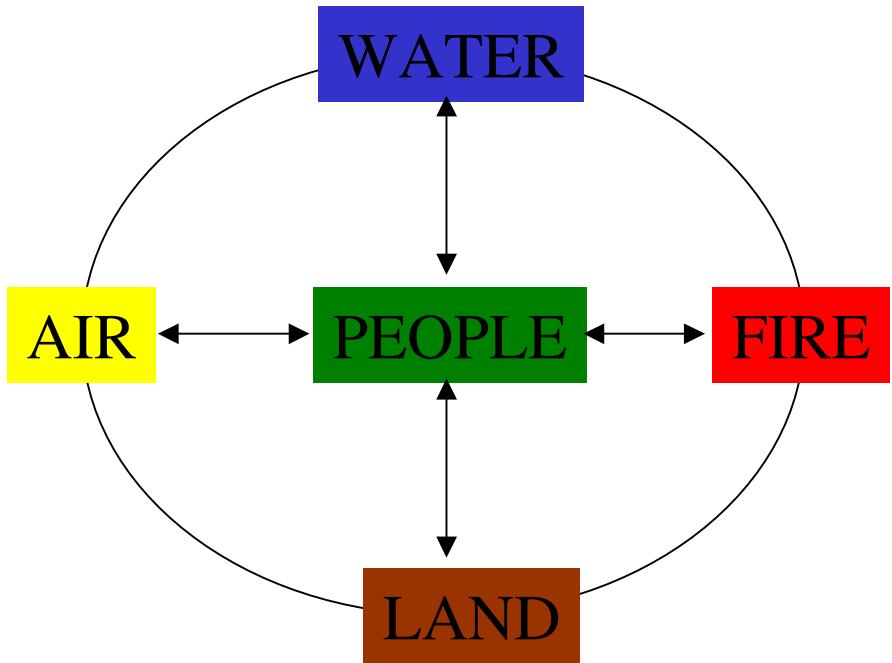
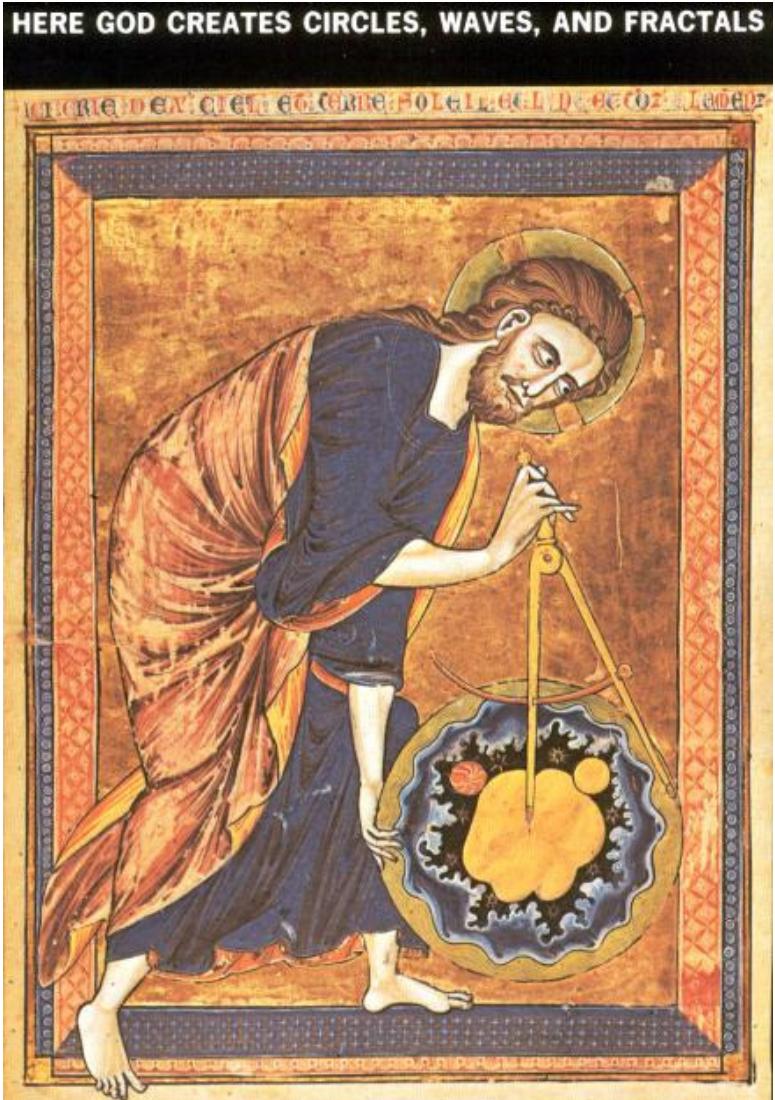
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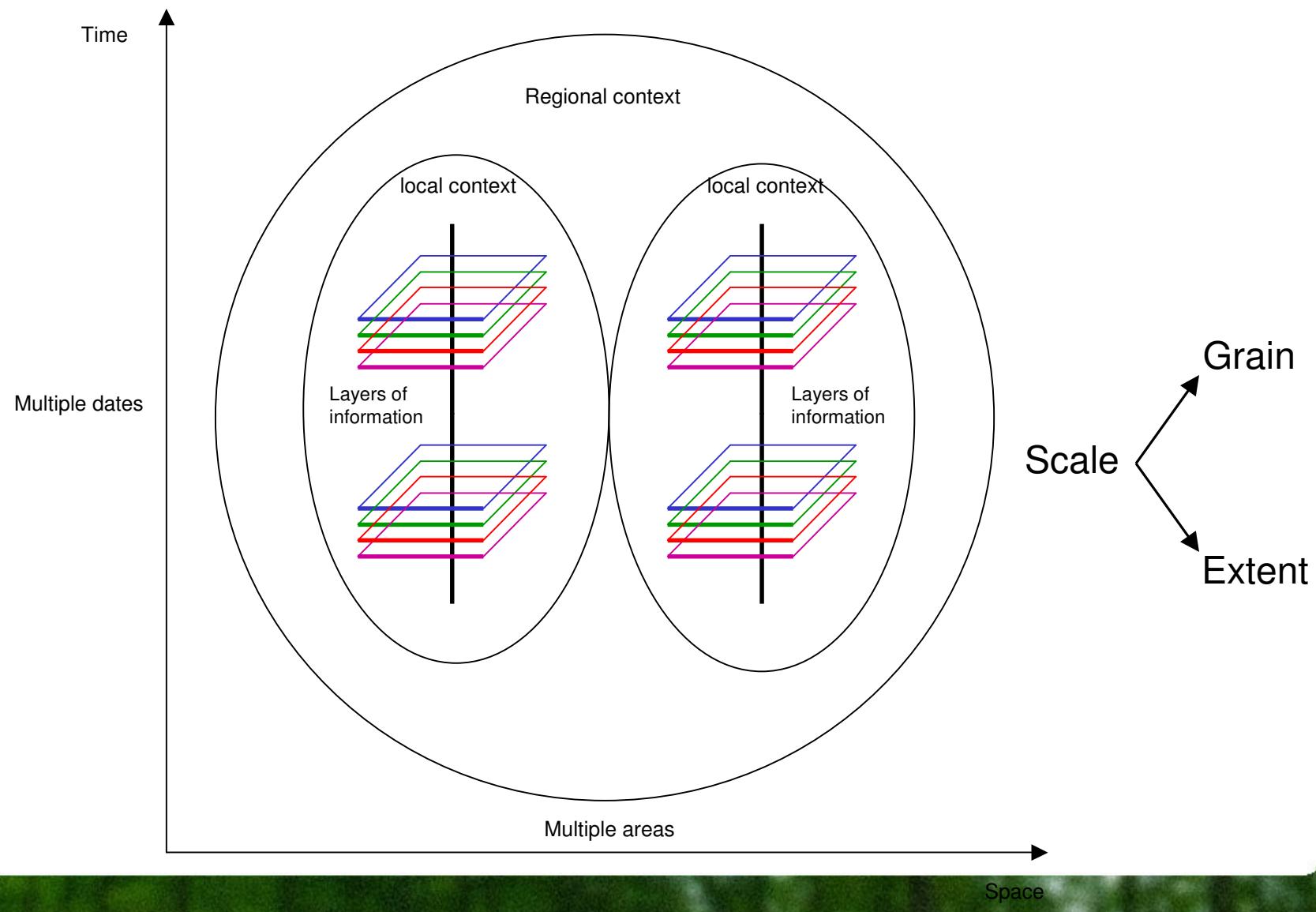
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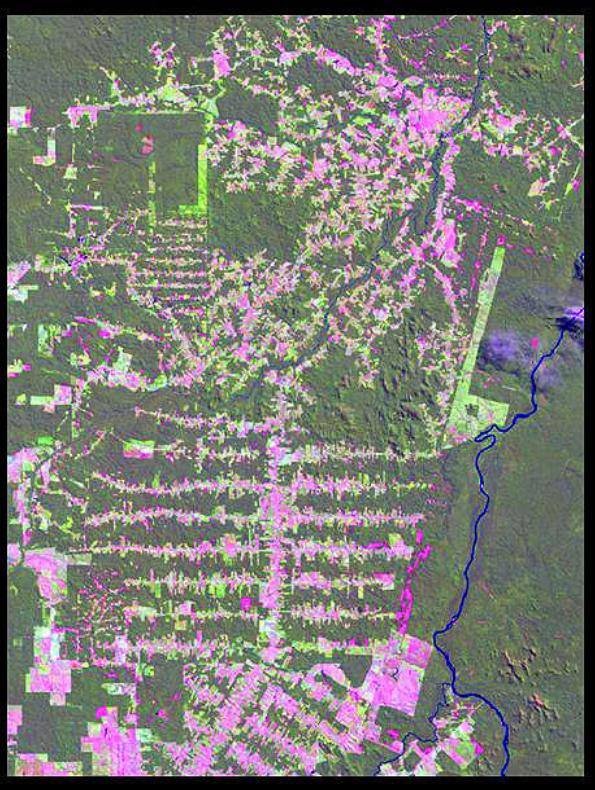


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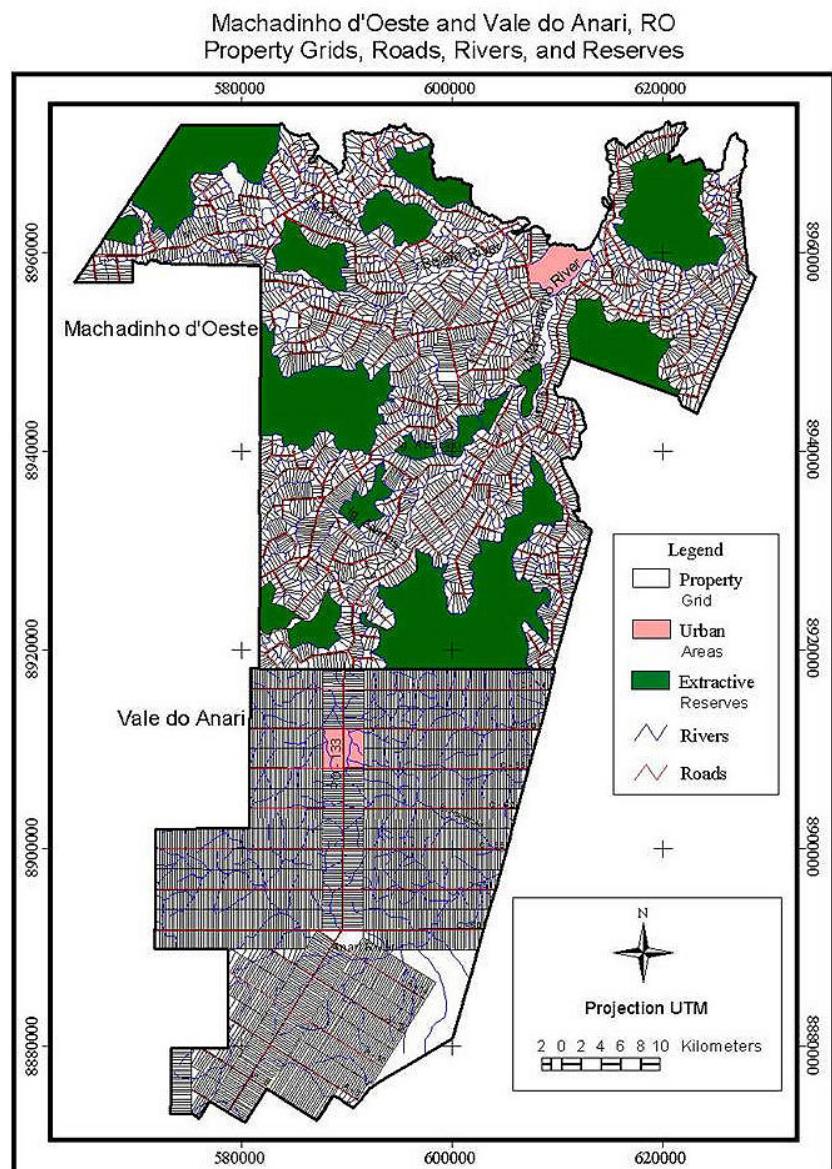


Conceptual approach for analyses of the human dimensions of landscape change



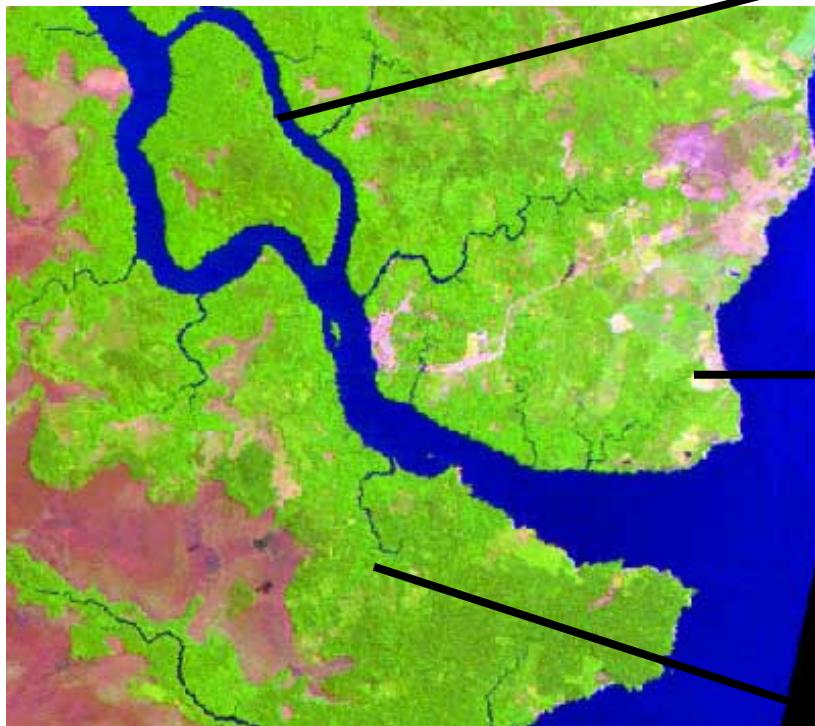


- Fieldwork: training samples
- Vegetation structure analysis: SS1, SS2, SS3, forest
- Multitemporal LULC classification
- GIS integration
- Landscape metrics calculation
- Institutional analysis



Batistella et al., PERS, 69 (7), 2003.

1 LOCATION → **3 SITES**



Land cover patterns associated with
land use systems in Marajo Island,
Amazon Estuary

Agroforestry



**Mechanized agriculture
and cattle ranching**

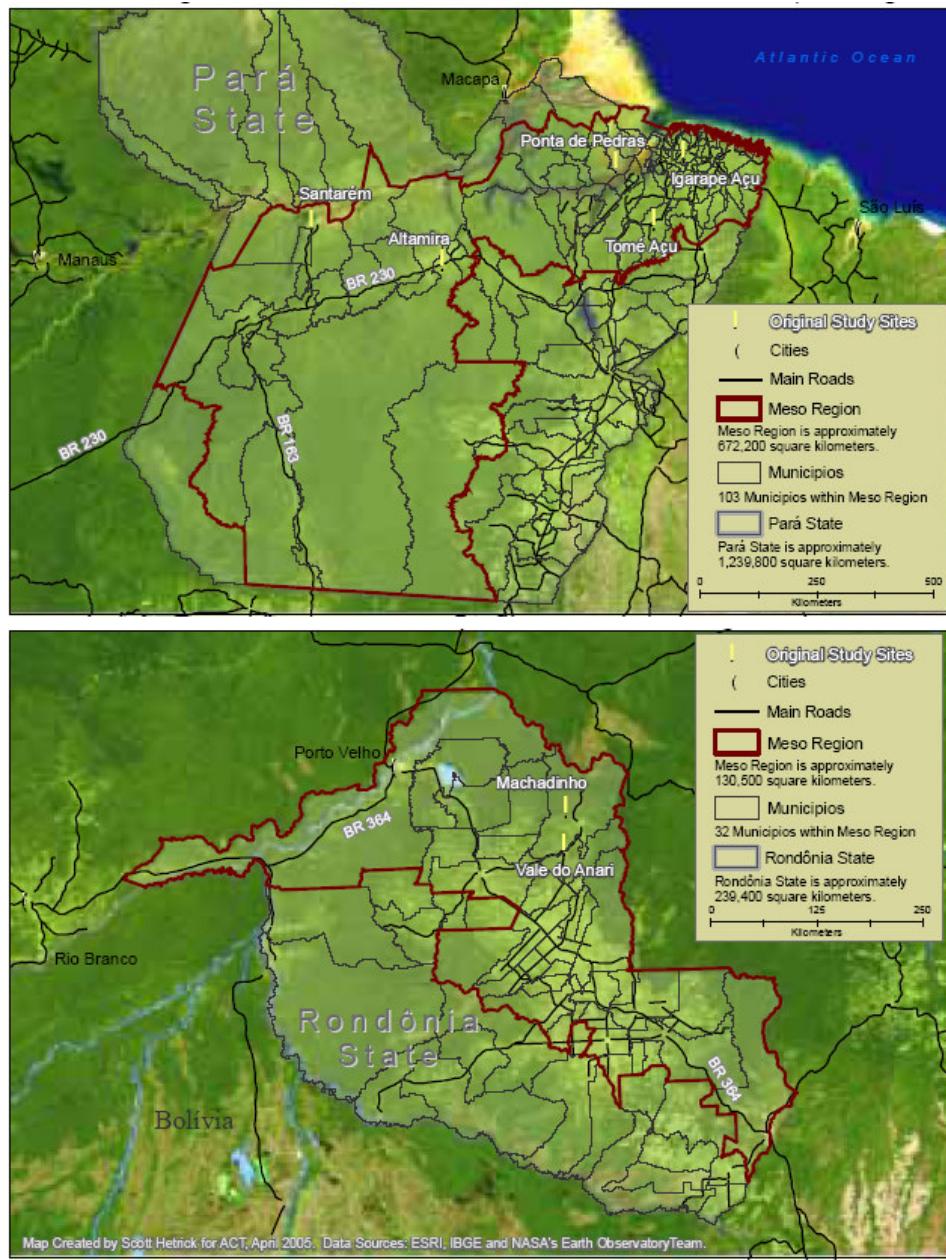


**Swidden Agriculture and
Agroforestry**



Brondizio *et al.*, Urban Ecosystems, 6, 2002.

Scaling up in LC-34



LBA-ECO LC-34 Scaling Up Approaches

- **Remote Sensing Lenses**
- To differentiate SS/AGF (high C content) from all other LC classes within the deforested areas in 2004
- To repeat the procedure in a multitemporal basis for 1997 (AVHRR) and 2001 (MODIS)
- **Demography Lenses**
- To address the human distribution among the study mesoregions through aspects related to the rearrangement of the agrarian structure (i.e., lot turnover, population mobility, household ‘reorganization’)

Scaling-up Research in Pará

MODIS

TM
Marajó

TM
Santarém

TM
Tome-Açu

TM
Altamira

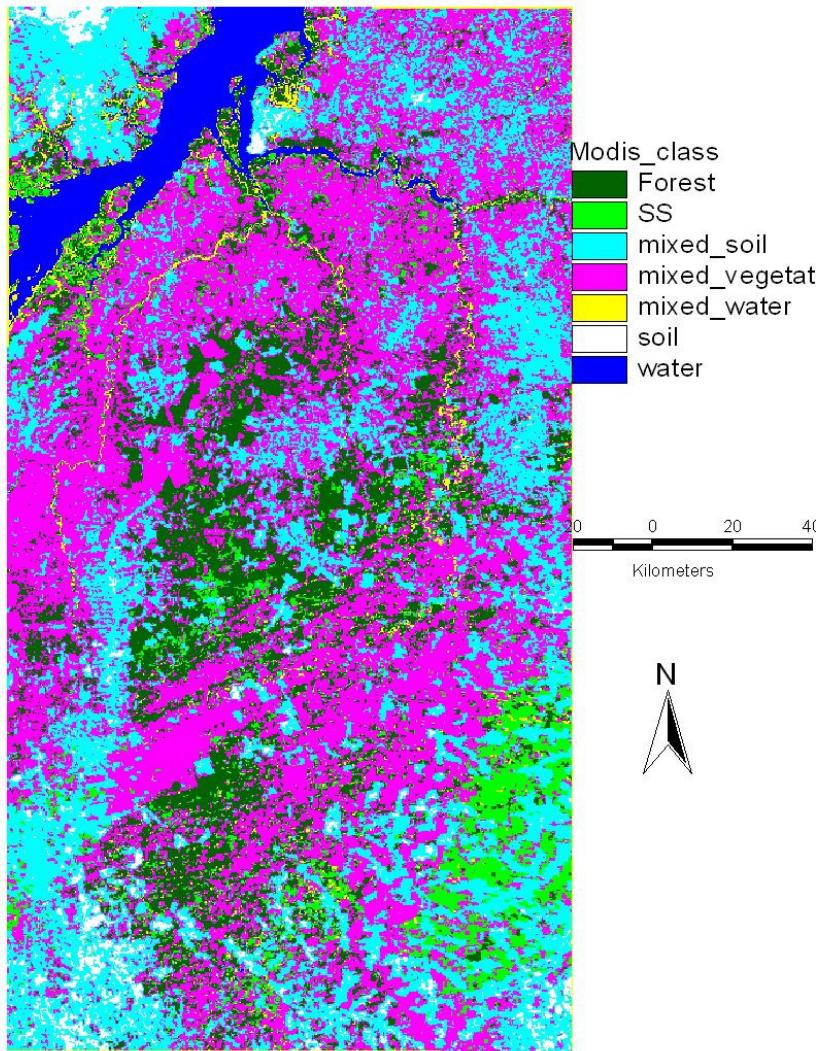
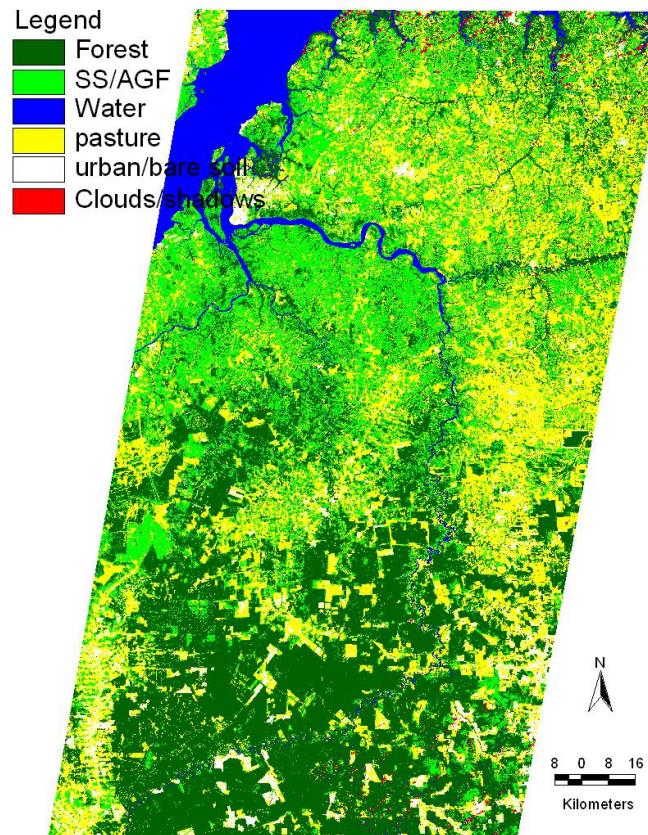
Scaling-up through Remote Sensing

- Image classification
 - TM image classification for selected four sites (Marajó, Tomé-Açu, Santarém, and Altamira): Five classes – forest, SS/AGF, pasture, water, and urban/bare soils)
 - MODIS image classification for the entire mesoregions in Pará and Rondônia based on fraction images (vegetation, shade, and soil): Five classes: forest, SS/AGF, pasture, water, urban/bare soils, and mixed classes

Previous Experience with Land-Cover Classification in the Amazon

- Lu, D., Batistella, M., Moran, E., and de Miranda, E. E., (in press). A Comparative Study of Landsat TM and SPOT HRG Images for Vegetation Classification in the Brazilian Amazon. *Photogrammetric Engineering and Remote Sensing*.
- Lu, D. 2005. Integration of Vegetation Inventory Data and Landsat TM Image for Vegetation Classification in the Western Brazilian Amazon. *Forest Ecology and Management*, 213(1-3), 369–383.
- Lu, D., Mausel, P., Batistella, M., and Moran, E. 2004. Comparison of Land-Cover Classification Methods in the Brazilian Amazon Basin. *Photogrammetric Engineering and Remote Sensing*, 70(6), 723–731.

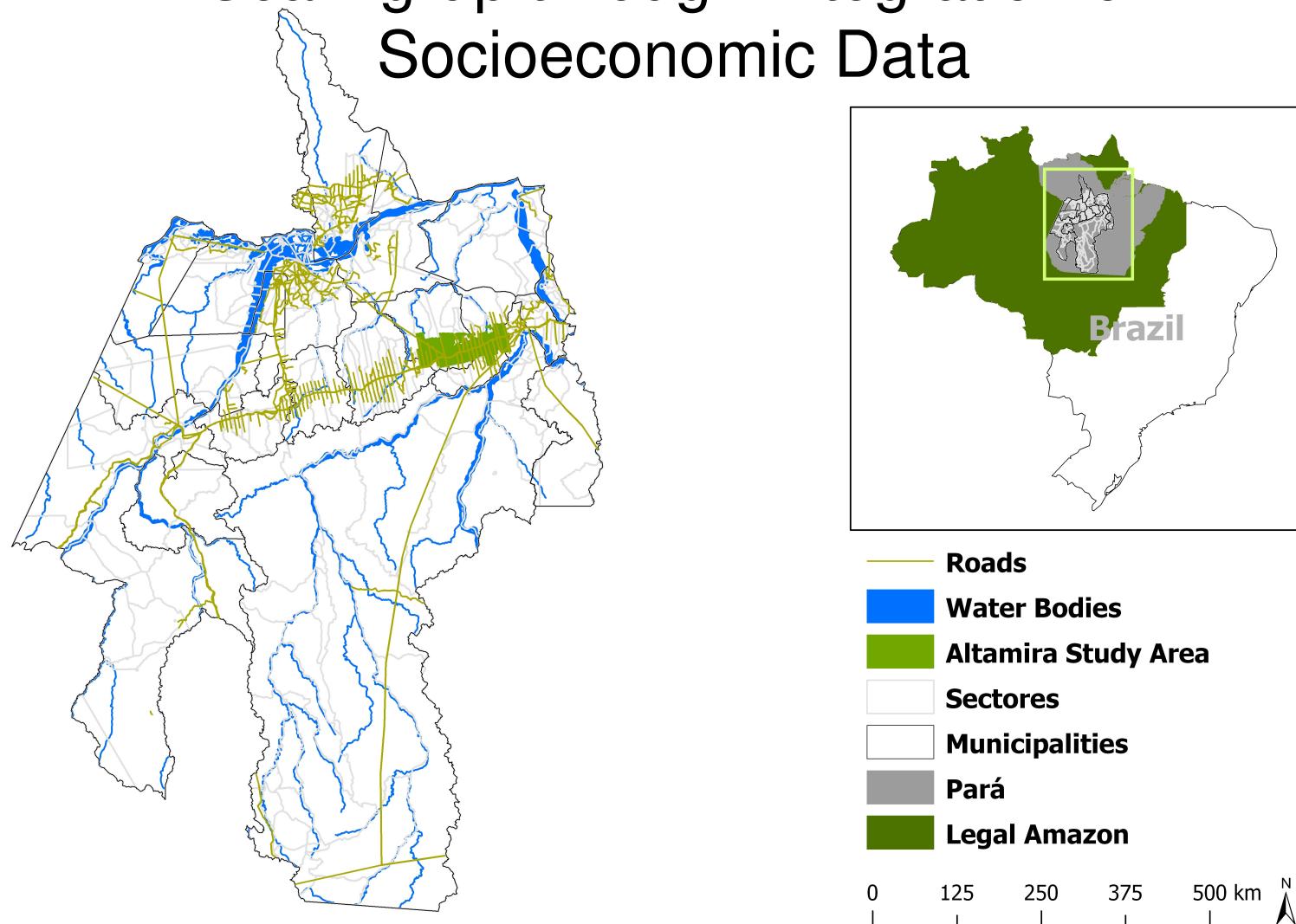
Preliminary Classification Images from TM and MODIS Data (2002) in Pará (Tomé-Açu Site)



Scaling-up through Remote Sensing (cont.)

- Selection of samples based on TM and MODIS classified images at the four selected sites for the mixed classes
- Development of scaling-up approaches based on per-pixel and census tract levels
 - Multiple regression analysis
 - Geostatistical analysis such as kriging
- Accuracy assessment and uncertainty analysis

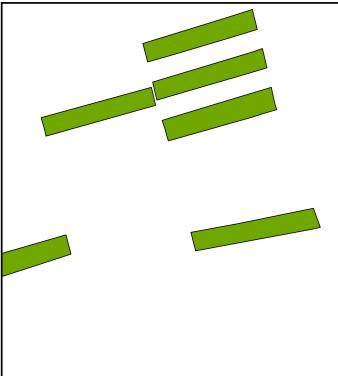
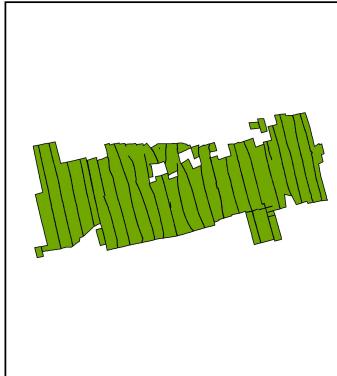
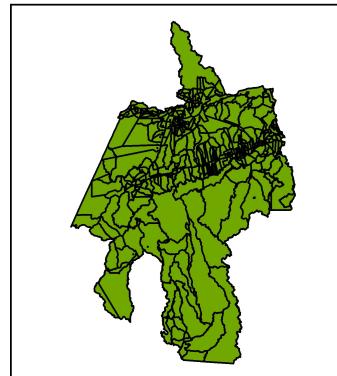
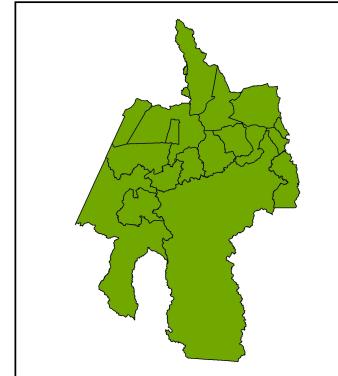
Scaling-up through Integration of Socioeconomic Data



Studies of population and environment have linked social surveys and satellite data to understand the role of human demography in land cover change. In both data sources, **scale** and **scale-dependency** are significant factors affecting data analyses and interpretation

Scaling-up through Integration of Socioeconomic Data

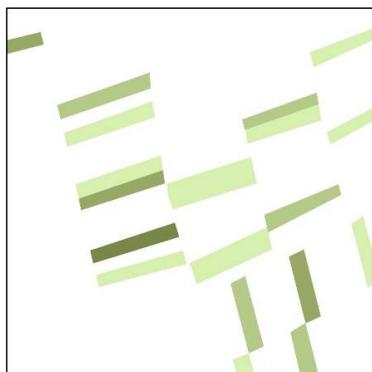
Scales of Study

	Rural Lot	Settlement	Census Tracts	Municipality
				
0 2 4 km	0 35 70 km	0 300 600 km	0 300 600 km	
Total Area (km²)	443.92	3,842.13	396,383.85	396,383.85
Number of Units	402 lots	3,916 lots	482 sectors	17 municipalities
Population (people)	3,072	N.D.	759,797	786,670

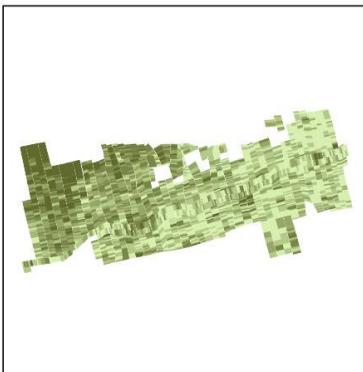
Scaling-up through Integration of Socioeconomic Data

Land Cover Variables

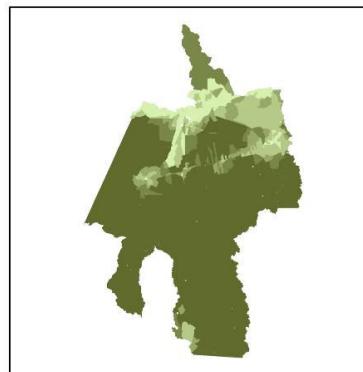
Rural Lot



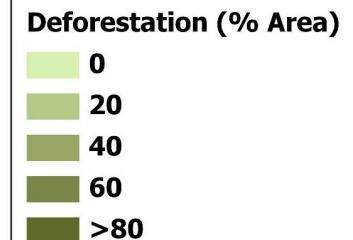
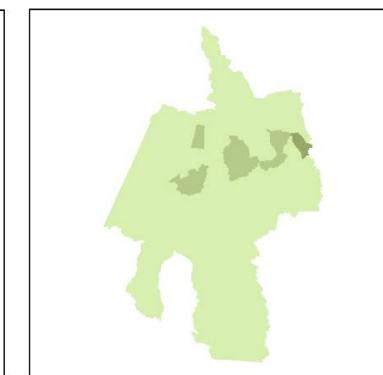
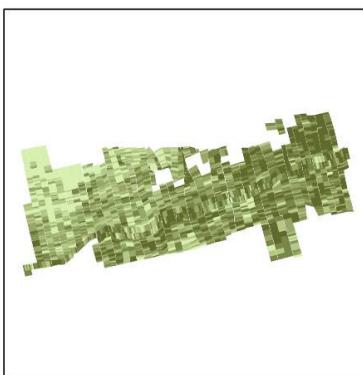
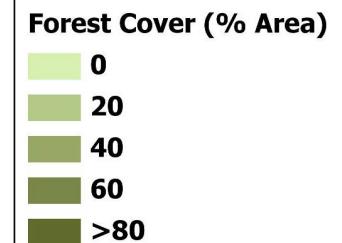
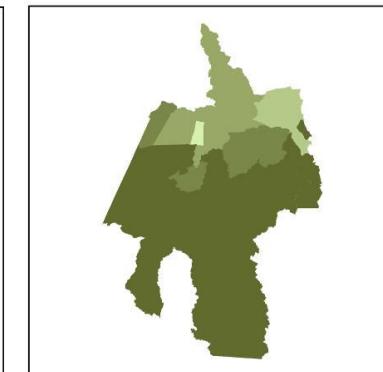
Settlement



Census Tracts

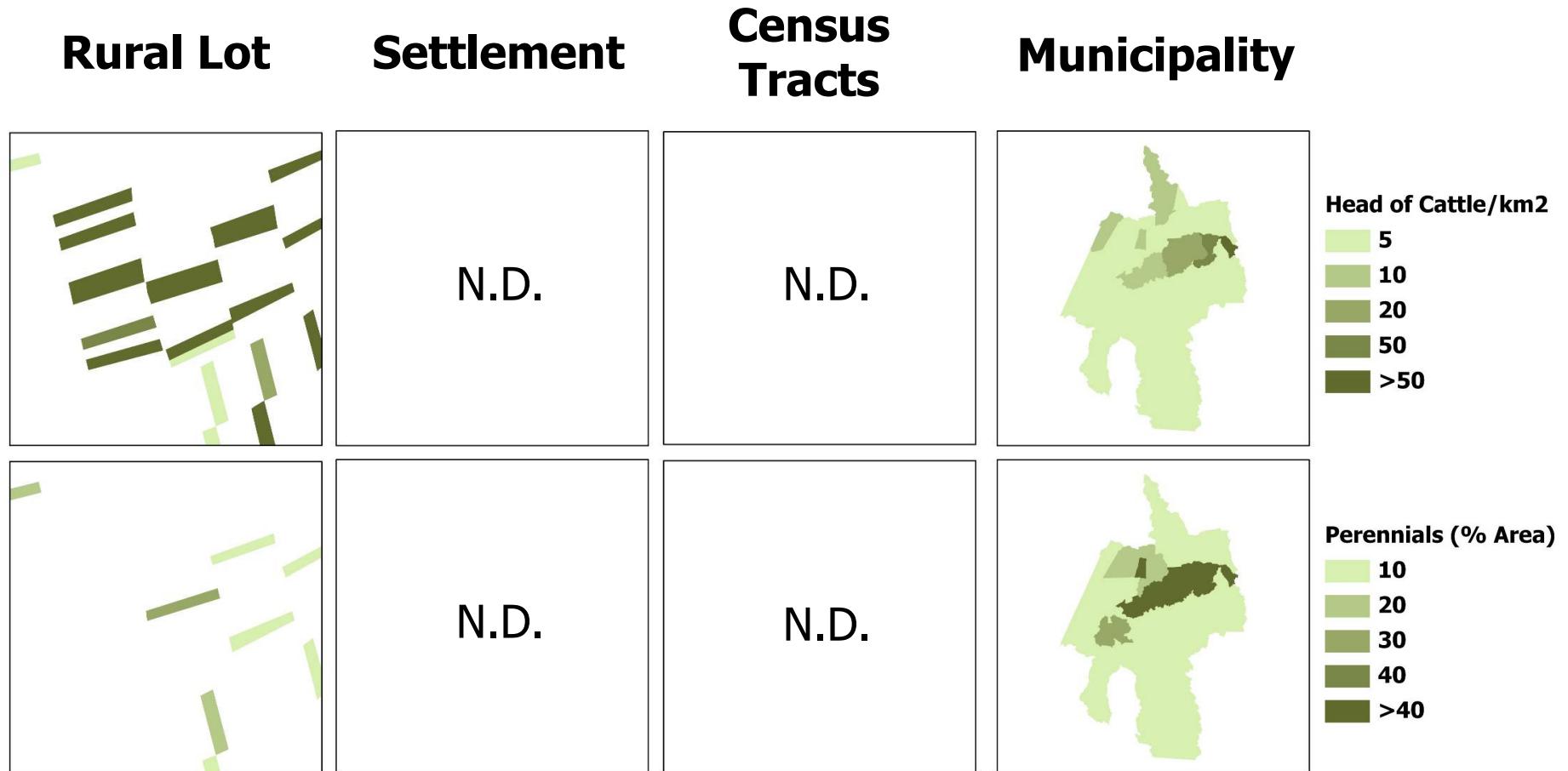


Municipality



Scaling-up through Integration of Socioeconomic Data

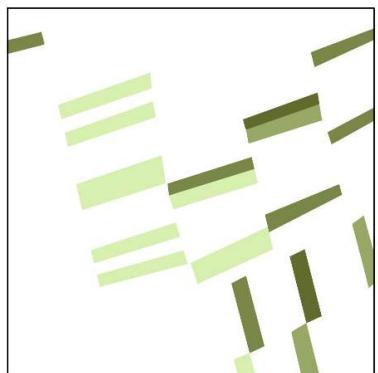
Land Use Variables



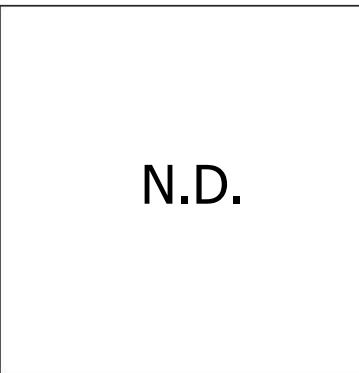
Scaling-up through Integration of Socioeconomic Data

Population Variables

Rural Lot



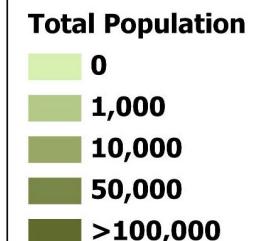
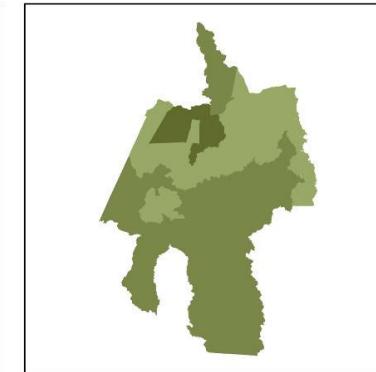
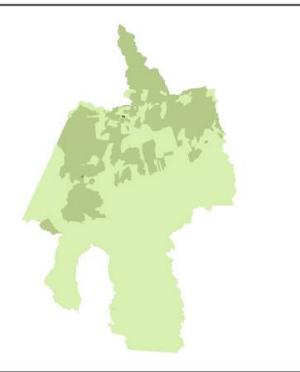
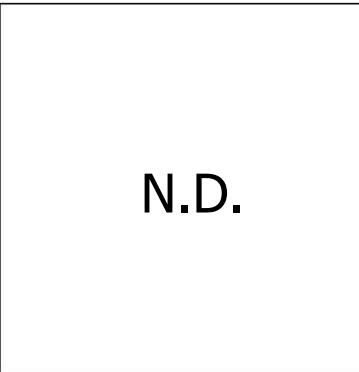
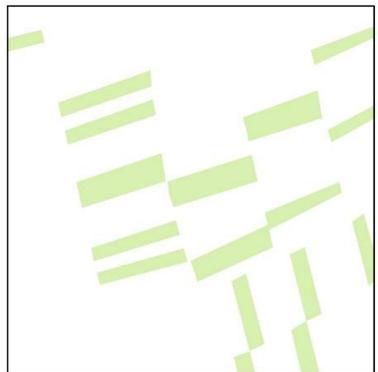
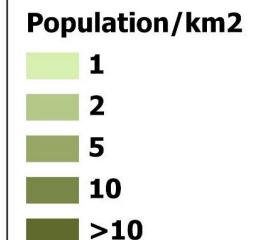
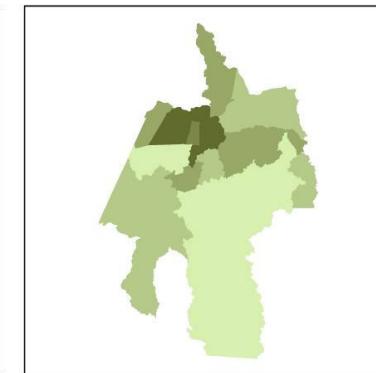
Settlement



Census Tracts



Municipality



1. Rural Lot Scale

	Forest (% Area)	Deforested (% Area)	Cattle (Head)	Perennials (% Area)	Pop. Dens. (Pop./km²)
Forest (% Area)	1.0000				
Deforested (% Area)	-0.9405*	1.0000			
Cattle (Head)	-0.2842*	0.2731*	1.0000		
Perennials (% Area)	-0.0459	0.0343	-0.1325*	1.0000	
Pop. Dens. (Pop./km²)	0.0482	-0.0139	-0.2338*	0.2952*	1.0000
Total Population	0.0062	0.0042	-0.1389*	0.3136*	0.8982*

2. Census Tract Scale

	Forest (% Area)	Deforested (% Area)	Cattle (Head)	Perennials (% Area)	Pop. Dens. (Pop./km²)
Forest (% Area)	1.0000				
Deforested (% Area)	-0.7239*	1.0000			
Cattle (Head)	---	---	---		
Perennials (% Area)	---	---	---	---	
Pop. Dens. (Pop./km²)	-0.1323*	0.2402*	---	---	1.0000
Total Population	-0.1059*	0.0619	---	---	0.2883*

3. Municipality Scale

	Forest (% Area)	Deforested (% Area)	Cattle (Head)	Perennials (% Area)	Pop. Dens. (Pop./km²)
Forest (% Area)	1.0000				
Deforested (% Area)	-0.5204*	1.0000			
Cattle (Head)	0.0457	0.4478+	1.0000		
Perennials (% Area)	0.2143	0.1608	0.2566	1.0000	
Pop. Dens. (Pop./km²)	-0.4344+	0.4153+	0.0370	0.0221	1.0000
Total Population	0.0062	-0.0650	0.2329	-0.0571	0.7167*

Insights from the current work

- Our research shows the importance of moving back and forth between basin-wide analysis and detailed case studies. Basin-wide analysis alone would miss observations and processes such as Marajo agroforestry intensification and the maintenance of forest cover by extractivists in Rondônia. Public policies based on basin-wide analysis alone could undermine important sustainable practices
- Understanding the behavior and drivers of LCLUC cannot be derived from land-cover analysis alone, but requires detailed human dimensions data analysis
- Data aggregated into larger administrative scales (e.g., municipalities) may result in a loss of understanding about local scale variability
- Disaggregation into census tracts, settlements or rural lots may allow a better understanding of intramunicipality variations, but does not allow mesoscale integration