



5th Workshop Foz do Iguaçu, Brazil 19-20 November 2012

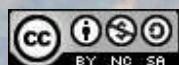


LuccME and TerraME: Open Source Tools for Spatially Explicit Land Use Change Modeling

Laércio M. Namikawa
Ana Paula Dutra Aguiar
Pedro Ribeiro Andrade
Talita Oliveira Assis



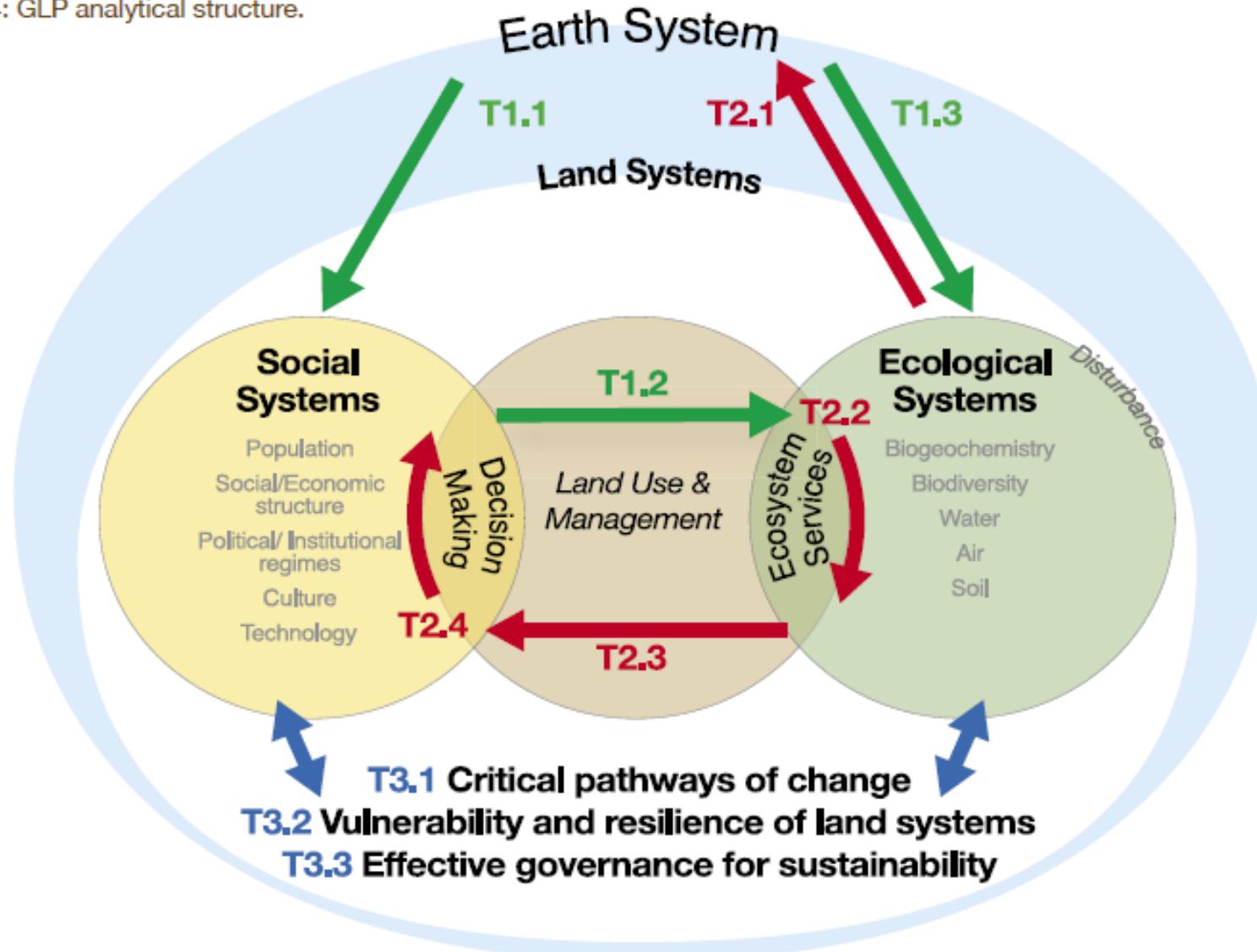
*Instituto Nacional de Pesquisas Espaciais
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Figure 4: GLP analytical structure.

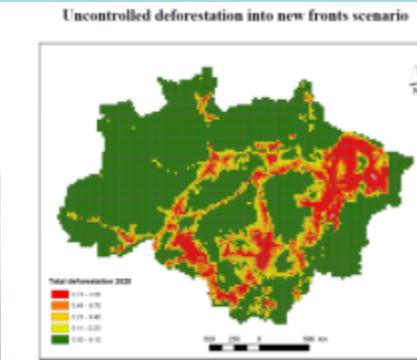
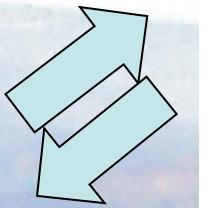


- T1. Dynamics of land systems
- T2. Consequences of land system change
- T3. Integrating analysis and modelling for land sustainability

CCST LUCC Modeling Group



Land use projections generated by
Spatially explicit dynamic LUCC
models (top-down and agent-based)



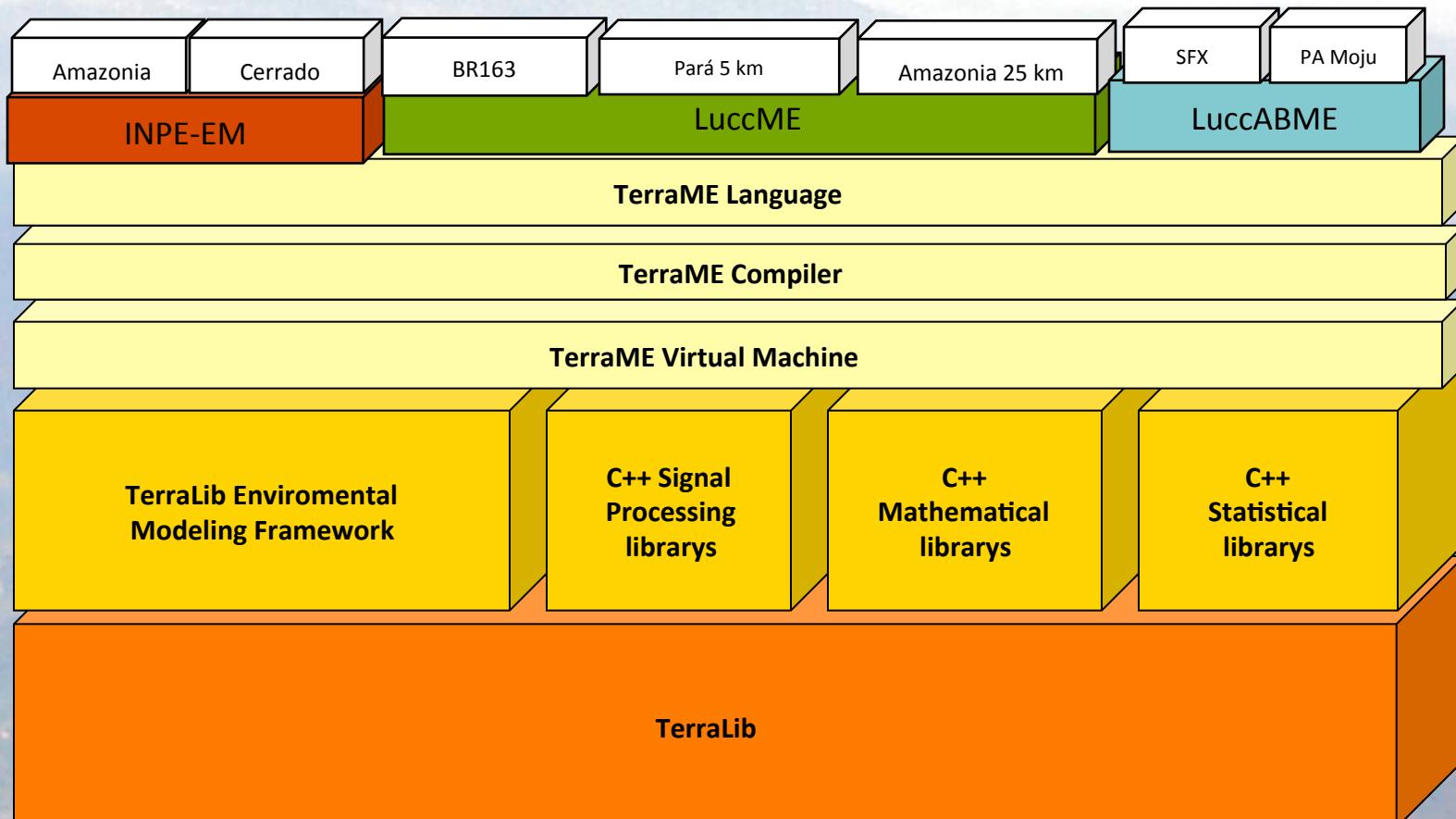
Integrated environmental models,
coupling to Vegetation (INLAND) and
Hydrological Models, aiming at
exploring bi-directional feedbacks

Scenarios:
information to
society about
alternative land use
change under
different scenarios

**Environmental
indicators :**
Integration to
greenhouse
emission and
secondary forests
dynamics models



Our tools are built on top of the TerraME and they make model creation easier



Source: Tiago Carneiro, 2006

Tiago Garcia de Senna Carneiro, "Nested-CA: A Foundation for Multiscale Modelling of Land Use and Land Cover Change". PhD Thesis in Computer Science, INPE, 2006.



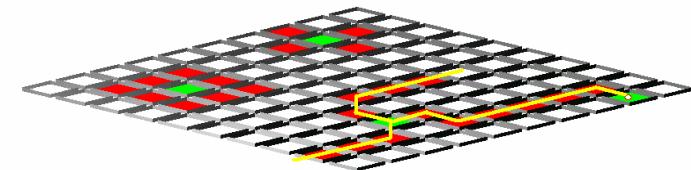
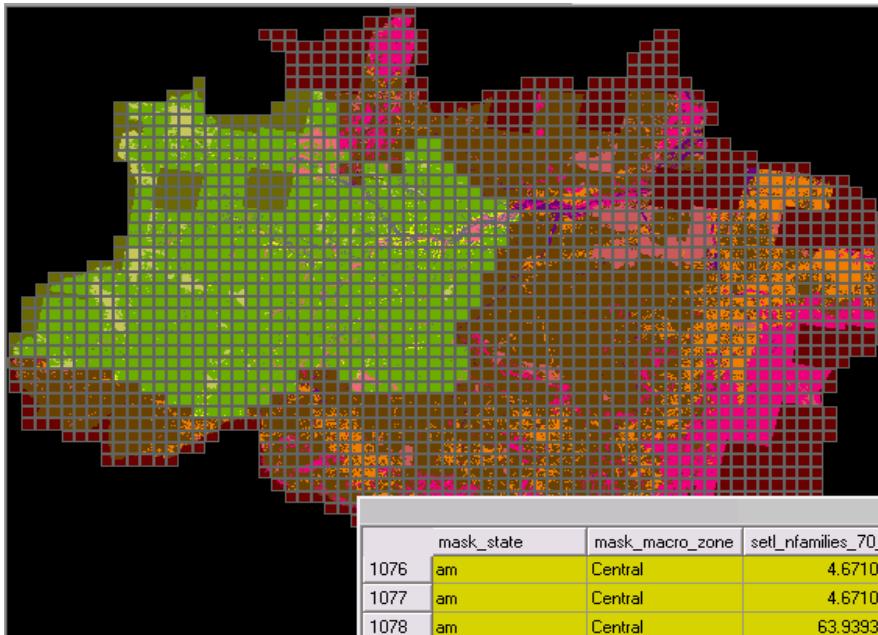
www.terrame.org



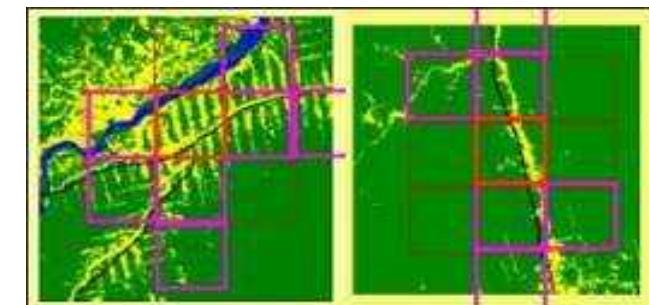
TerraME

TerraME: Multiparadigm Computational Environment for the Development of Nature-Society Integrated Models

Cell Spaces



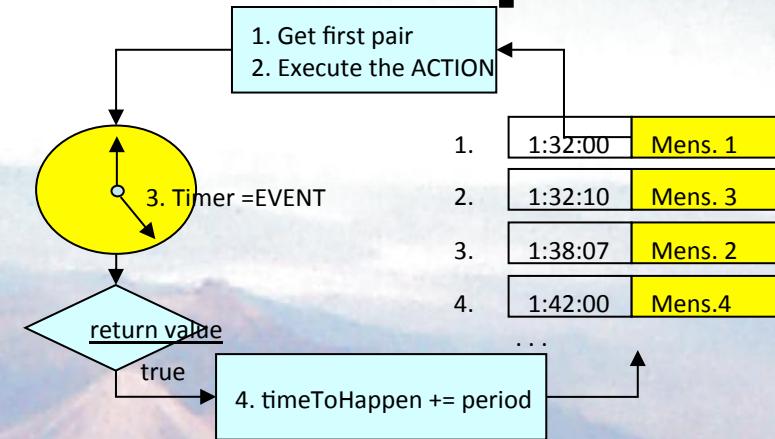
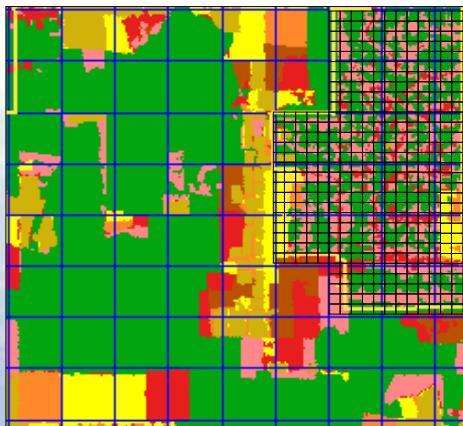
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1076	am	Central	4.671096	146.23648	
1077	am	Central	4.671096	146.23648	
1078	am	Central	63.939396	23501.954167	
1079	am	Central	81.582006	29565.766222	
1080	pa	Central	12.805476	1287.076729	
1081	pa	Central	13.10852	1329.578364	
1082	pa	Central	13.10852	1329.578364	
1083	pa	Central	11.466334	1163.013824	



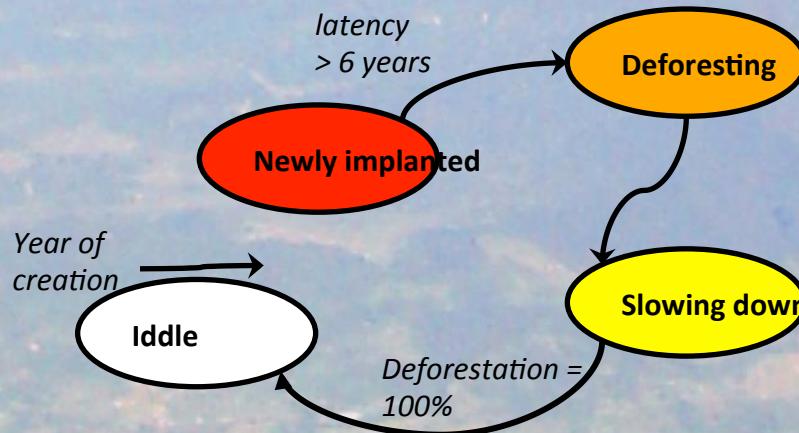
Hypothesis: No single approach alone is enough to represent the complexity of human-environment interactions

Source: Tiago Carneiro, 2006

TerraME: Modular Components

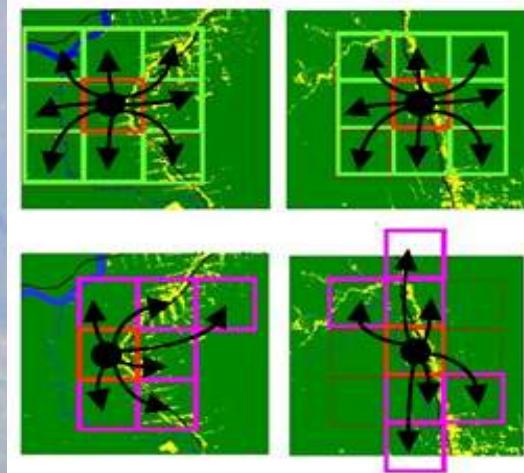


Spatial structure



Rules of behaviour

Temporal structure



Spatial relations

LuccME

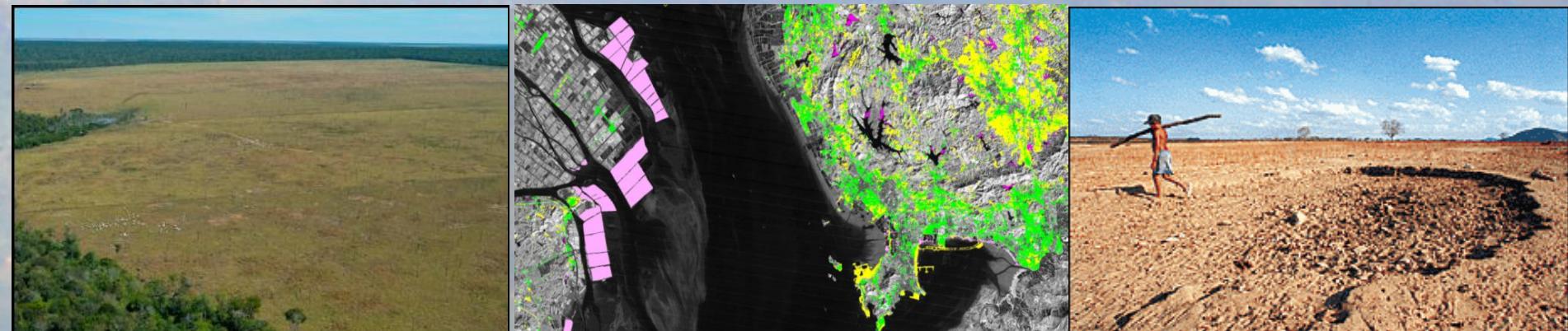
A generic and extensible open source framework to build spatially explicit land use and cover change models for different applications and scales.

Based on the common structure of several well known LUCC models (Verburg et al. 2006, Eastman et al., 2005)

Academic (operational) tools:

[Clue family](#) (Veldkamp et al. 1996, Verburg et al., 2002)

[Dinamica](#) (Soares-Filho et al., 2002)



What is a LuccME Model?



Definition of:

1. Spatial and temporal scale of analysis
2. Database location
3. Land use variables
4. Spatial drivers
5. Potential, Demand and Allocation components (choice and parameterization)
6. Output parameters



What is a LuccME Model?



Spatial scale: Amazonia, 25 x 25 km
Temporal scale: 2000-2050, annual
Goal: deforestation scenarios

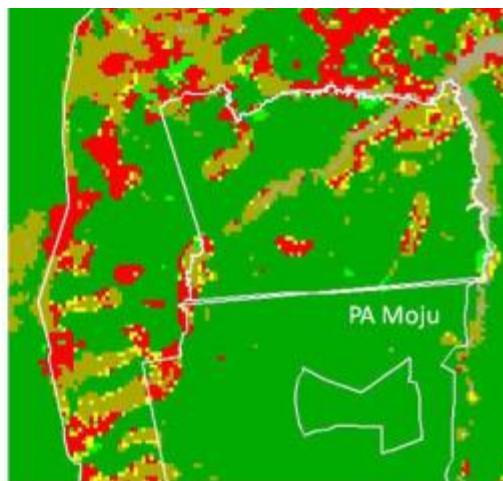


Spatial scale: Bauru, 500 x 500 m
Temporal scale: 1990-2010, bi-annual
Goal: urban expansion

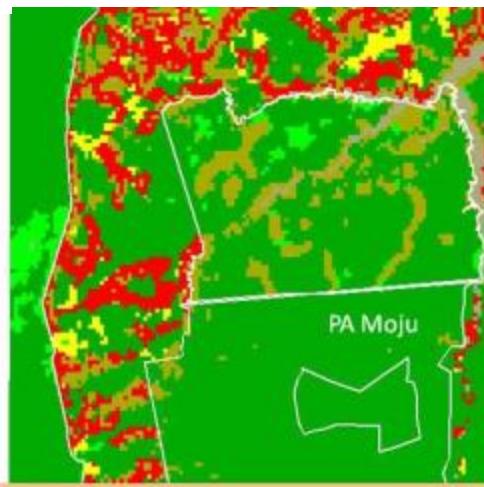


You can compare existing components results, verify which one fits better your application, or even develop new components.

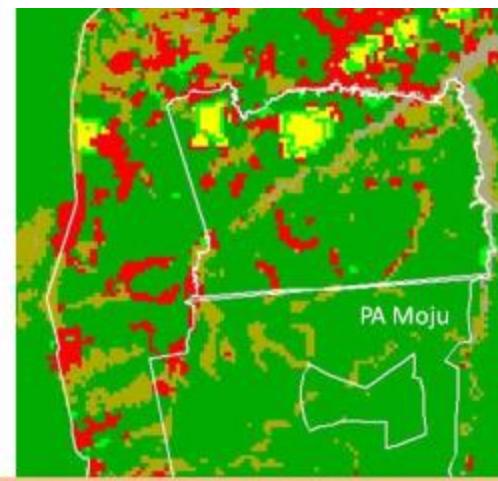
M1



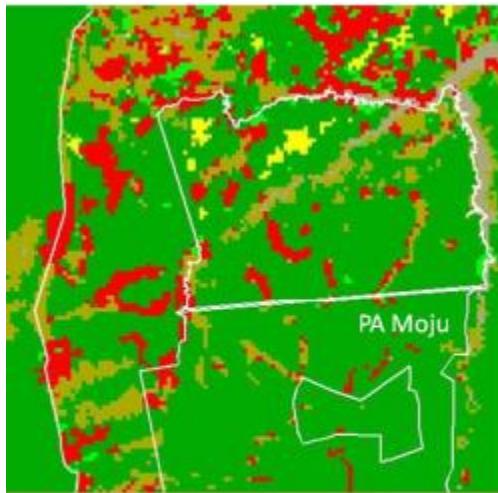
M2



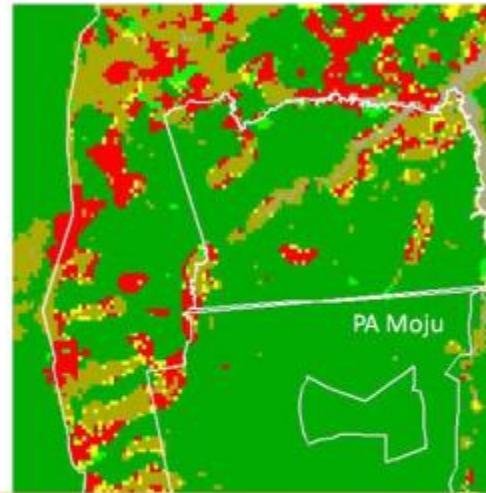
M3



Real (observed 2007)



M2 (simulated 2007)



Floresta

Pasto

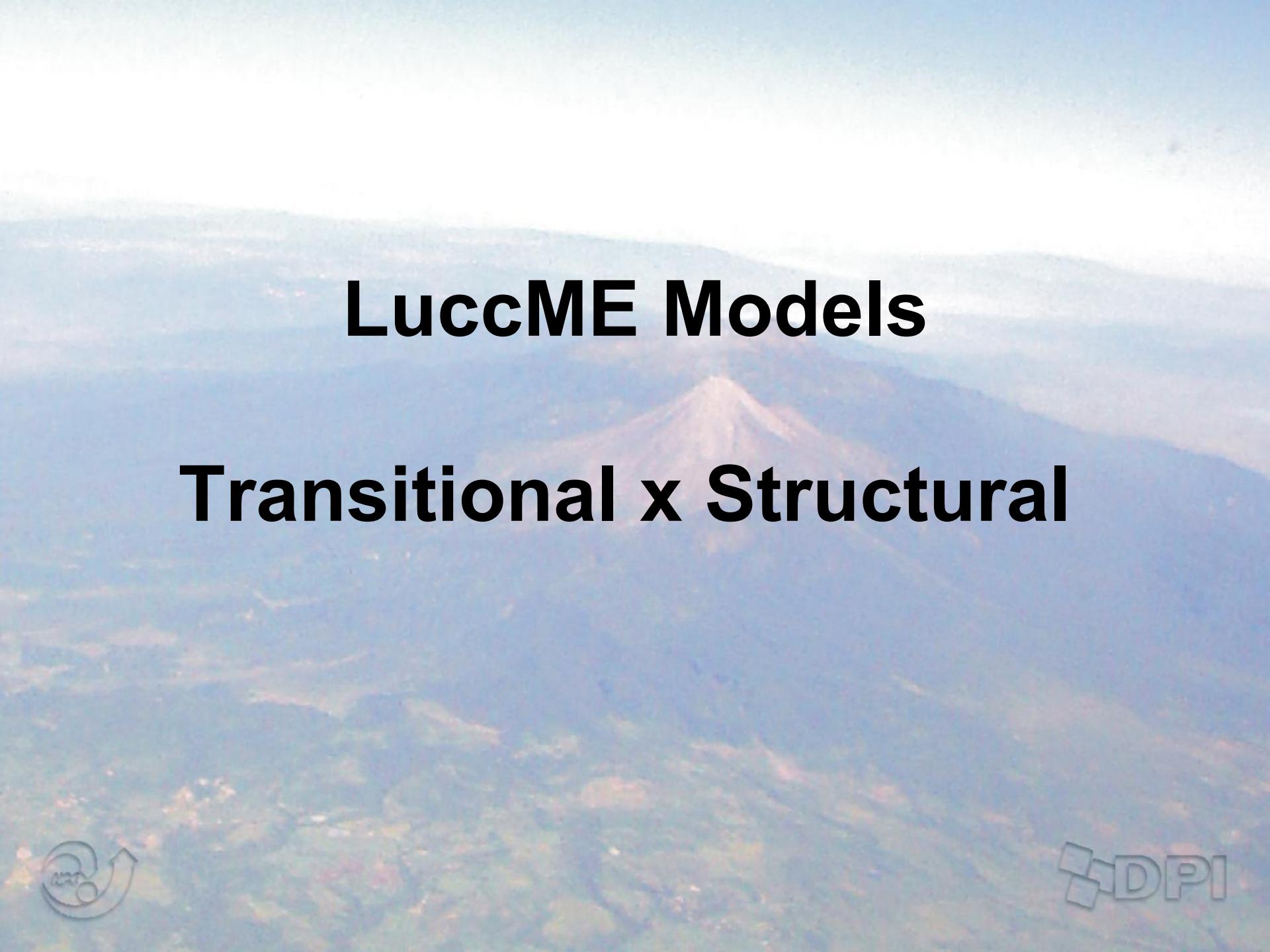
Agricultura Mecanizada

Vegetação Secundária

Agricultura Familiar

Outros

Source: Pimenta (2010)



LuccME Models

Transitional x Structural



Transitional models: differences between two dates

1. Define land use transitions
2. Define drivers which explain each transition (quantity and location)
3. Compute **potential** for each transition
4. Compute **demand** for each transition
5. Perform allocation of the transitions (not the land use themselves)

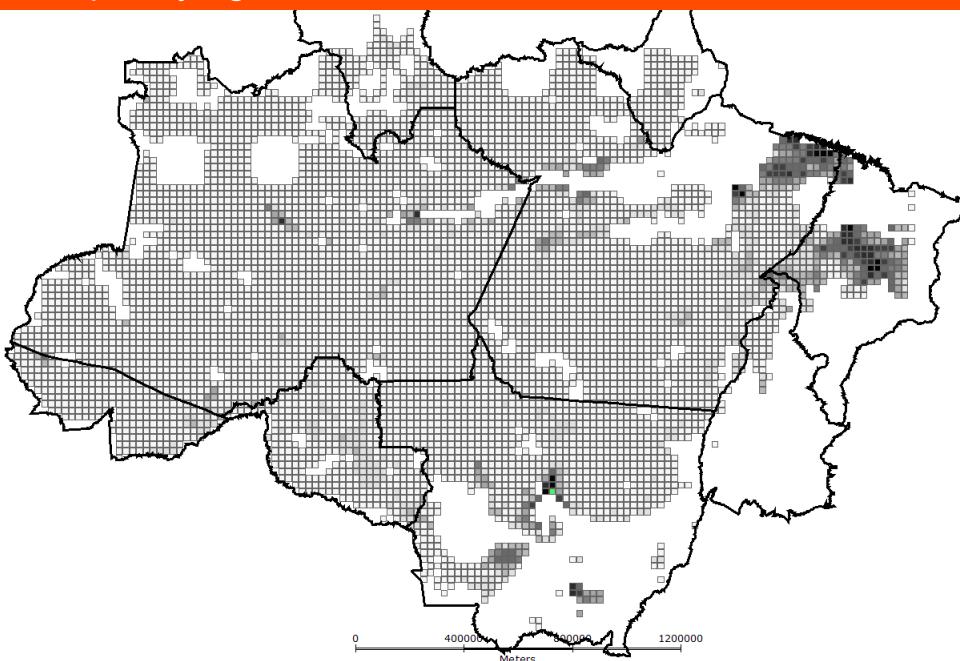


*Example of transition
Non-urban->Urban
(Recreation)*

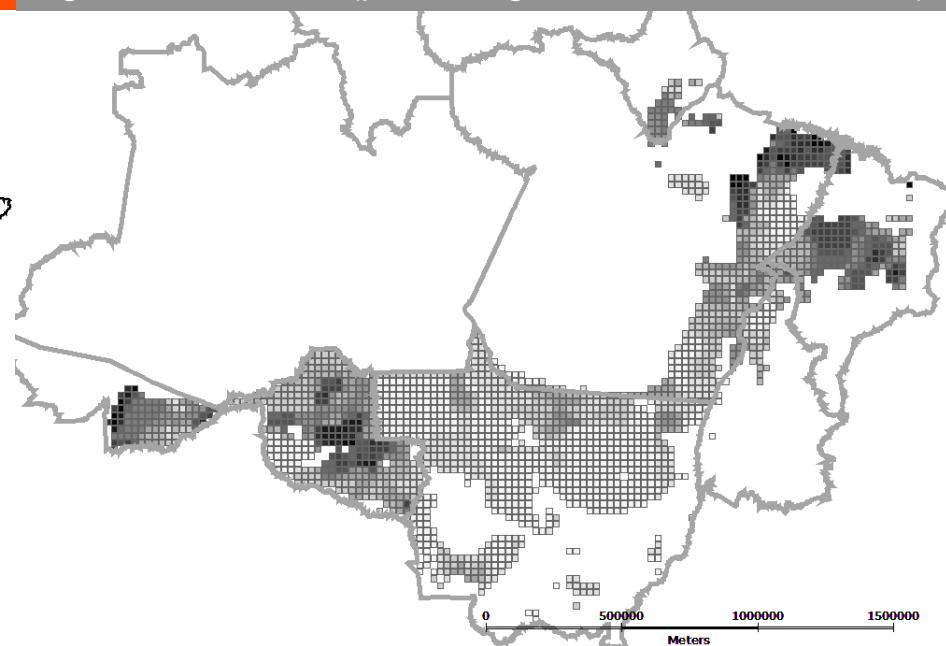
Structural models: input land uses at one date

1. Define land use classes
2. Define drivers which explain each land use pattern/structure (accumulated changes)
3. Compute **potential** for each land use
4. Compute **demand** for each land use
5. Perform allocation of land use classes

Temporary agriculture in 1997



Agrarian Structure (percentage of small farms in area)



A soft-focus photograph of a mountain range under a hazy sky, serving as the background for the text.

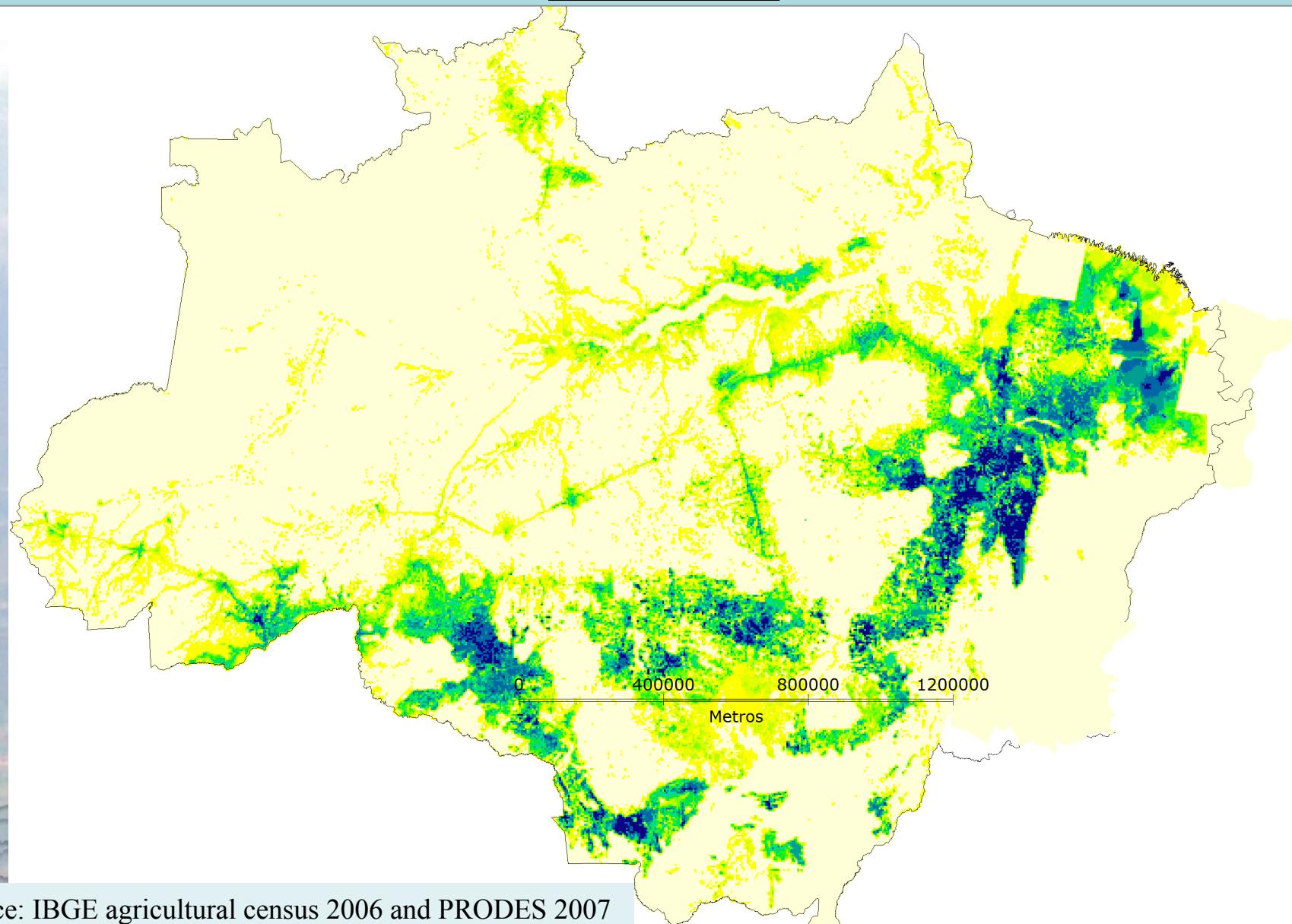
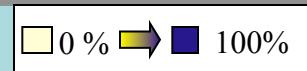
LuccME

Continuous x Discrete



CONTINUOS MODELS: PERCENTAGE OF EACH USE IN THE CELLS

Pasture percentage in each 5x5 km²

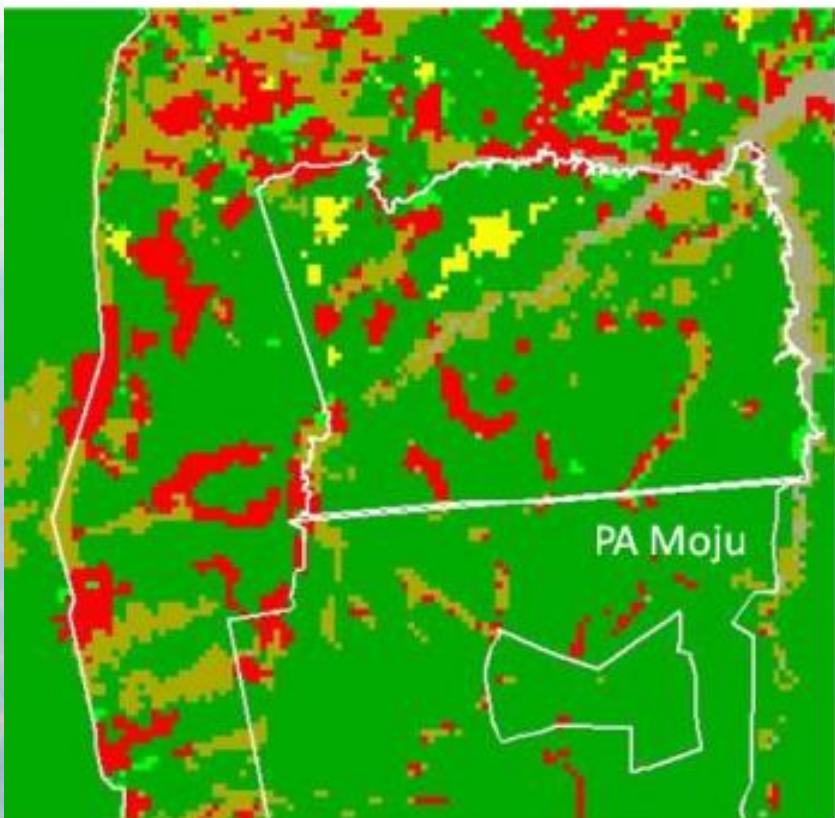


source: IBGE agricultural census 2006 and PRODES 2007

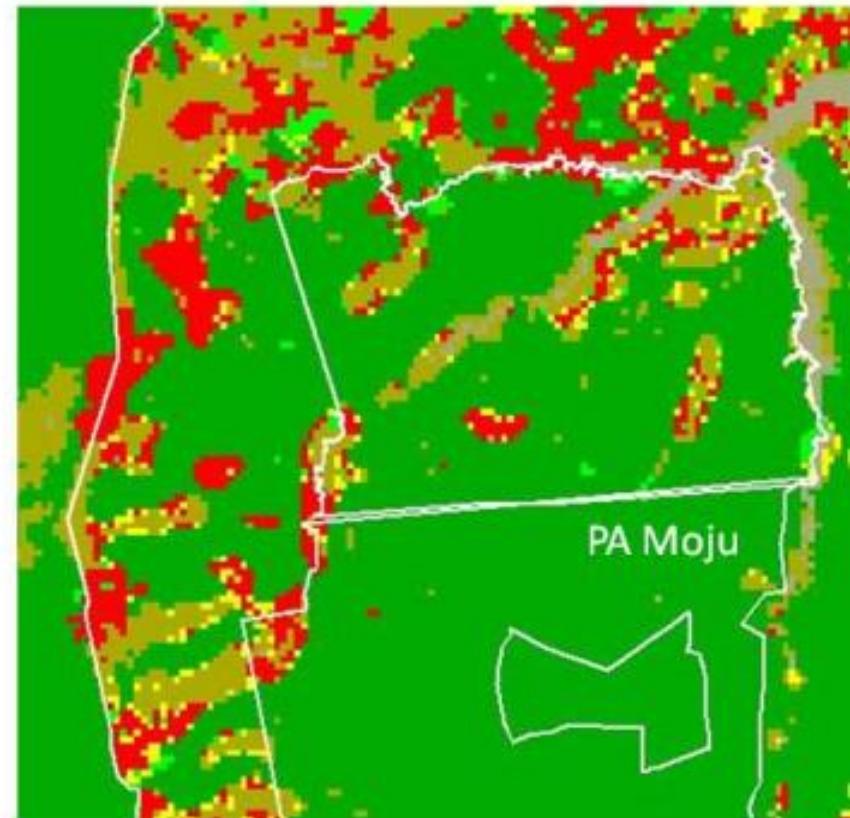
DISCRETE MODELS: CATEGORICAL LAND USE CLASSES

EACH CELL IS CLASSIFIED AS MECHANIZED AGRICULTURE *XOR* PASTURE *XOR* FOREST

Classificação Real - 2007



Simulação modelo M2- 2007



Floresta

Pasto

Agricultura Mecanizada

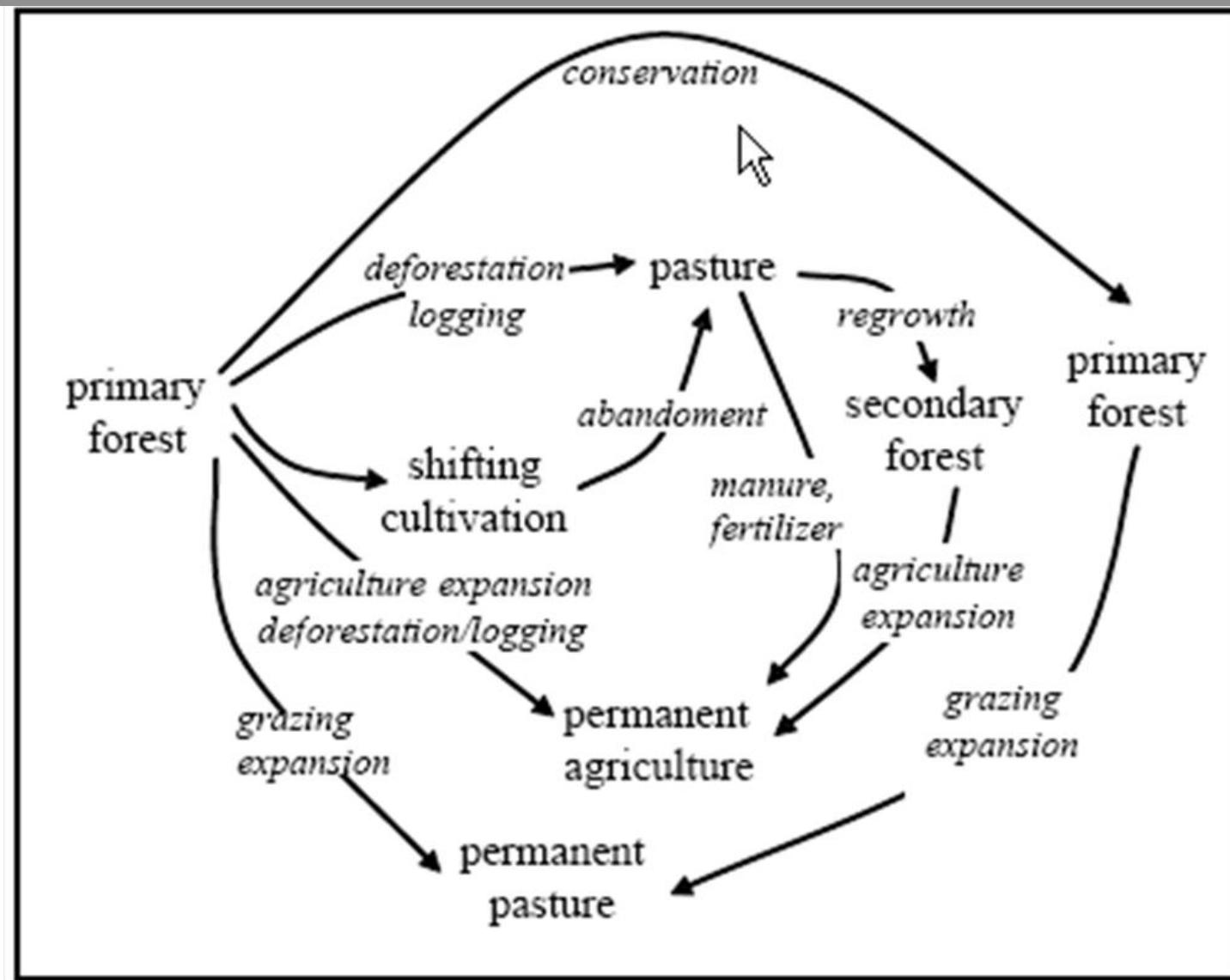
Vegetação Secundária

Agricultura Familiar

Outros

DISCRETE MODELS

LAND USE TRAJECTORIES EXPLICIT REPRESENTATION

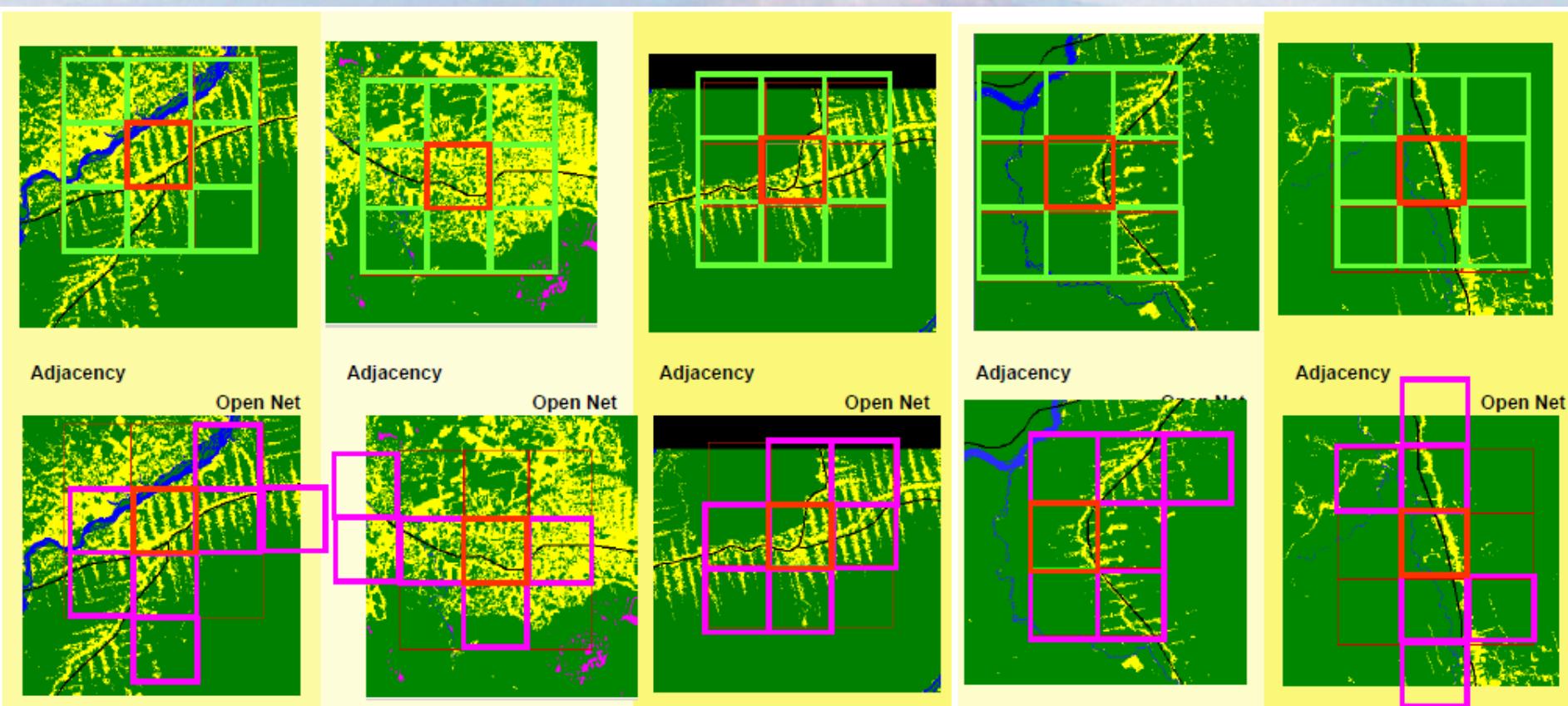


LuccME Advanced Features

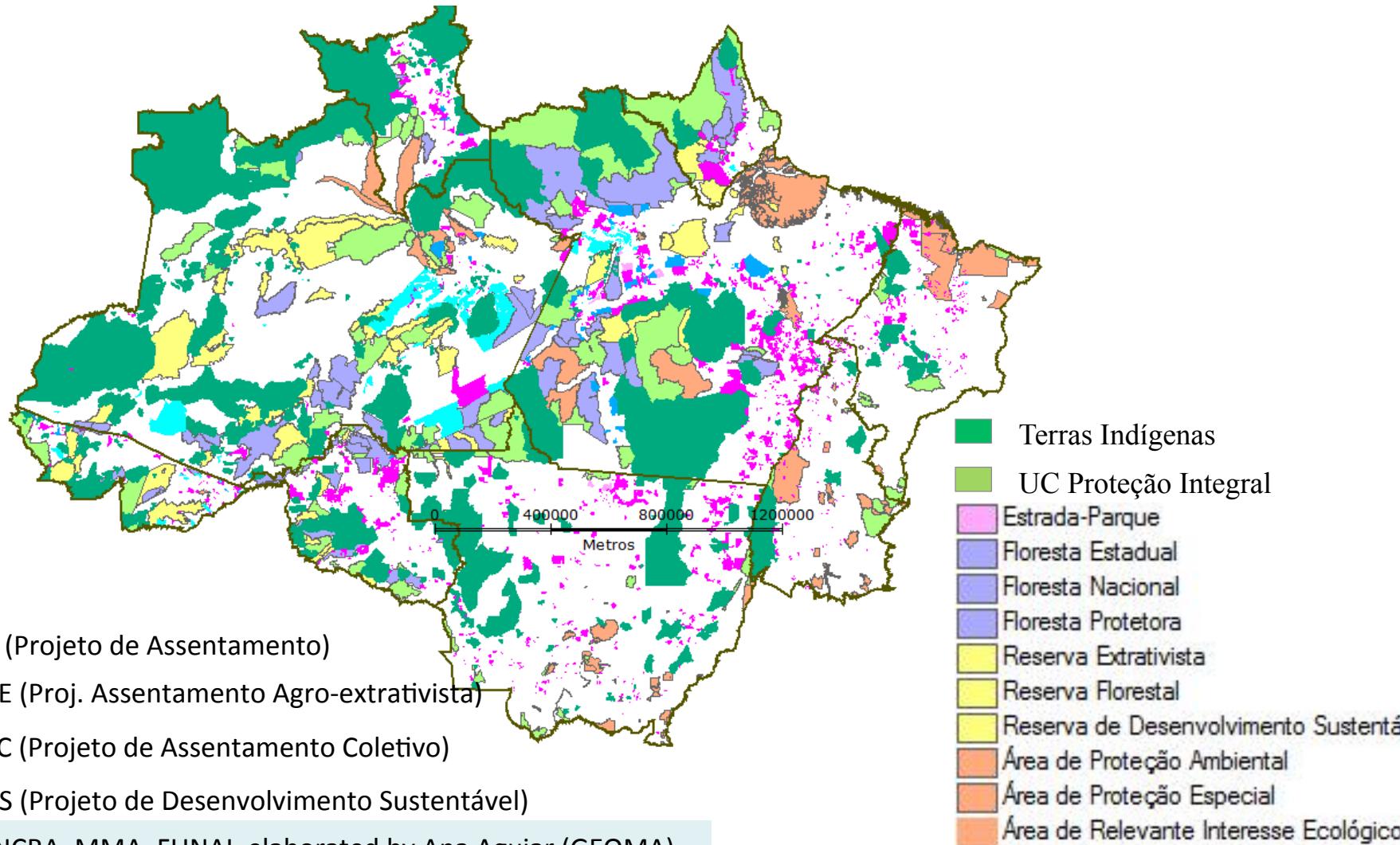
1. Advanced potential component features
2. Advanced allocation component features
3. Model coupling



TerraME incorporates the GPM concept: neighborhood based on Euclidian distance, adjacency and network relations



Example of heterogeneous rules of territory use (Mosaic of Territorial Units in Amazonia)



Model coupling using TerraME Environment

Multi-scale/hierarchical coupling

Regionalization of demand

Update of dynamic variables (regions and drivers)

Natural and social system models

To combine potential/allocation components sequentially at the same time step (e.g., like Dinamica combines Expander and Patcher)

(see www.terrame.org/luccme for explanation and details about these items)



TerraME: www.terrame.org

LuccME: www.terrame.org/luccme



laercio@dpi.inpe.br

ana.aguiar@inpe.br

pedro.andrade@inpe.br

talita@dpi.inpe.br



MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

