

# **Strengthening the Human Dimension in the NASA LCLUC**

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# NASA LCLUC Program

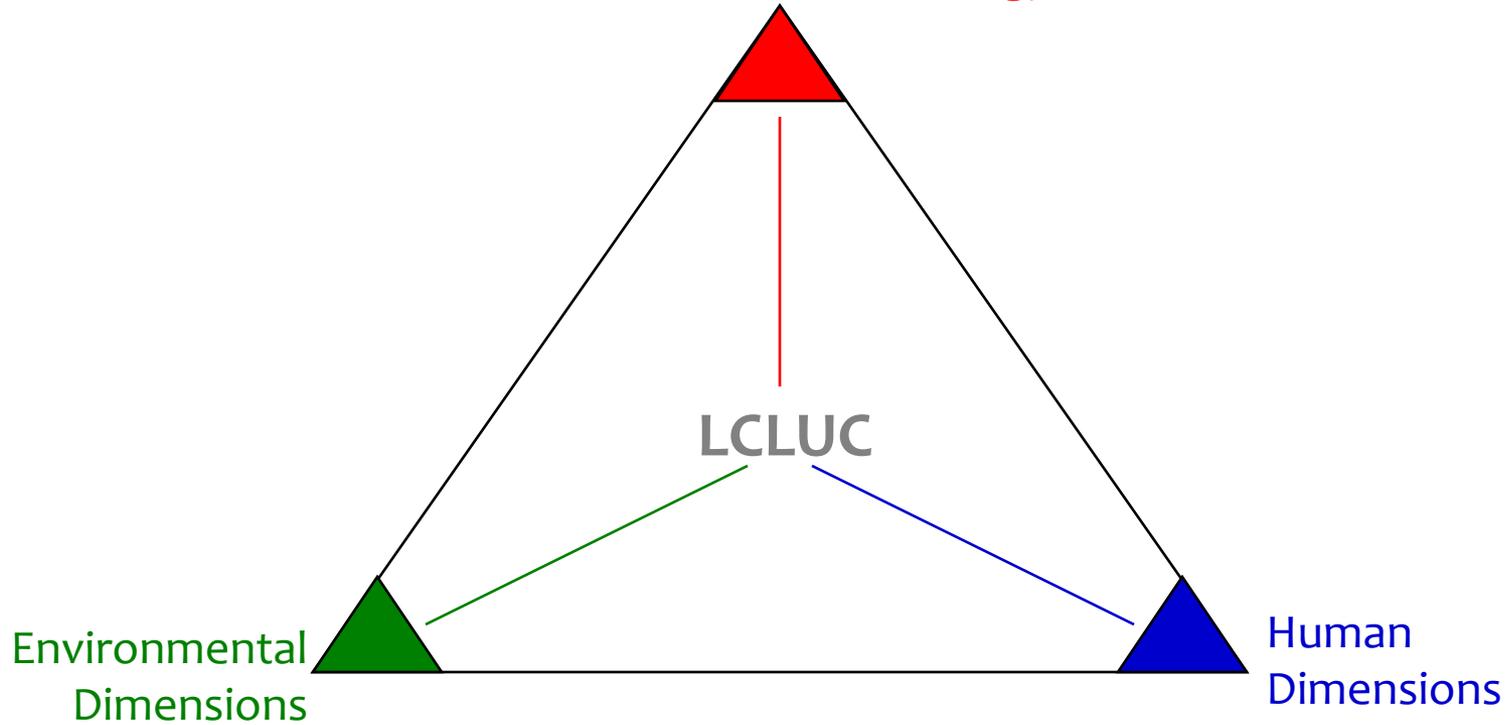
“The LCLUC Program, through an interdisciplinary approach, is developing and using NASA remote sensing technologies to improve understanding of human interactions with the environment and, thus, provides ***a scientific foundation for understanding the sustainability, vulnerability and resilience of human land-use and terrestrial ecosystems.***”

LCLUC Web Site

<http://lcluc.umd.edu/>

# LCLUC Intent

NASA  
satellite & data technology



# From Then To Now

- LCLUC began with NRA's focused on regional case studies & social processes of land change

- assumption: understanding processes will improve process driven models critical for global environmental & climate change communities \_

- impact: attention to drivers & movement beyond simple PAT variables (Population, Affluence, Technology)

- issues unresolved:

- Some comparative-synthesis work → BUT general rules not reached

- Models developed in specific cases, but few integrated models

- Subsequent LCLUC NRA's on LC Data sets, Carbon, Hydrology, Model Projections & Adaptation

- retains a strong emphasis on regional scale initiatives and in-country partnerships (e.g. NEESPI, MAIRS) but HD component patchy

- steady decline in HD elements on proposals

- proposals tend to be strong on remote sensing or HD but not both

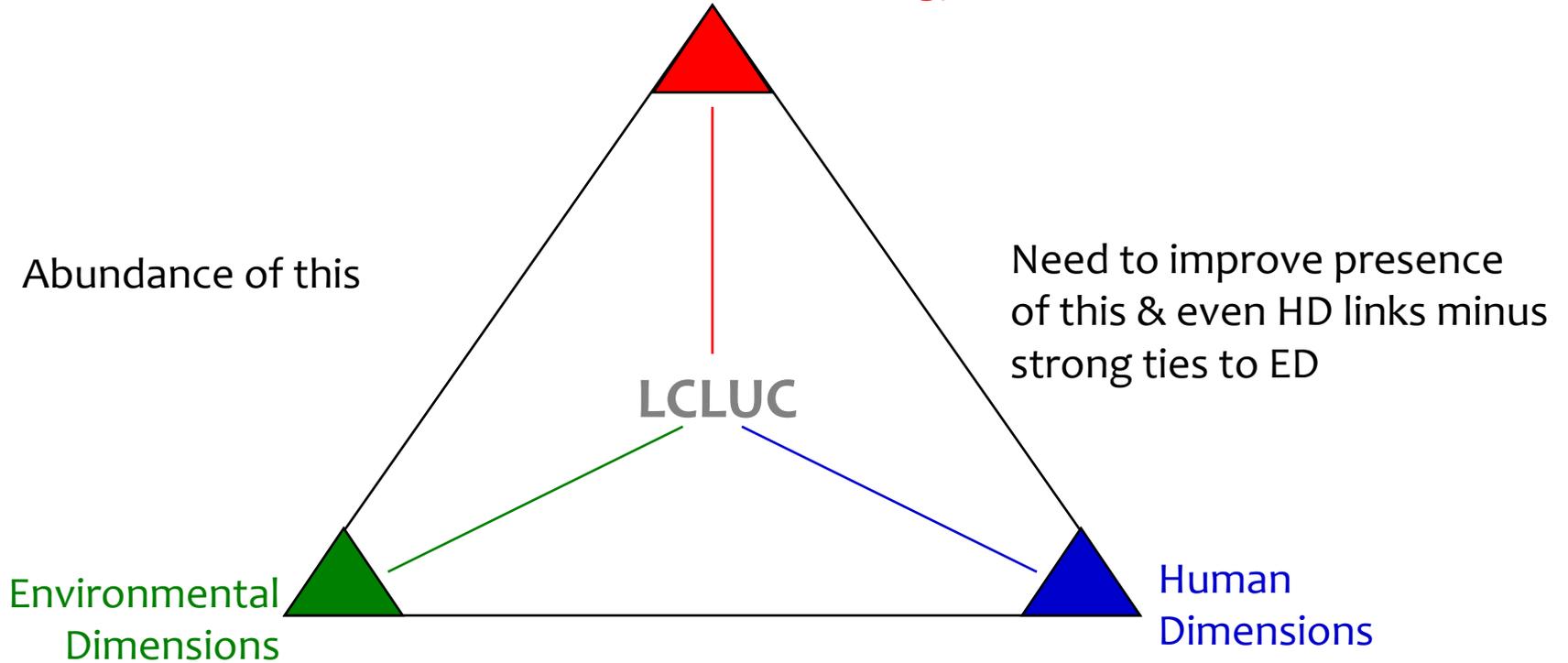
- some, but not all, of this decline may be linked to spatial resolution of RS imagery & the emergence of other programs with emphasis on HD (e.g., CNH, NIH, Biocomplexity).

- challenge of regional to global scale understanding not met.

- LCLUC seeks to rectify trend & reinvigorate the HD element

# LCLUC Practice

NASA  
satellite & data technology



# Contributing to Complementary Programs

- International - GLP, Regional Integrated Programs (NEESPI, MAIRS)
- National - CCSP [US Climate Change Science Program], ACC [American Climate Choices]
  - Calls for a stronger HD - Human responses to climate change
  - Synthesis science activities “of bringing or coupling the human and environment subsystem”– in LCLUC, for land systems
    - Sustainability, vulnerability, resilience, adaptation, mitigation, tradeoffs
- NASA emphasis on developing the Decadal Survey Missions
- LCLUC science needs to be responsive to but not solely guided by these initiatives



**Resilience Alliance &  
Millennium Ecosystem  
Assessment**

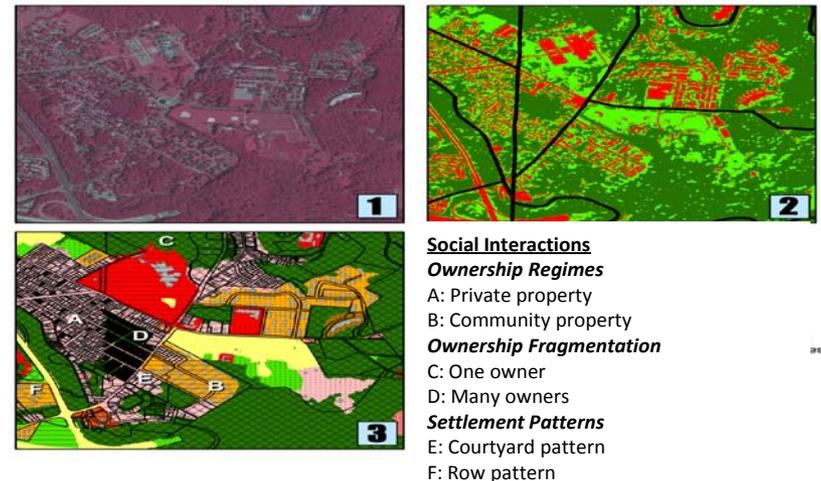


# Areas for HD Emphasis?

- Inferring & Scaling -- Human Behavior
- Land System Trade-Offs
- Topical Themes
  - Climate Change, Land Use and HD
  - Urbanization
  - Institutions and LU Decisions
  - Global economy and international protocols
- LCLUC in Integrated Models

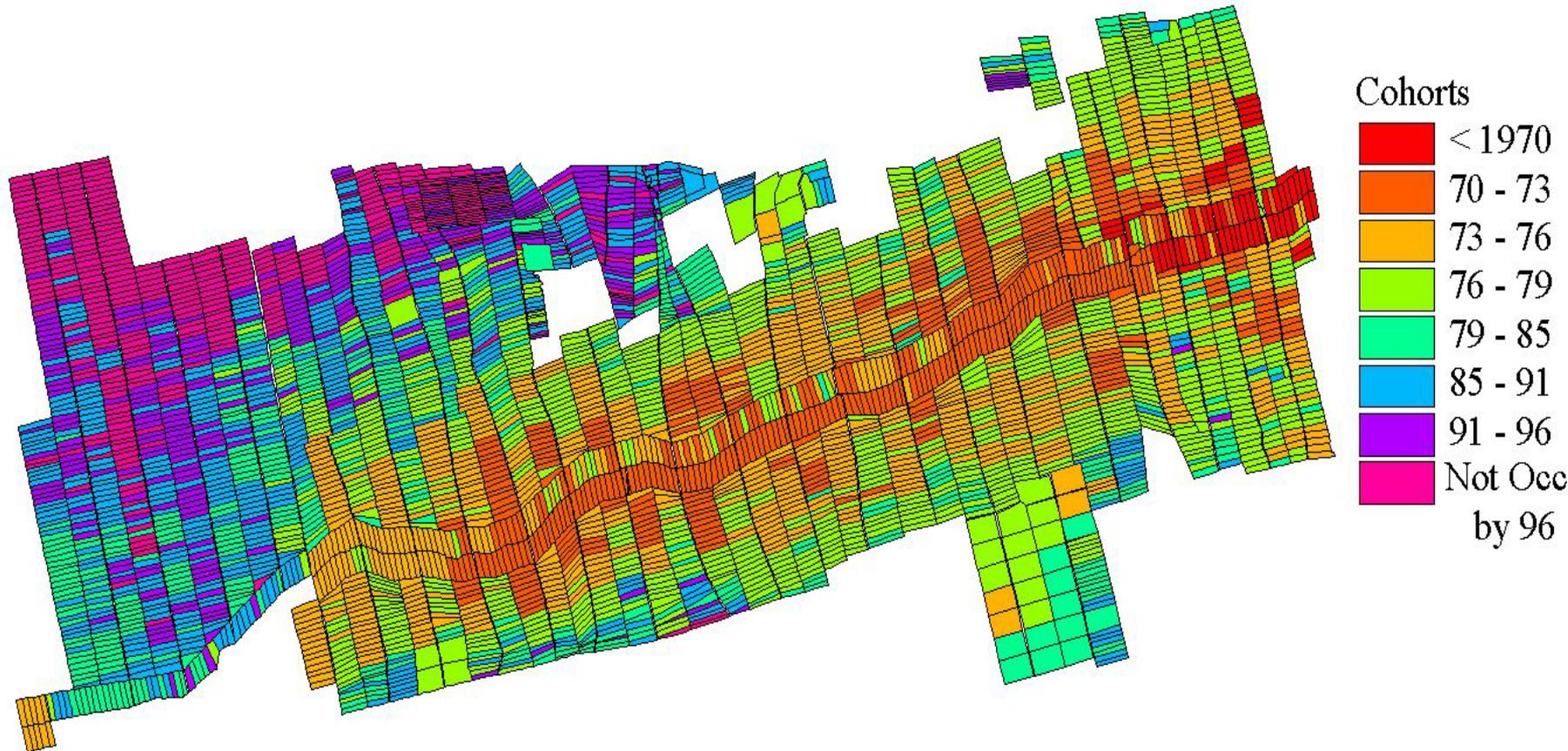
# Inferring & Scaling Human Behavior

- Address *population behavior and outcomes* at 1 m resolution & upscale to 30 and 250 m resolutions to learn rules for more precise coarse-grain or regional assessments & thus improving behavioral dimensions of regional studies
  - 4 LTERs already undertaking for questions of household lawns, water use, and climate change
- Work of this sort needs to be integrated with social information, from surveys to censuses, and understanding of scaling relationships in social/environmental process dynamics.



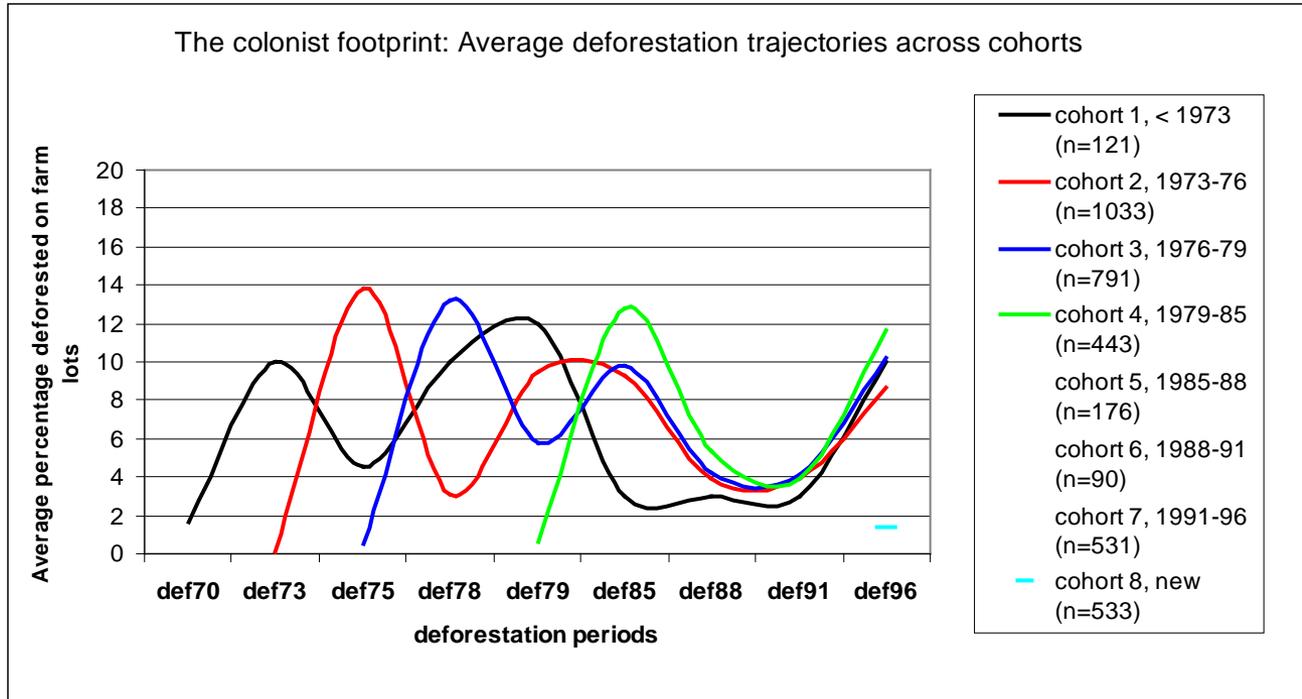
# Altamira – Brasil Novo - Medicilândia

## Cohort of Farm Property Occupancy



(McCracken et al 1999, 2002, Moran et al 2002, Brondizio et al 2002)

# Average distribution of deforestation events by cohorts



# Land System Tradeoffs

- What are the tradeoffs among environmental services & between those services & human subsystem outcomes by “architecture” (kind, amount & pattern) of LCLUC & its change
  - Permits id’ of hotspots of coupled system vulnerability – or poor resilience
  - Potentially powerful planning information for sustainable cities and land systems
- What are the changes in these tradeoffs as scale of analysis changes
  - Solutions applicable for one scale may not serve other scales

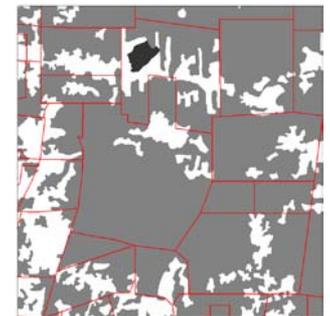
+ Biodiversity  
+ Available soil P  
+ Evapotranspiration  
- Soil moisture  
- On farm income  
CHOICE OF STATE AGENTS



- Biodiversity  
- Available soil P  
- Evapotranspiration  
+ Soil moisture  
+ On farm income  
-CHOICE OF FARMERS



CHOICE OF STATE AGENTS AT ONE SCALE NEGATED BY CHOICE OF FARMERS AT ASCENDING SCALE



# Expanding Topical Themes

- Climate change, LU & HD
  - Link HD processes and LULUC as a driver of or mitigation strategy & adaptation to CC
  - Already an issue in ULTERs and international agendas (e.g., REDD)
  - Research questions (examples):
    - How does climate change, and its perception at the farm gate, affect property rights?
    - As cropping zones migrate poleward, how can flexible systems of land uses be designed to migrate with changing conditions?
    - What are the social and institutional dimensions that facilitate or impede such adjustments to climate change?
- Global urbanization demands attention to urban problems-issues
  - Emissions, pollution, disease-health, and population movement across the urban and peri-urban landscape
- Global economy and protocols-accords (macro-structures) affect local-regional land systems, often with unknown time lags
  - Global commodity prices, REDD, cap and trade, certification programs
- Understanding *adaptation* of land systems to climate & environment change
  - Institutions facilitating-inhibiting adaptations, environmental justice
  - Feedbacks between adaptations and environmental change

# Integrated Models

- Develop “true” CHES, CHANS, SES Models in which
  - **process-based** land-system models are integrated with other Earth System models (all spatially explicit & thus NASA linked)
  - such models can address
    - tradeoffs within and between the coupled systems
    - adaptation, resilience, mitigation as system properties
- System-dynamics and agent-based models provide means to represent these dynamics but challenges remain:
  - Right scaling processes to question and modeling at scales that allow integration with other earth system models.
  - Integrating micro (e.g., survey, field) and macro (e.g., multi-temporal satellite images of pattern) data with models.

# Value of Integrated Modeling

Outcomes of interest:

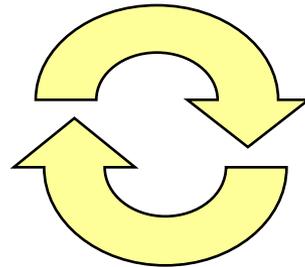
Adaptive Capacity

Vulnerability

Equity

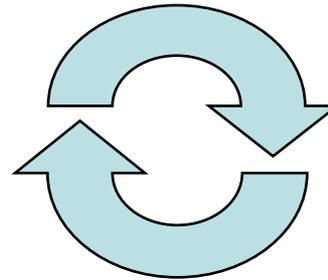
Well being

*Social System*



Land Use Change

*Natural System*



Land Cover Change

Outcomes of Interest:

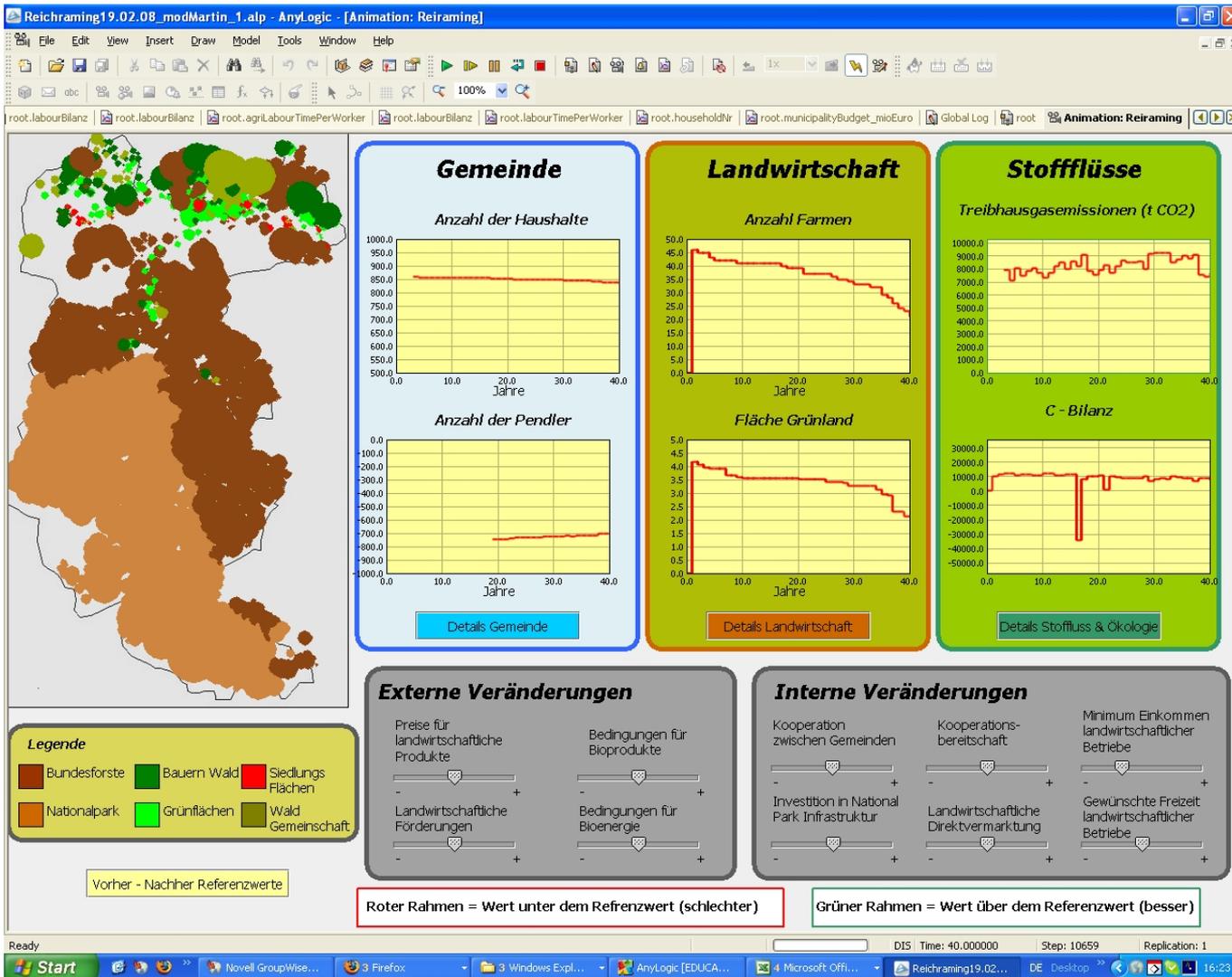
Water Quantity and Quality

Biodiversity

Ecosystem productivity

- We can simultaneously evaluate outcomes of interest in the social and environmental systems. Only by taking them together dynamically can this set of outcomes can help us define *sustainability*.

# SERD model for scenario analysis



Model uses socio-political & environmental drivers in a model that combines agent-based and stock-flow approaches.

Outputs include

- #households
- #commuters
- #farms
- green land area
- GHG emissions
- carbon balance

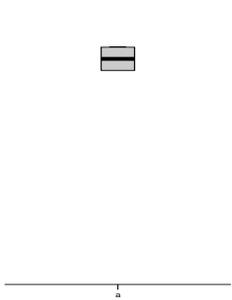
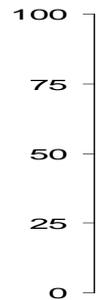
# Suggested Next Steps for Human Dimensions in LCLUC

Figure 1

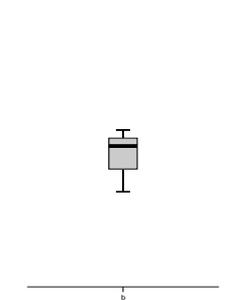
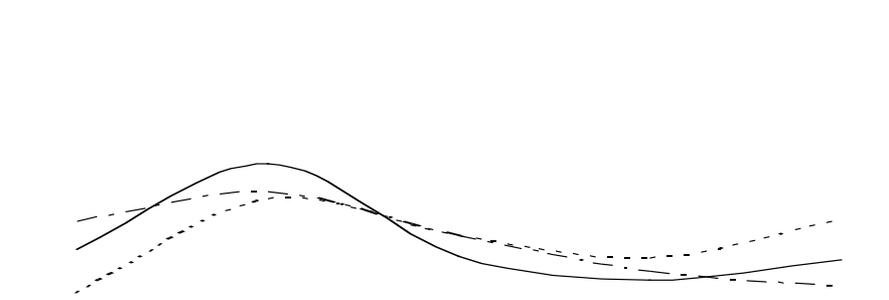
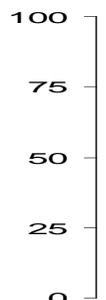
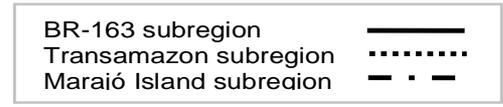
Deforestation Trajectories 1970-2001

% Forest 2001

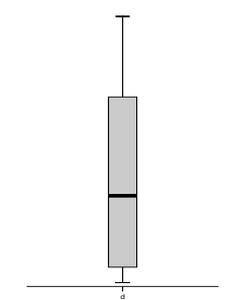
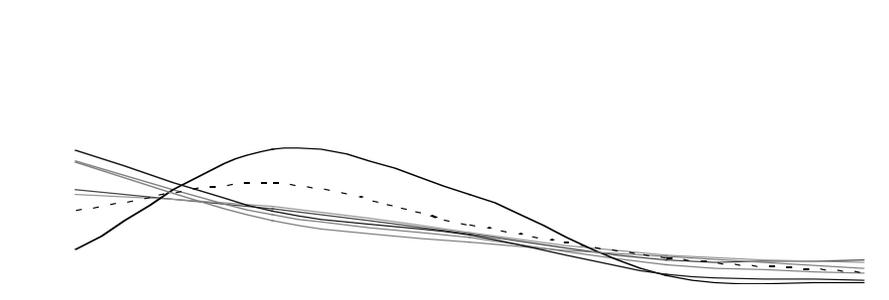
(a) Regional



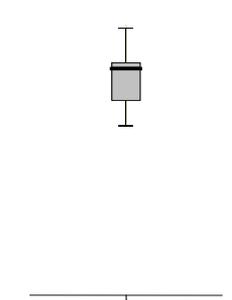
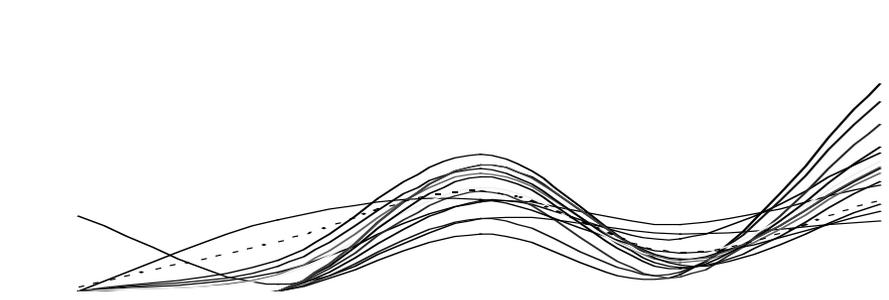
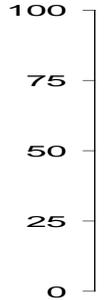
(b) Subregions



(c) Riverine and upland communities, Amazon estuary subregion (n = 6)

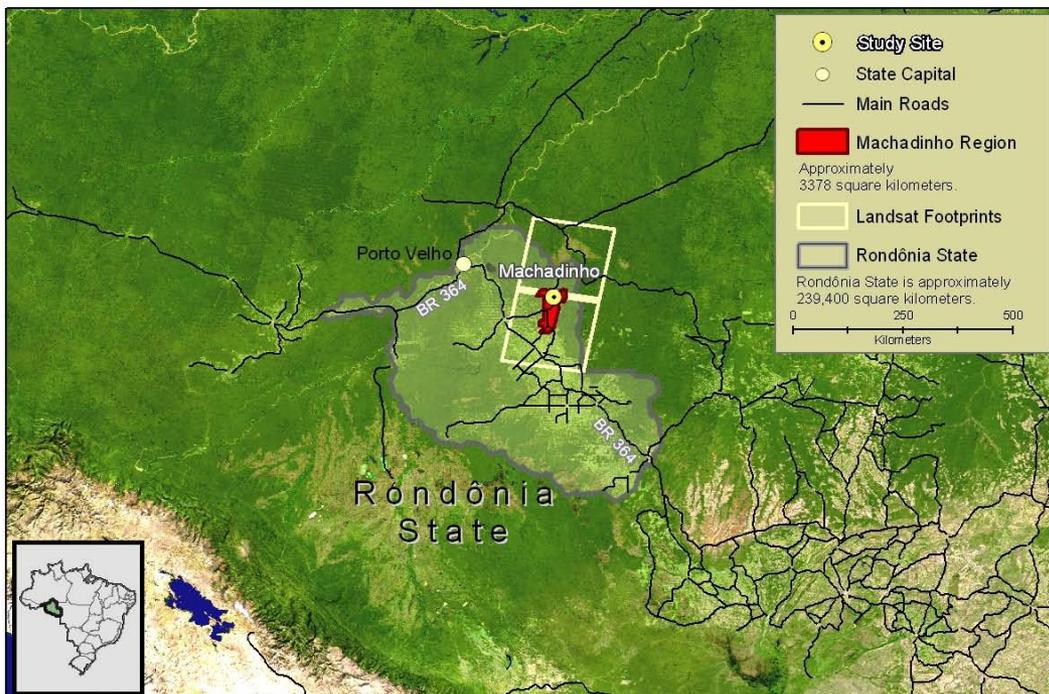
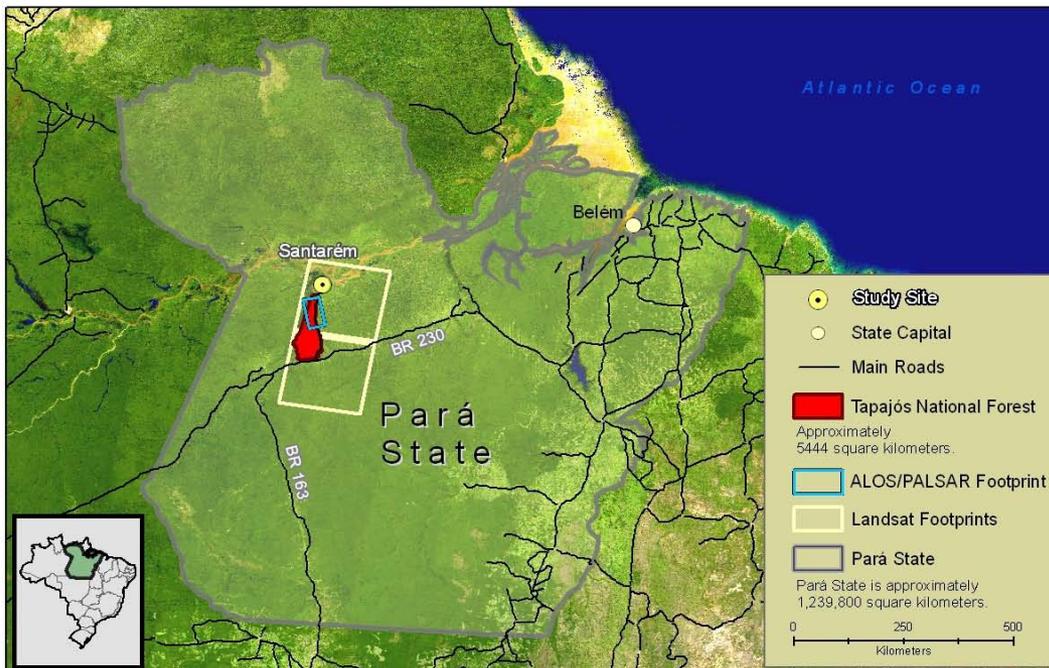


(d) Traditional populations, Flona Tapajós (n = 14)



# Scale Analyses

- The earlier figure shows the different outcome of analysis at each scale
- At Amazon Basin scale, we have one trajectory of deforestation, mirrored by what we see at Para state (due to size of the state and its hot spot status)
- However, focus on the Basin, turns out to be a focus on a piece of it, and overlooks the very different outcomes in other states of the Basin, and at other scales, where temporal and spatial dynamics are different....



# New Methods needed in the humid tropics

This is not a HD issue per se]

The use of optical remote sensing techniques has inherent limitations due to cloud coverage. This fact is important in the humid tropics, because of cloud cover. To overcome these difficulties, SAR data has been used as a complement.

The potential of radar data in C and L bands for analyzing tropical forest changes, has been demonstrated by several researchers. SAR data in one polarization presents limitations. The launching of new polarimetric radar satellites, such as ALOS/PALSAR (L-band) and RADARSAT2, may improve discrimination of land cover classes.

One can link the use of the above polarimetric radar data, together with Landsat data, in achieving the goals of this project—and the capabilities of polarimetric radars in LCLUC science.

Next figure shows an example linking spatially the ALOS/Palsar and TM data coverages