A Panamazonian Model of Forest Fire, Agricultural Expansion, and Logging: Amazon Scenarios

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CI: Tim Killeen, Marc Steininger

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Objectives:

- Identify the macro-drivers of Amazon land use change
- Model and simulate forest fire, logging, deforestation and their interactions
- Estimate forest fire effects on carbon emissions, hydrology, Amazon economy.

Simulating Future Scenarios of Amazon Land Cover

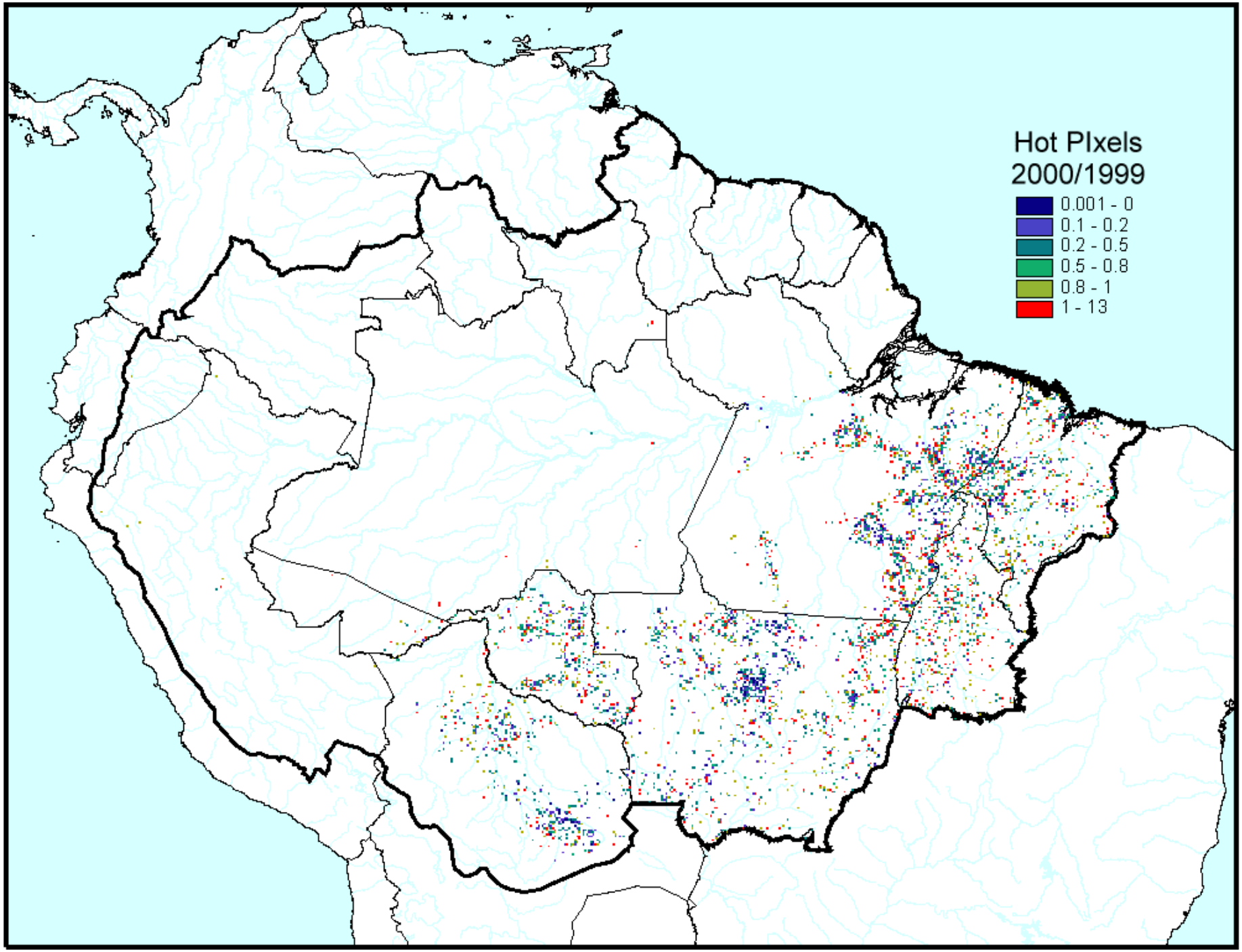
- Inputs: Policy (high and low frontier governance), rainfall regime, macro-economic variables.
- Short-term outputs: Agricultural expansion (extensive vs. intensive), logging (predatory vs. managed), forest fire.
- Long-term outputs: GDP, jobs, income.

Governance Variables

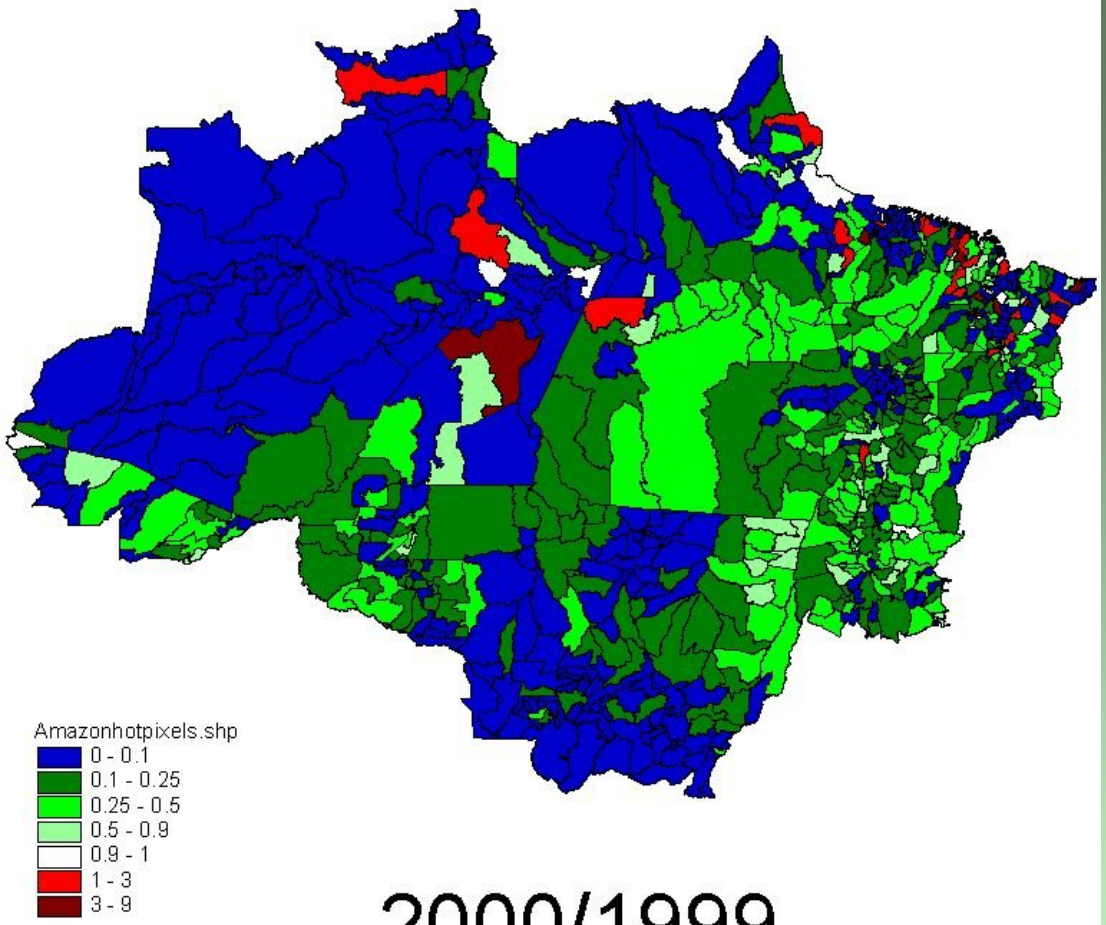
- Forest policies enforced: forest management plans, deforestation limits
- Local infra-structure: secondary roads, energy
- Agricultural credit
- Land titling

The Great Brazilian Policy Experiment

- Avanca Brasil: 6,000 km of road paving
- Environmental Crimes
- PROARCO: $20 M loan for fire reduction
- Mato Grosso deforestation licensing
- National Water Agency
- Acre “Governo da Floresta”
- Movimento pelo D. do Transamazonica e Xingu


Hot PIxels
2000/1999
0.001 - 0
0.1 - 0.2
0.2 - 0.5
0.5 - 0.8
0.8 - 1
1 - 13

The effect of enforcement?



2000/1999

Map showing spatial distribution of hot-pixel reductions between 2000 and 1999. Areas in red had more hot pixels in 2000 than 1999, and shades of green and blue show areas with significant reductions in hot pixel density in 2000.

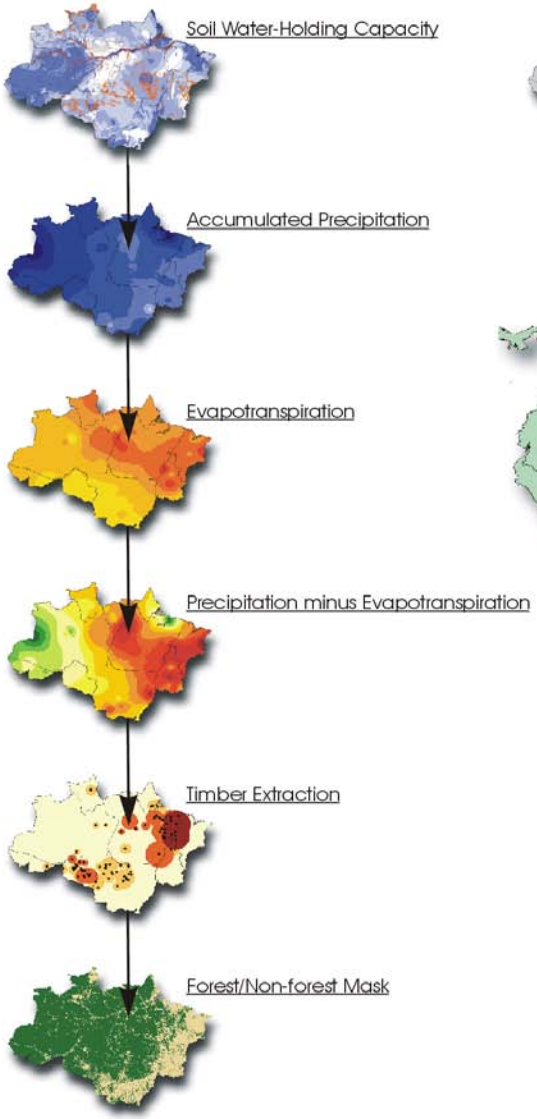
Approach:

- Basin-wide forest flammability mapping
- Historical analyses of deforestation & forest fire
- Meso-scale analyses along new economic corridors; logging industry, agricultural trends, modeling
- Field msts of forest flammability, fire effects on hydrology and carbon
- Economic models of logging and agricultural expansion

RisQue98

Predicting the Forest Fires of Brazilian Amazonia

Forest Flammability

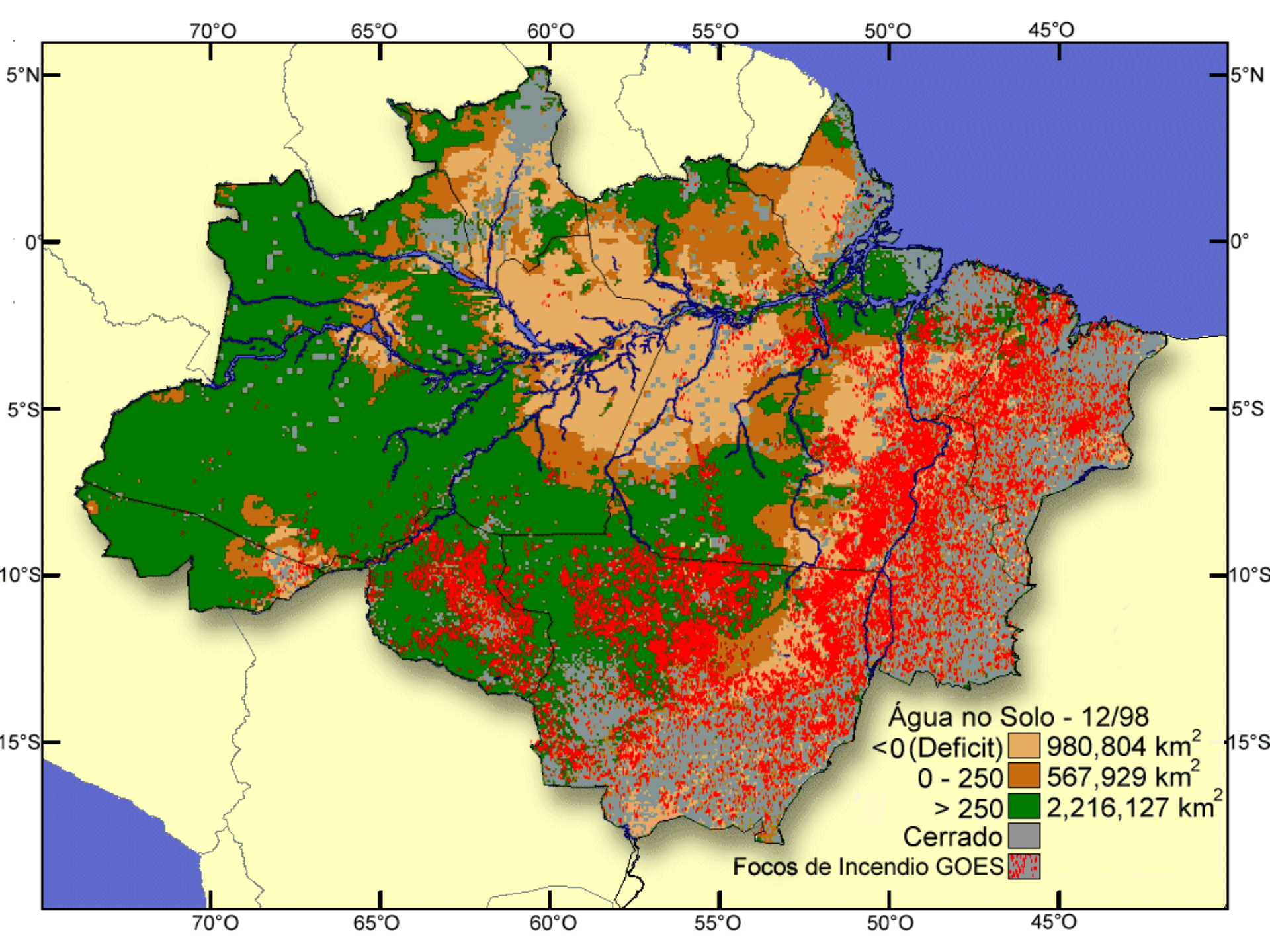


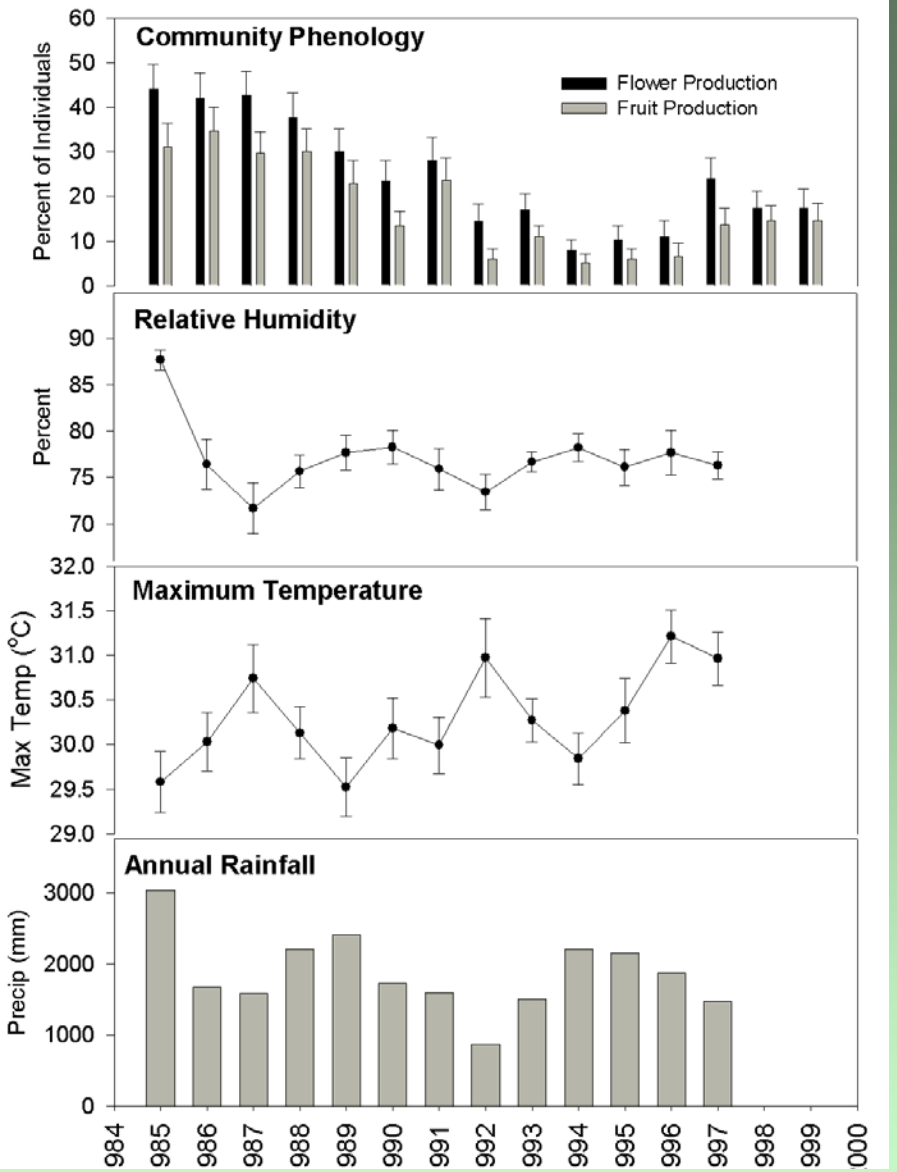
Non-forest Areas

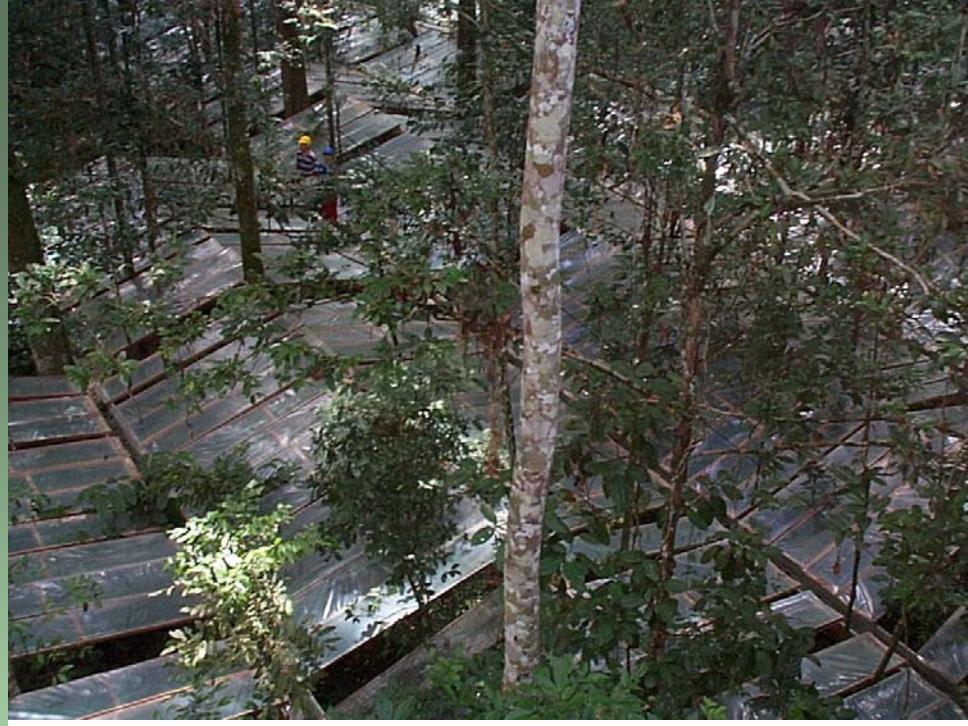
Fire Risk Map
December, 1998 Prediction

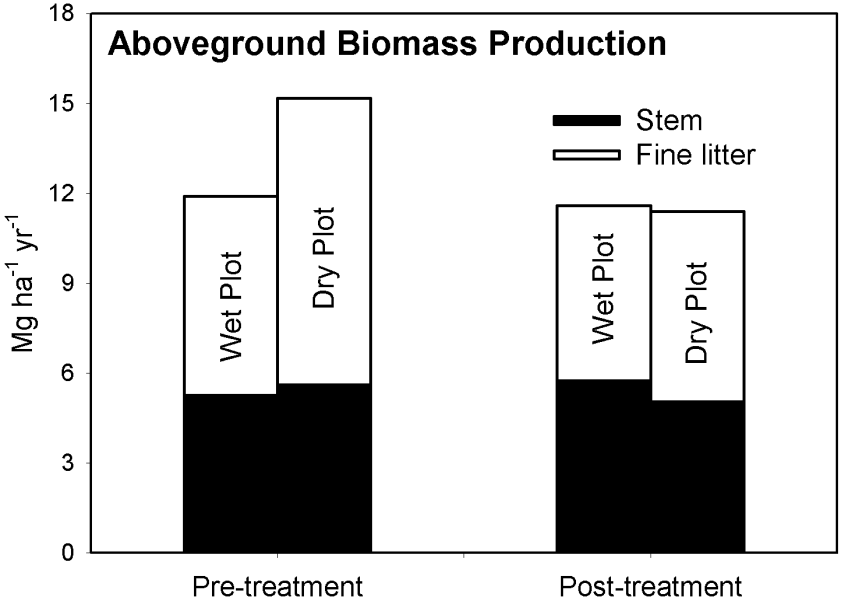
The Woods Hole Research Center
http://www.whrc.org

IPAM - INSTITUTO DE PESQUISA AMBIENTAL DA AMAZÔNIA
http://www.ipam.org.br

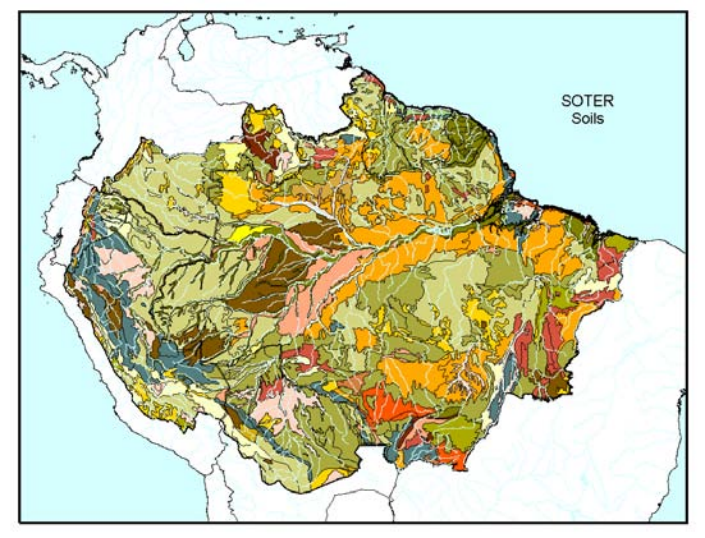

70°O
65°O
60°O
55°O
50°O
45°O
5°N
0°
5°S
10°S
15°S
Água no Solo - 12/98
<0 (Deficit) 980,804 km²
0 - 250 567,929 km²
> 250 2,216,127 km²
Cerrado
Focos de Incendio GOES

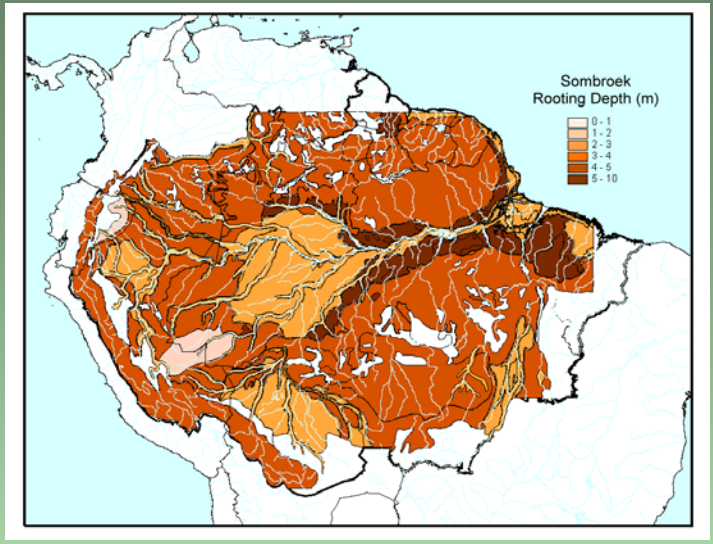

Community Phenology
Percent of Individuals
Flower Production
Fruit Production
Relative Humidity
Percent
Maximum Temperature
Max Temp (°C)
Annual Rainfall
Precip (mm)
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
000

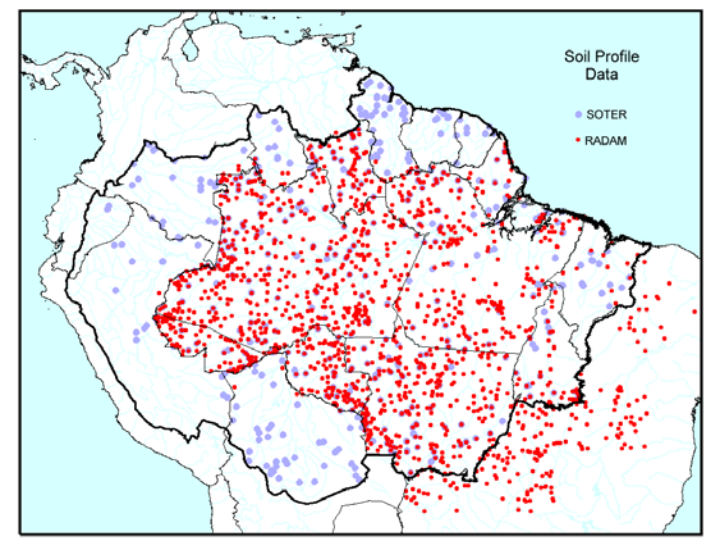


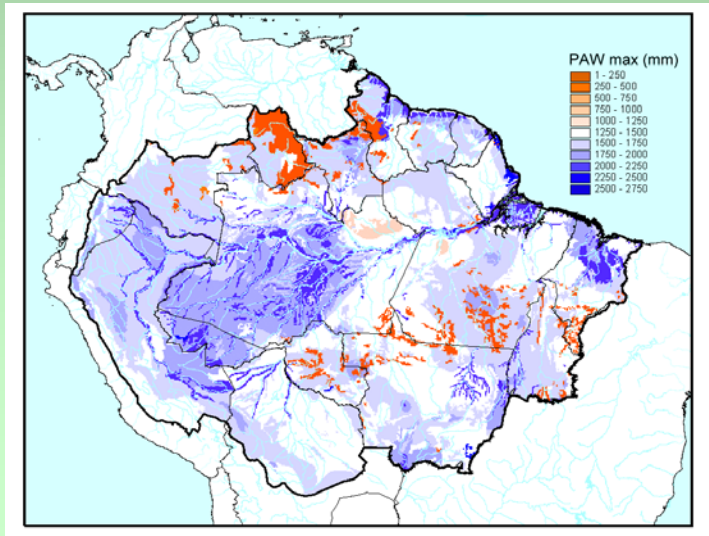

Aboveground Biomass Production
Mg ha-1 yr-1
Stem
Fine litter
Wet Plot
Dry Plot
Wet Plot
Dry Plot
Pre-treatment
Post-treatment

RisQue: real-time flammability

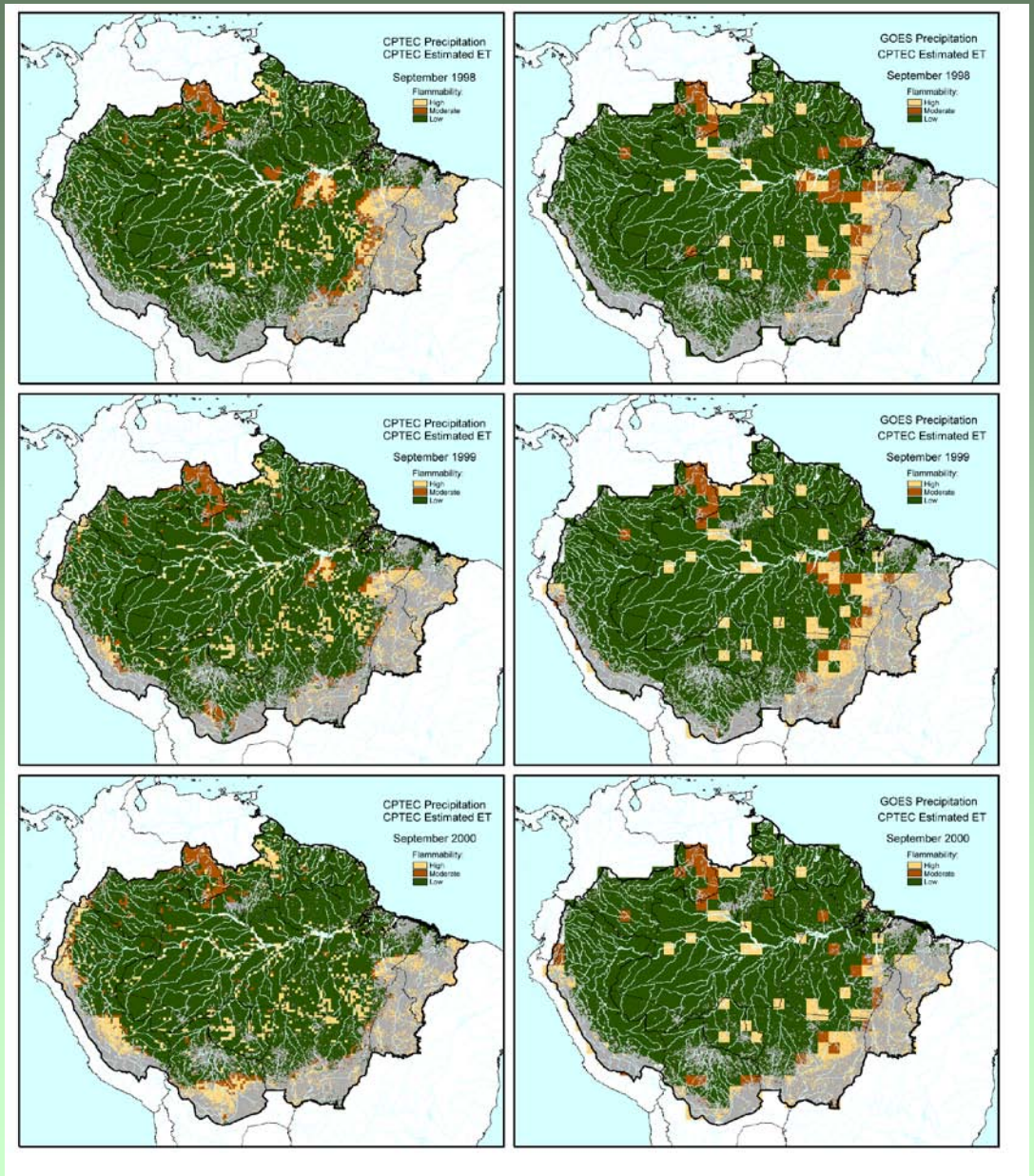




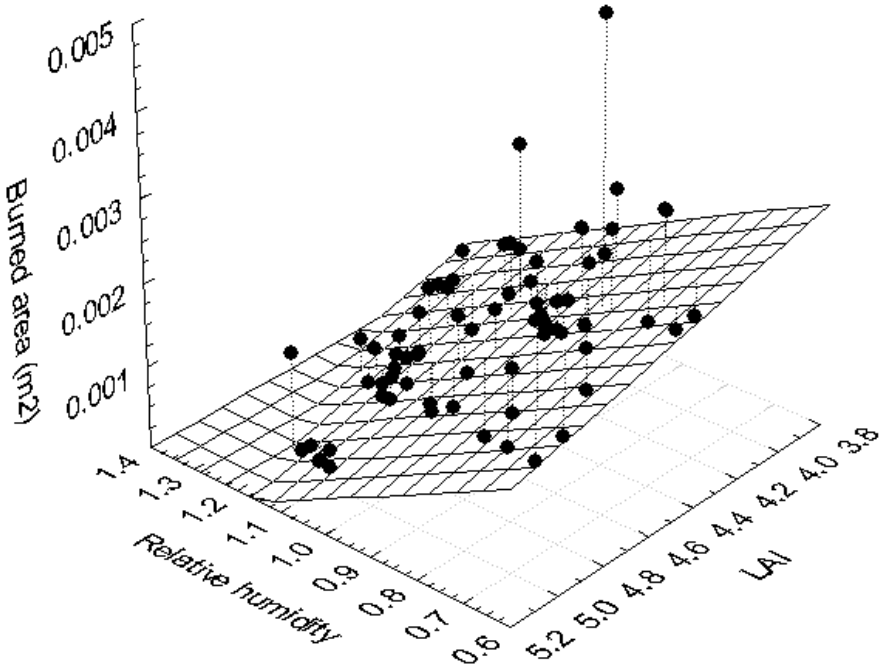


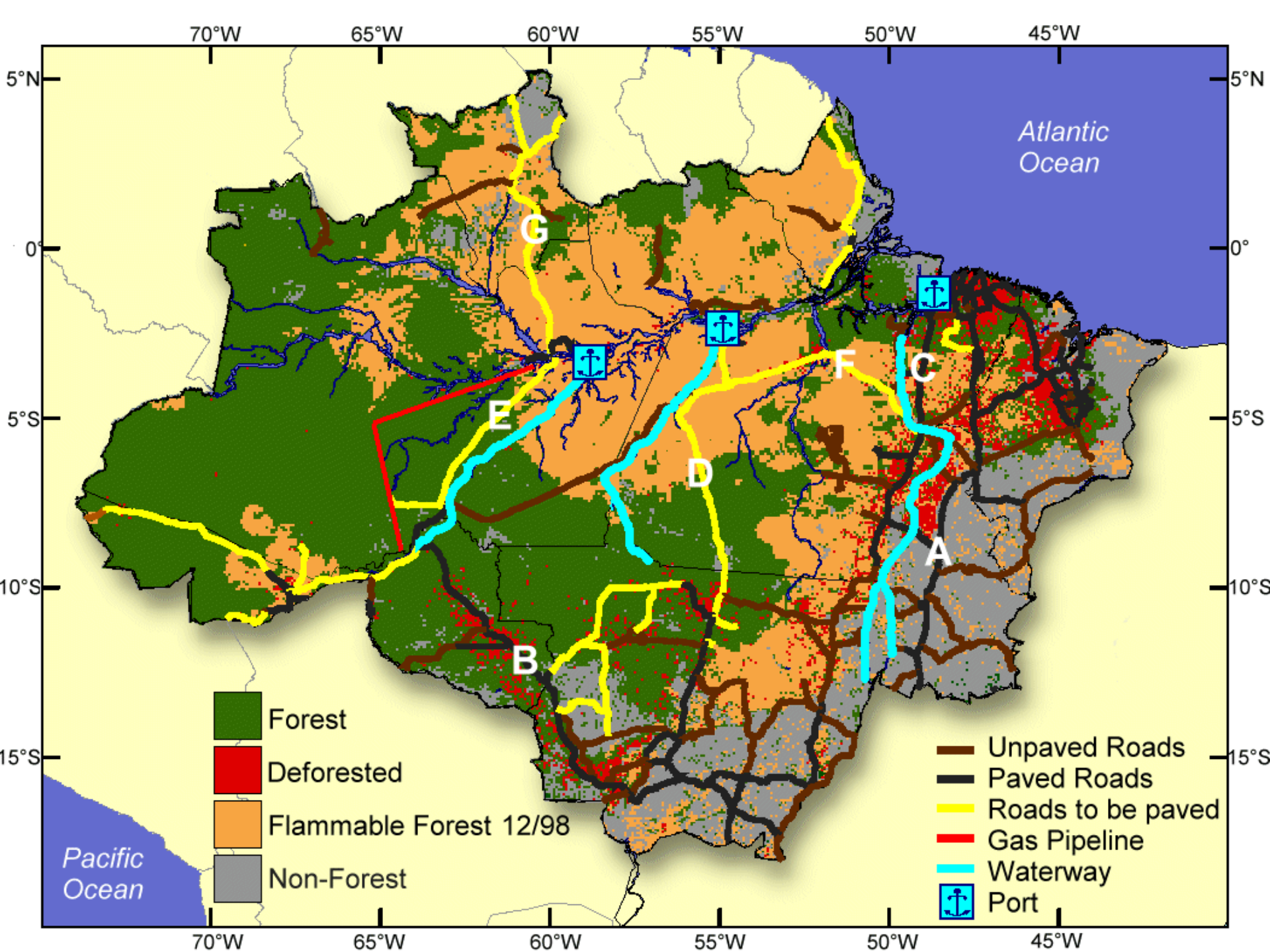


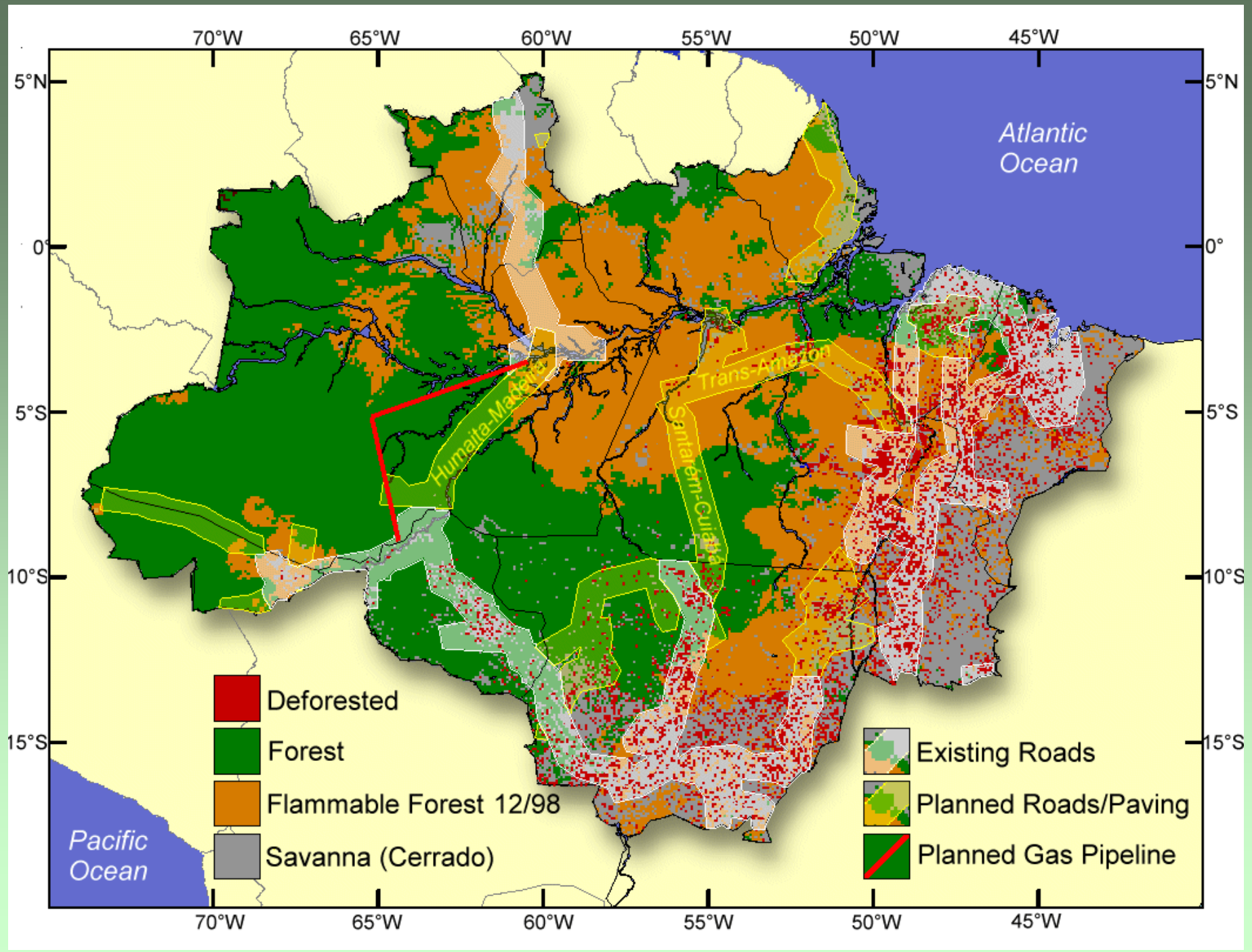
RisQue: Flammability

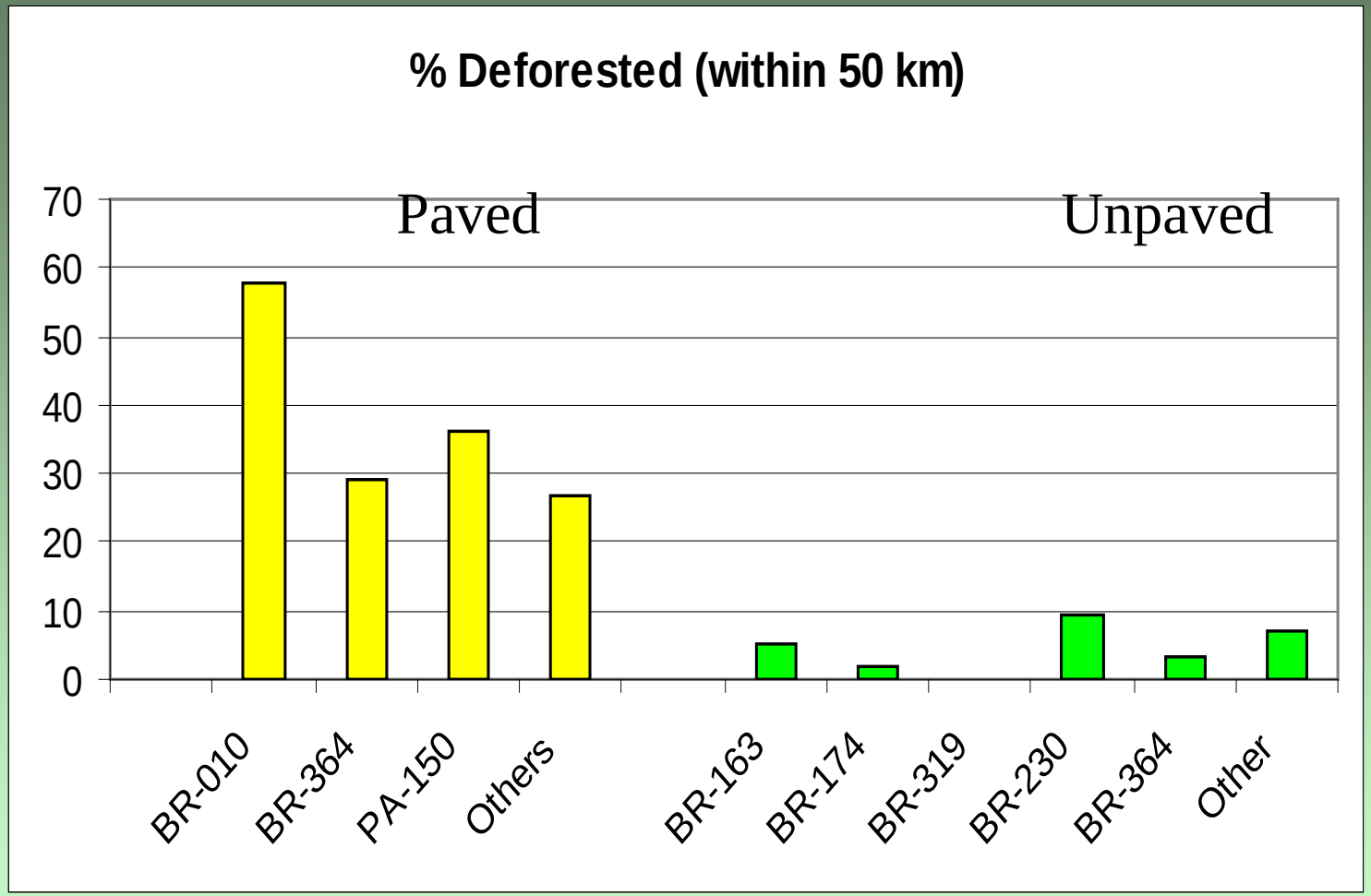


Fire experiments: empirical functions



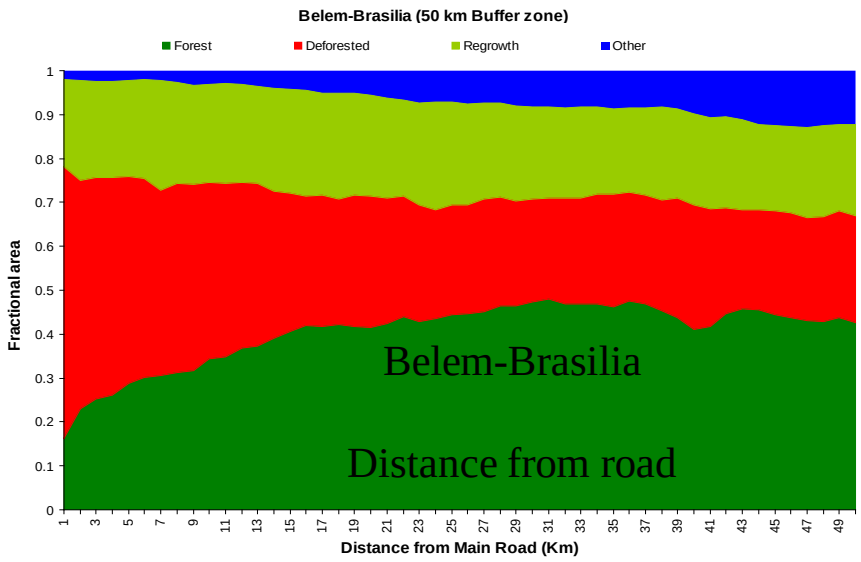

70°W
65°W
60°W
55°W
50°W
45°W
5°N
0°
5°S
10°S
15°S
Atlantic Ocean
Pacific Ocean
G
F
C
E
D
A
B
Forest
Deforested
Flammable Forest 12/98
Non-Forest
Unpaved Roads
Paved Roads
Roads to be paved
Gas Pipeline
Waterway
Port

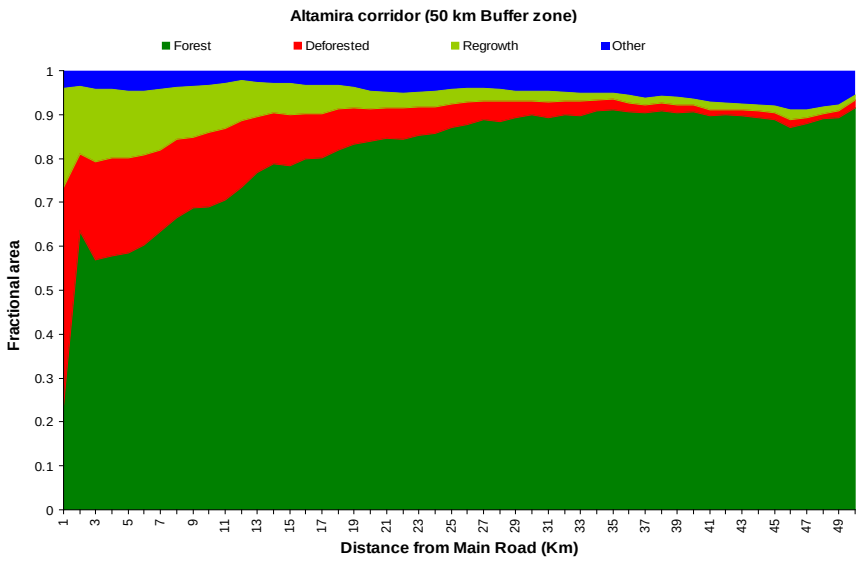

70°W
65°W
60°W
55°W
50°W
45°W
5°N
0°
5°S
10°S
15°S
Atlantic Ocean
Pacific Ocean
Humaita-Manaos
Trans-Amazon
Santarem-Cuiaba
Deforested
Forest
Flammable Forest 12/98
Savanna (Cerrado)
Existing Roads
Planned Roads/Paving
Planned Gas Pipeline

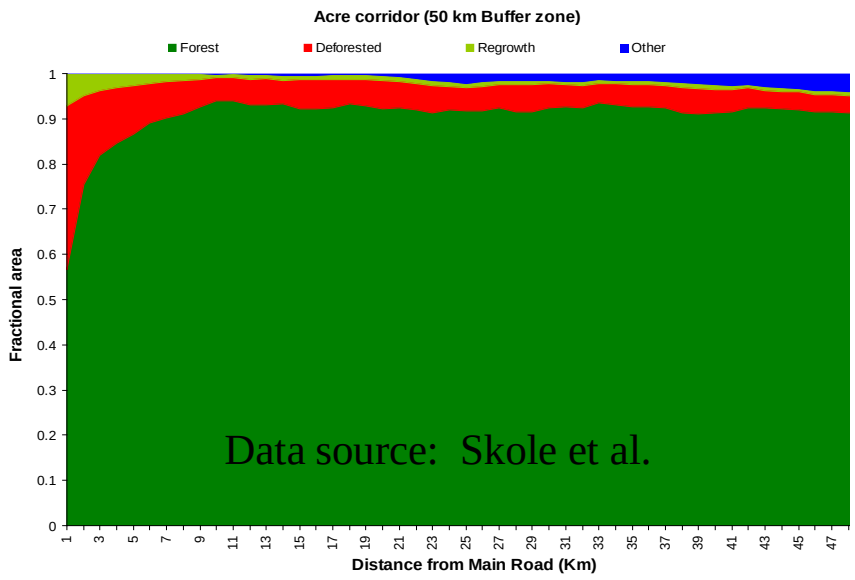


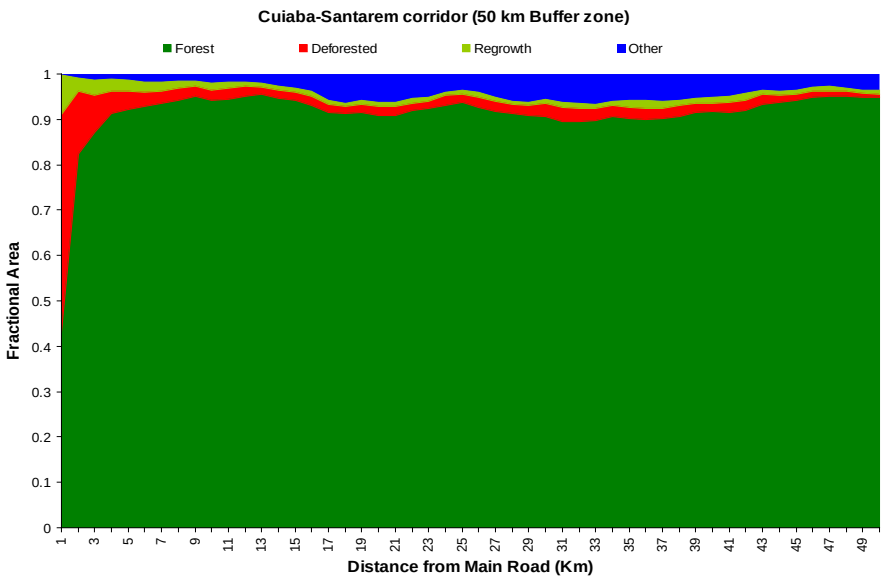
Data source: Skole et al. (MSU/BSRSI)

Spatial patterns along main corridors

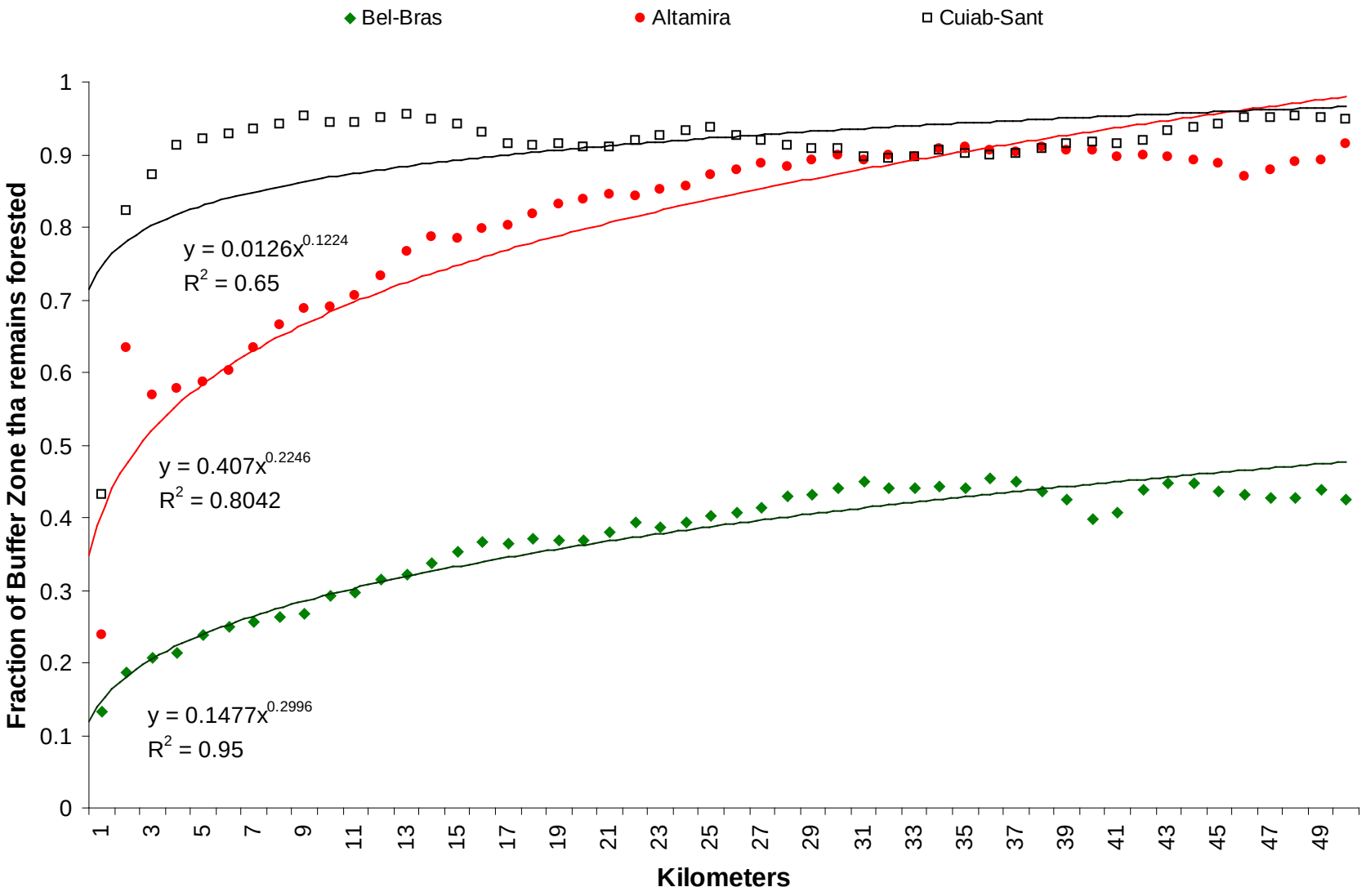




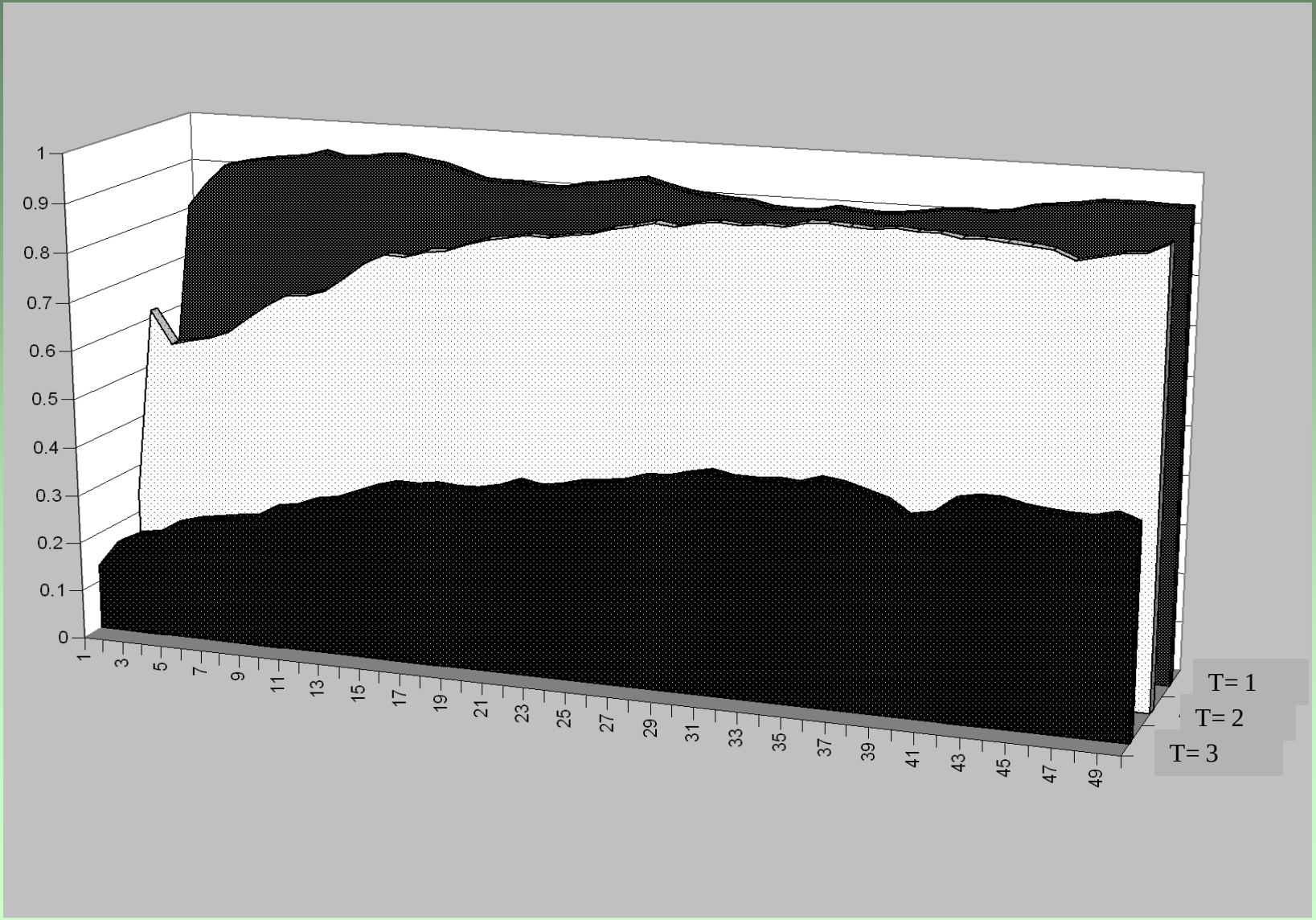




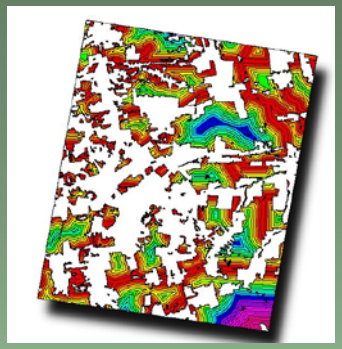
Empirical functions for distinct types of corridors



Time series: reconstructing land-cover along main corridors

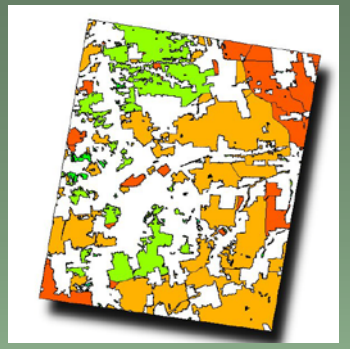


Pattern Detection, Quantification and Statistical Models

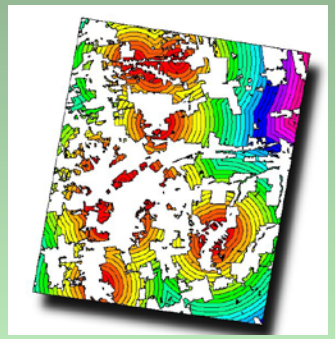


Proximity to Roads

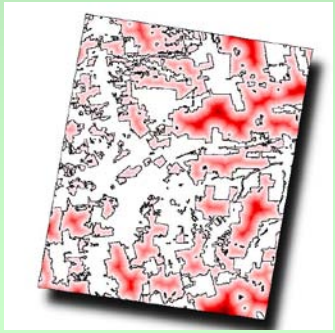
Degradation Index



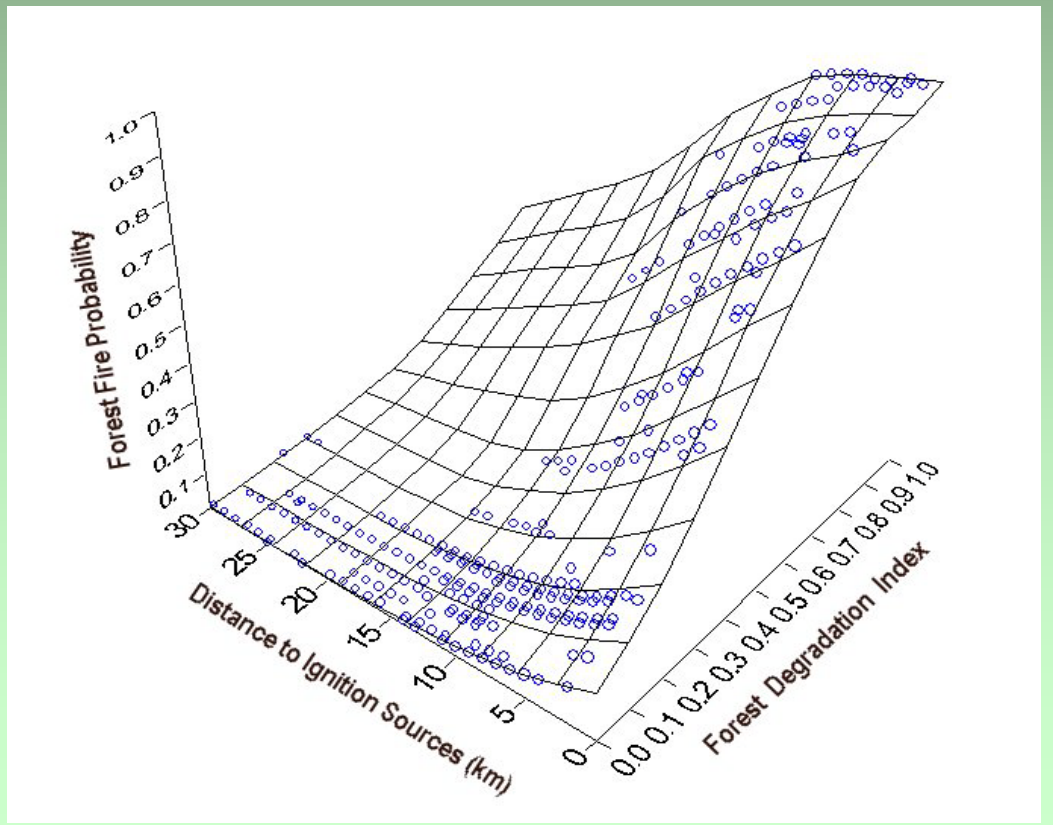
Fractal Dimension



Distance to Ignition Sources

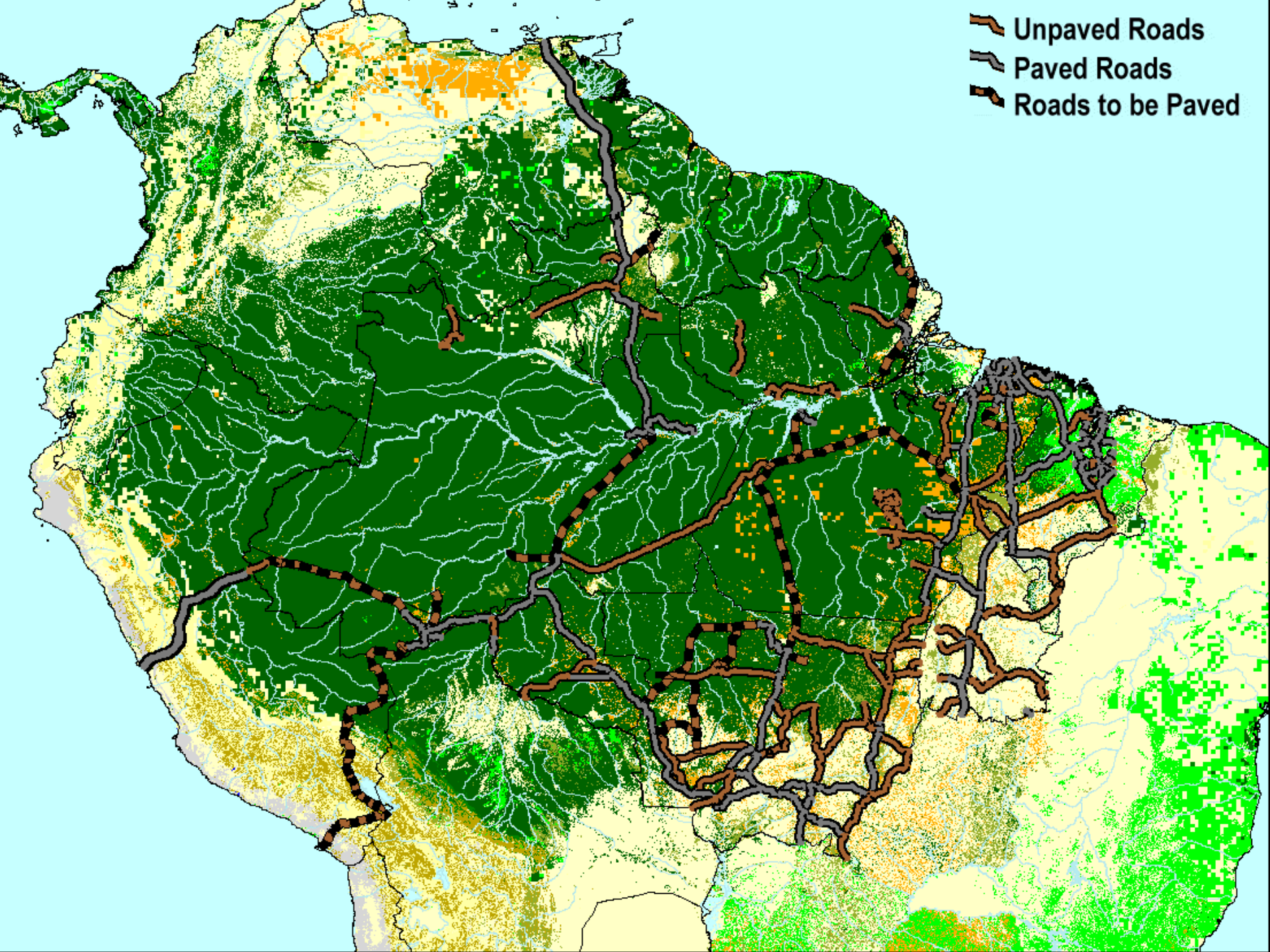


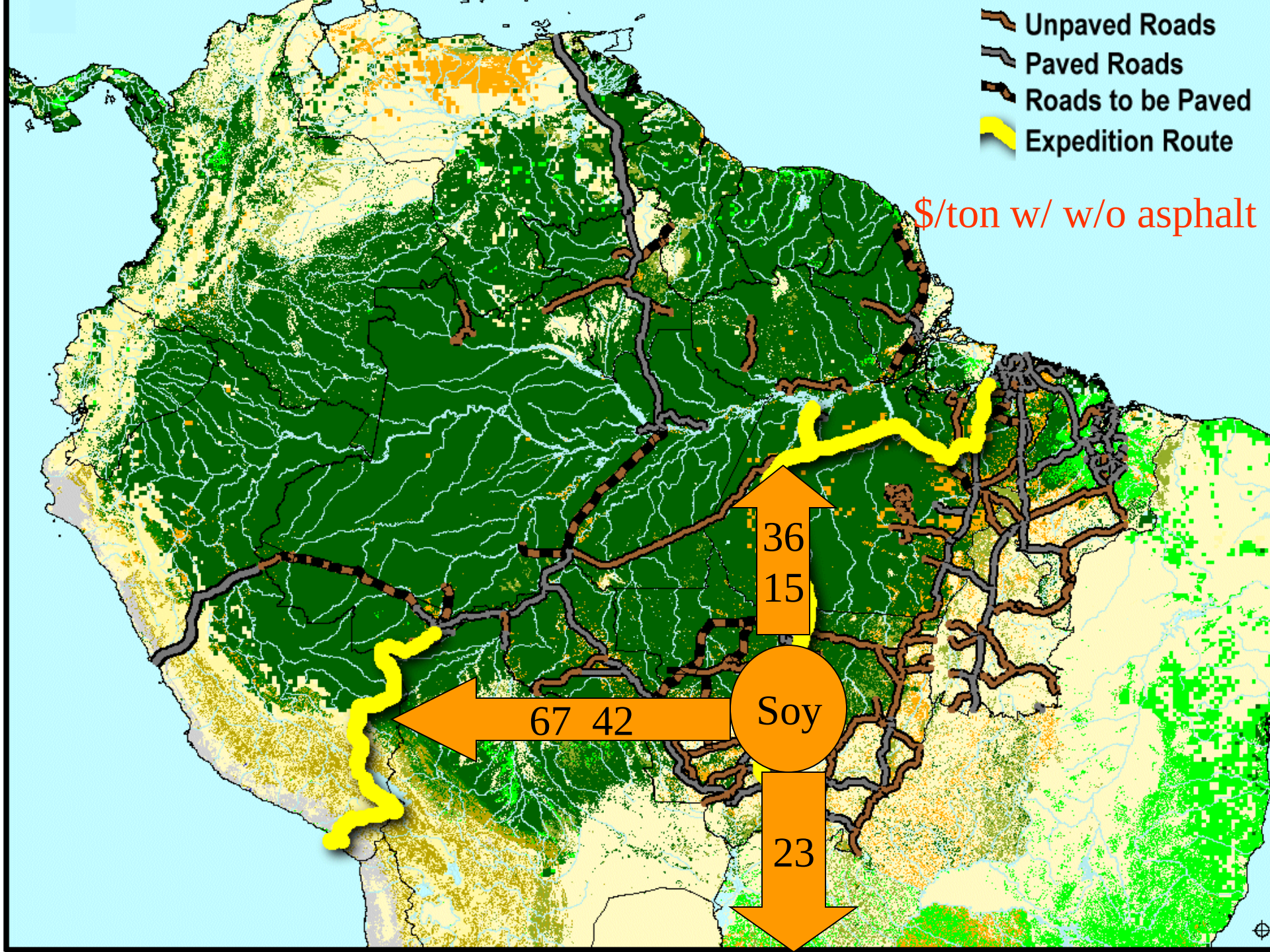
Edge Effect

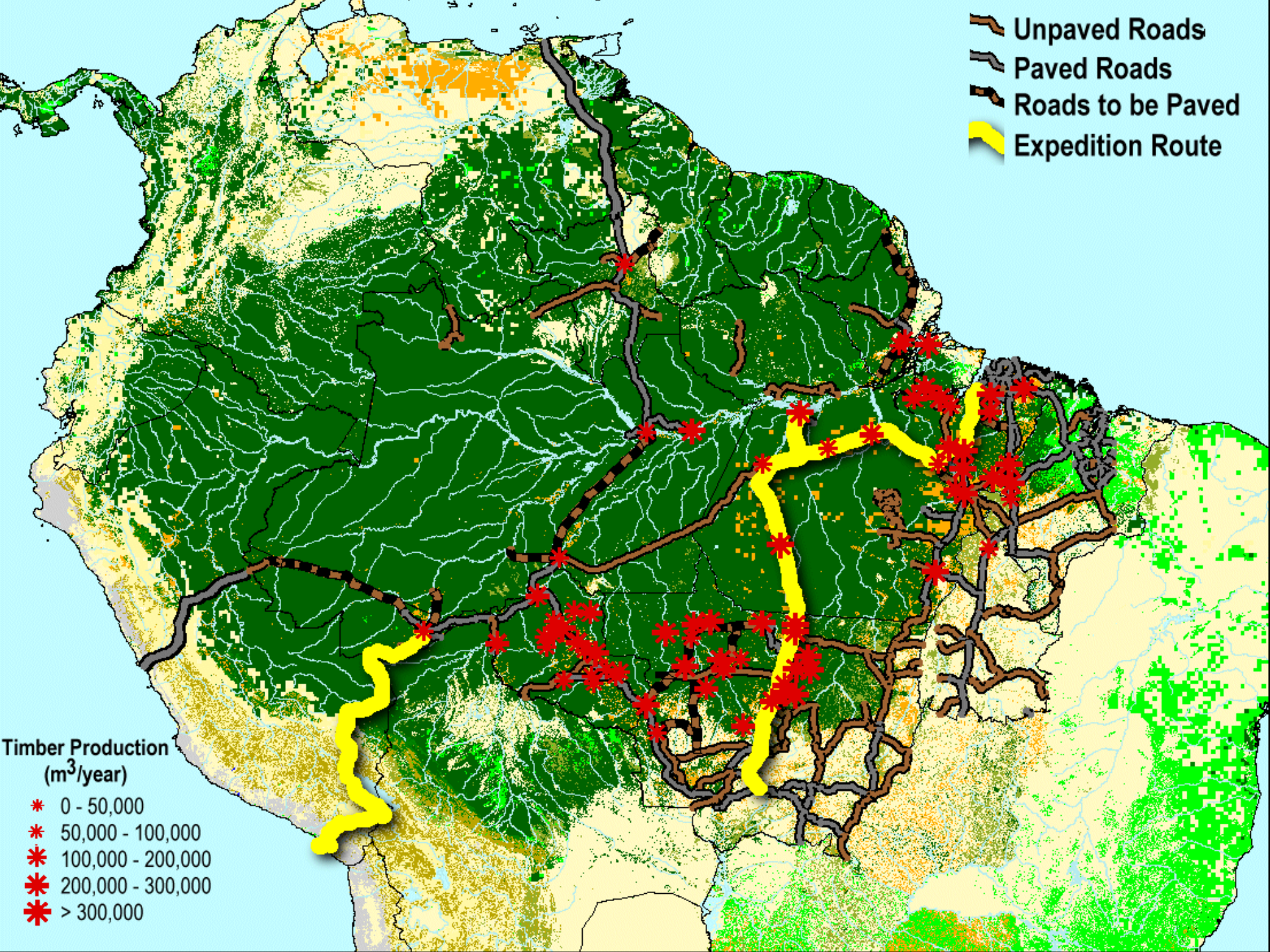


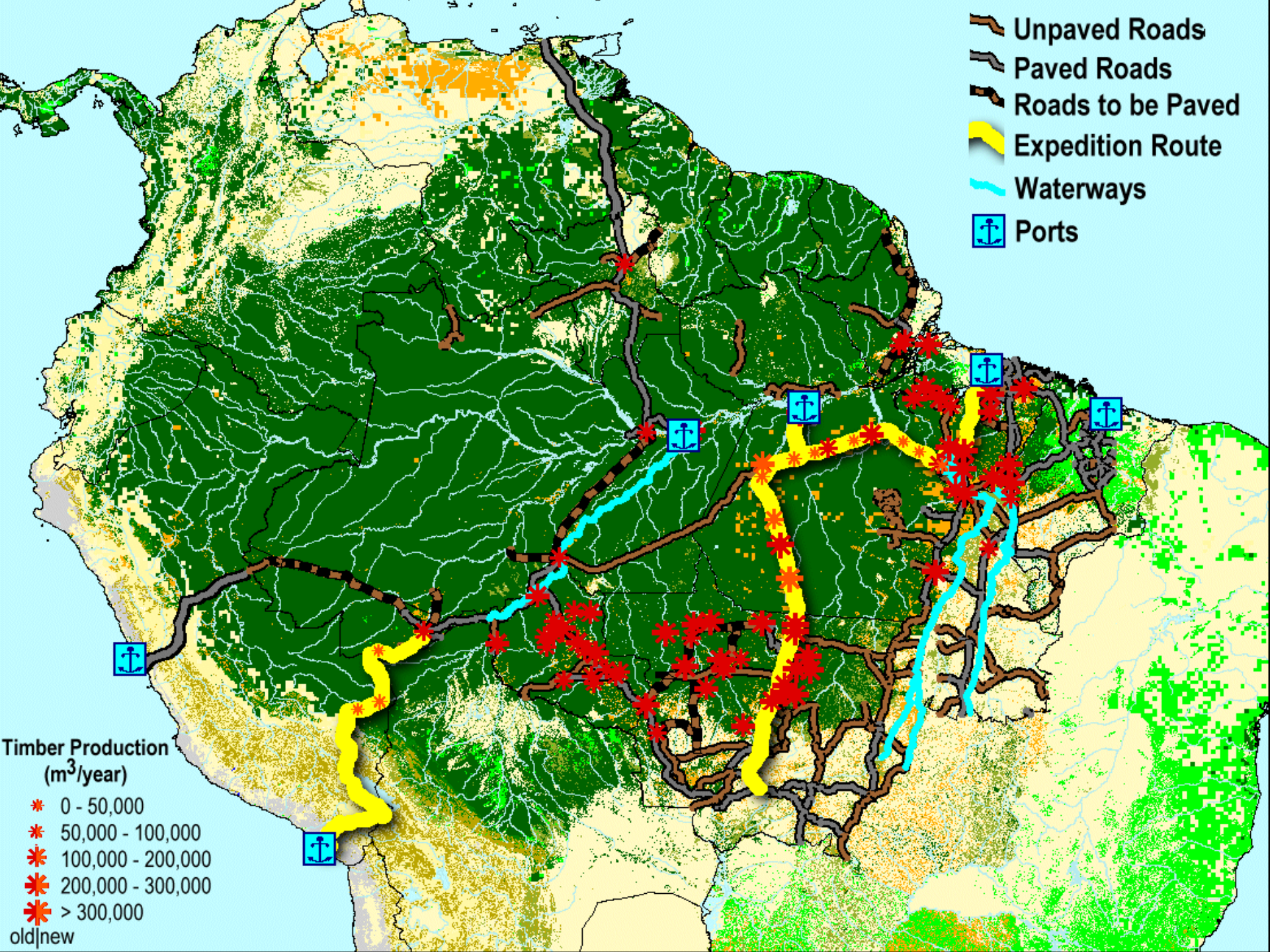
Reference Landscapes:

- Georeferenced and dated scars of logging and forest fire
- Paragominas (50 x 64 km, completed)
- Santarem (12 x 12 km, in progress)
- N. Mato Grosso (12 x 12 km, in progress)

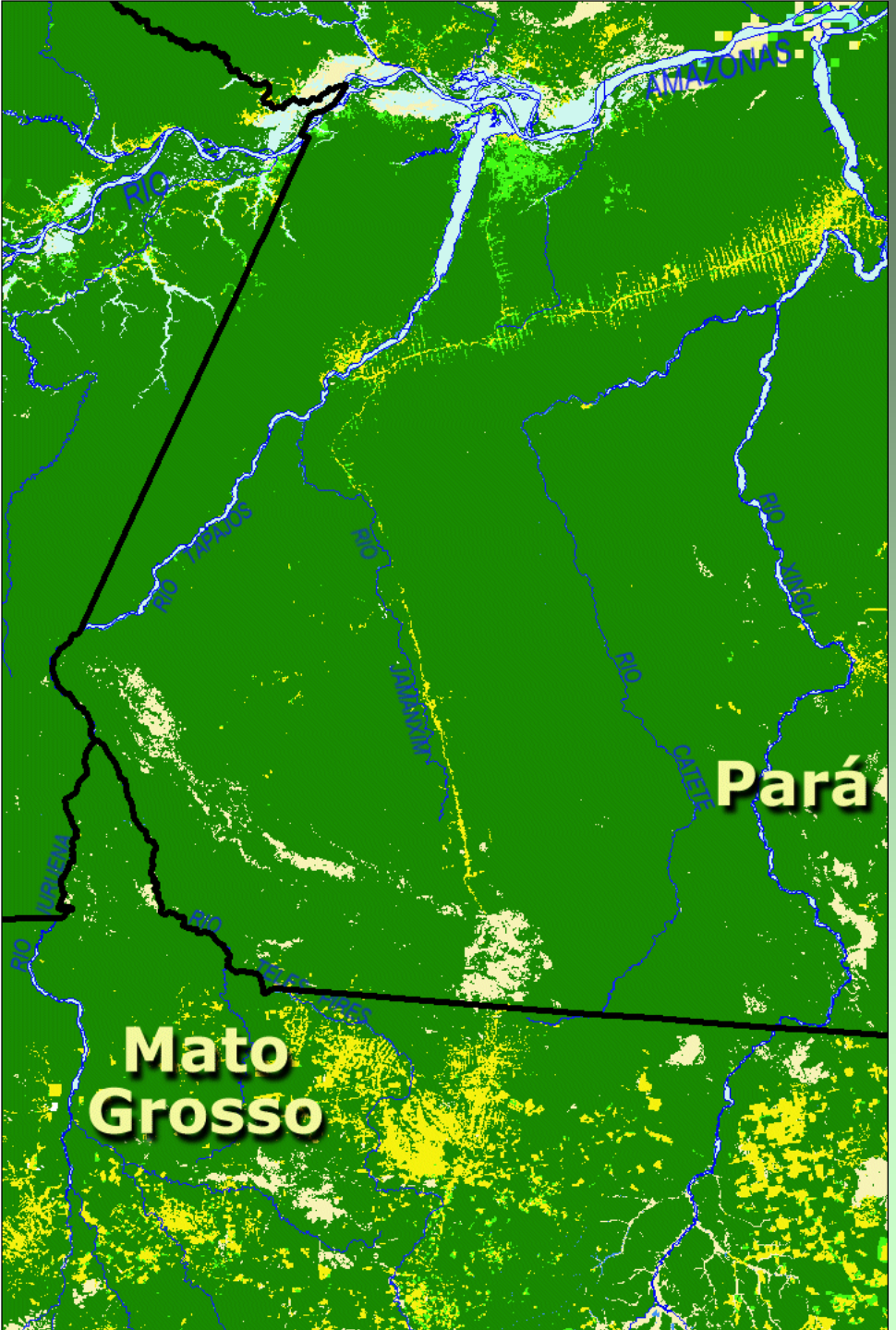

Unpaved Roads
Paved Roads
Roads to be Paved


Unpaved Roads
Paved Roads
Roads to be Paved
Expedition Route
$/ton w/ w/o asphalt
36
15
67 42
Soy
23


Unpaved Roads
Paved Roads
Roads to be Paved
Expedition Route
Timber Production
(m3/year)
0 - 50,000
50,000 - 100,000
100,000 - 200,000
200,000 - 300,000
> 300,000

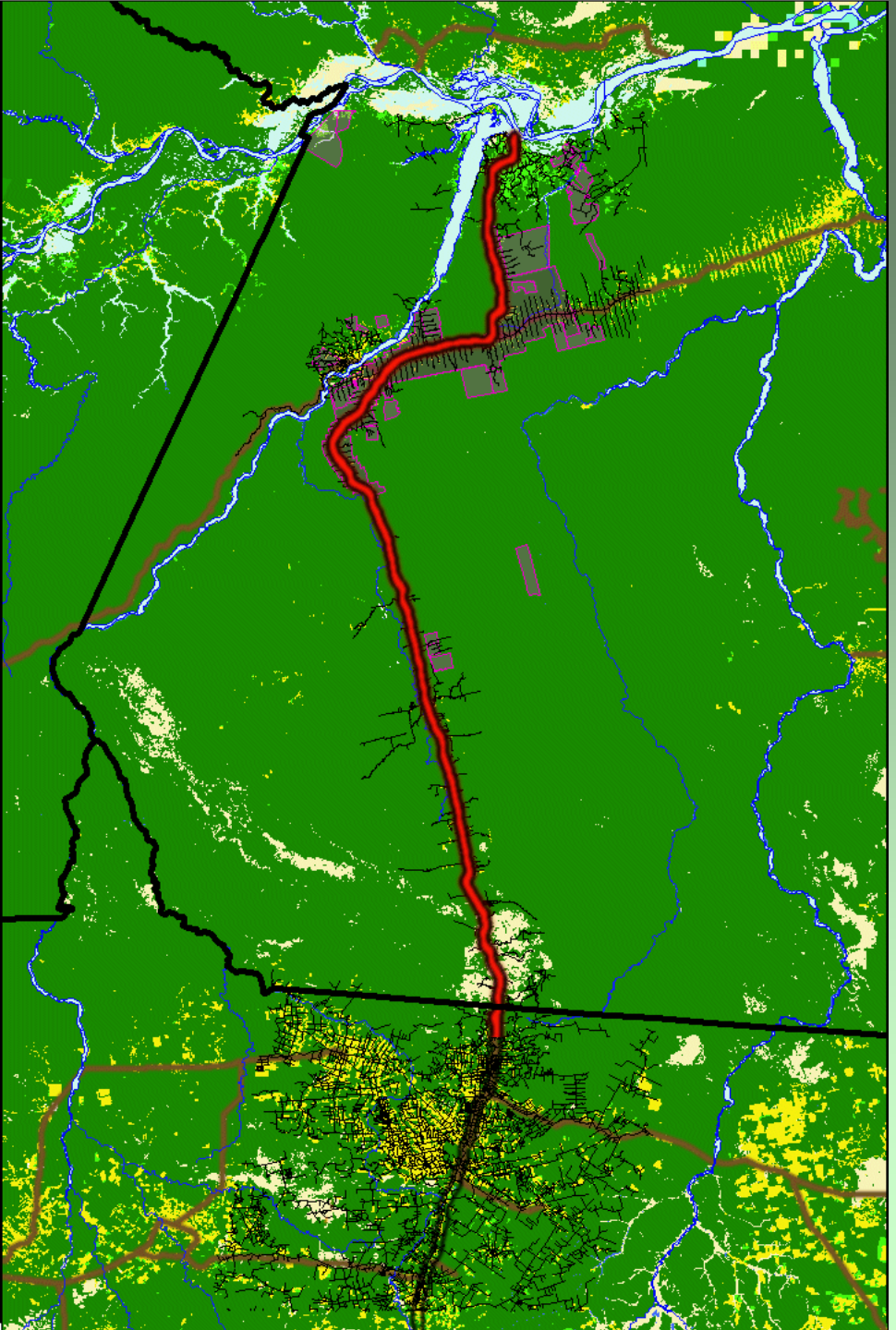

Unpaved Roads
Paved Roads
Roads to be Paved
Expedition Route
Waterways
Ports
Timber Production
(m3/year)
0 - 50,000
50,000 - 100,000
100,000 - 200,000
200,000 - 300,000
> 300,000
old|new


1450
1950
INFLAMABLE
PELIGRO
COMBUSTIBLE
530
W2-4530

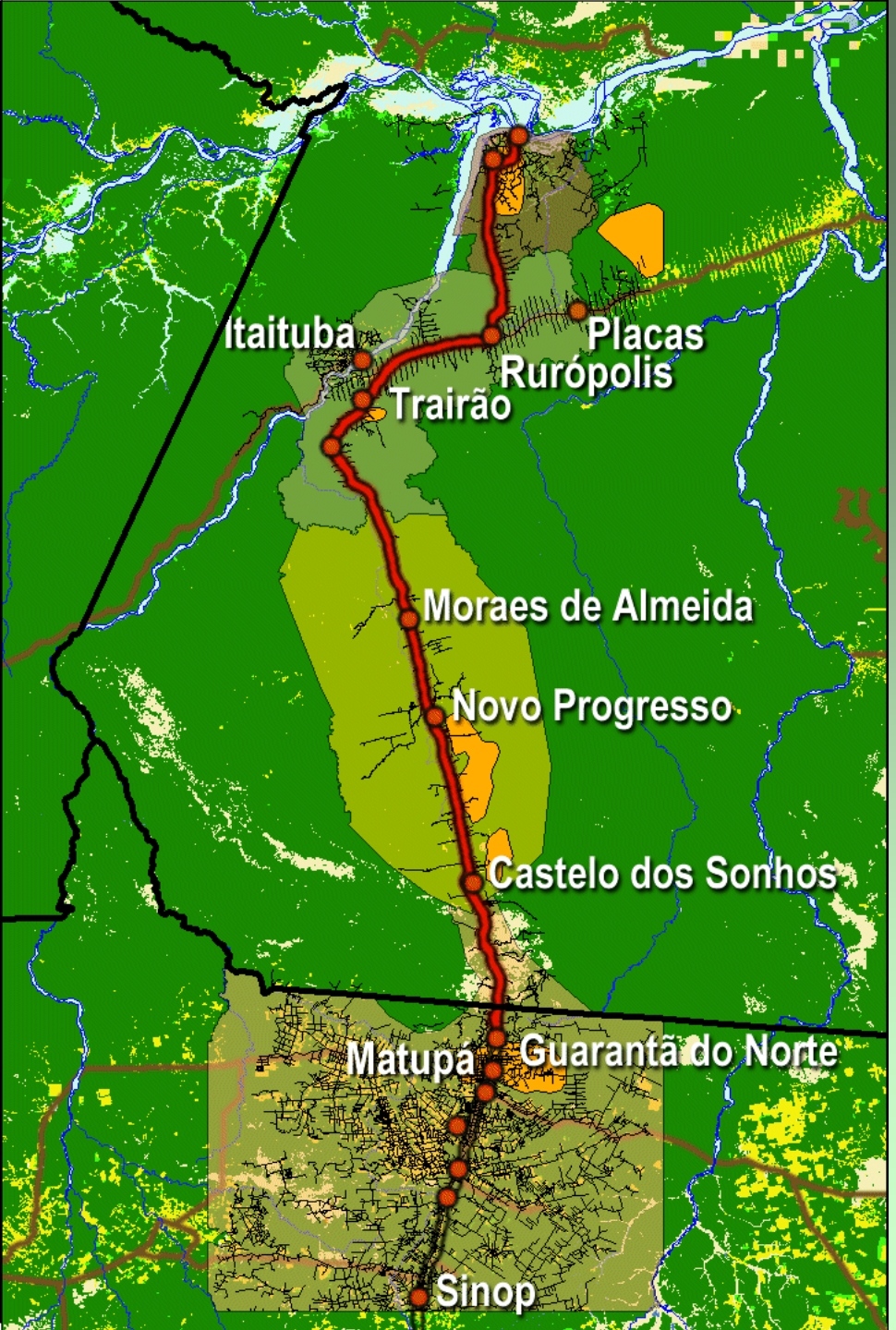


Deforestation in colonization areas

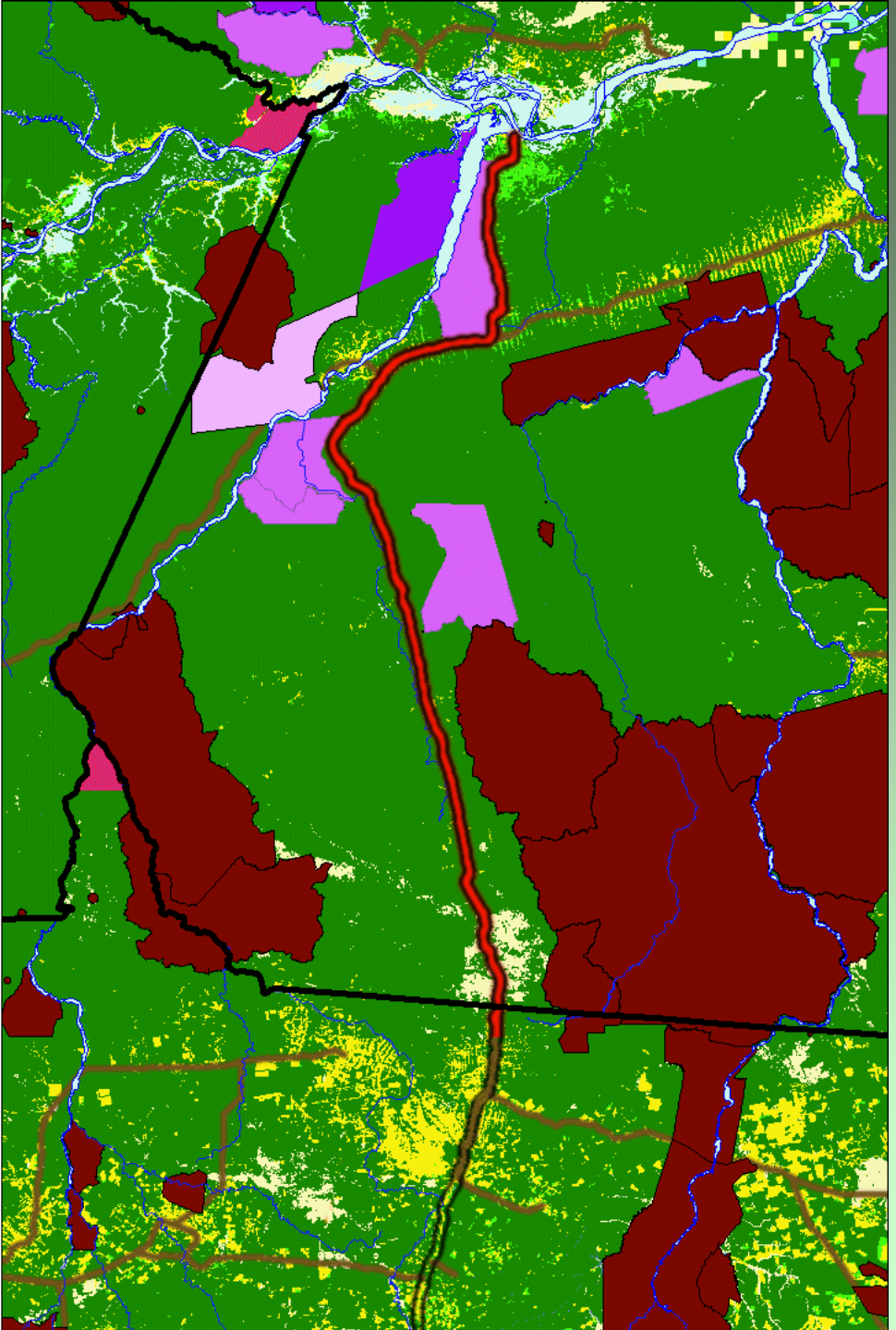
Large Municipios



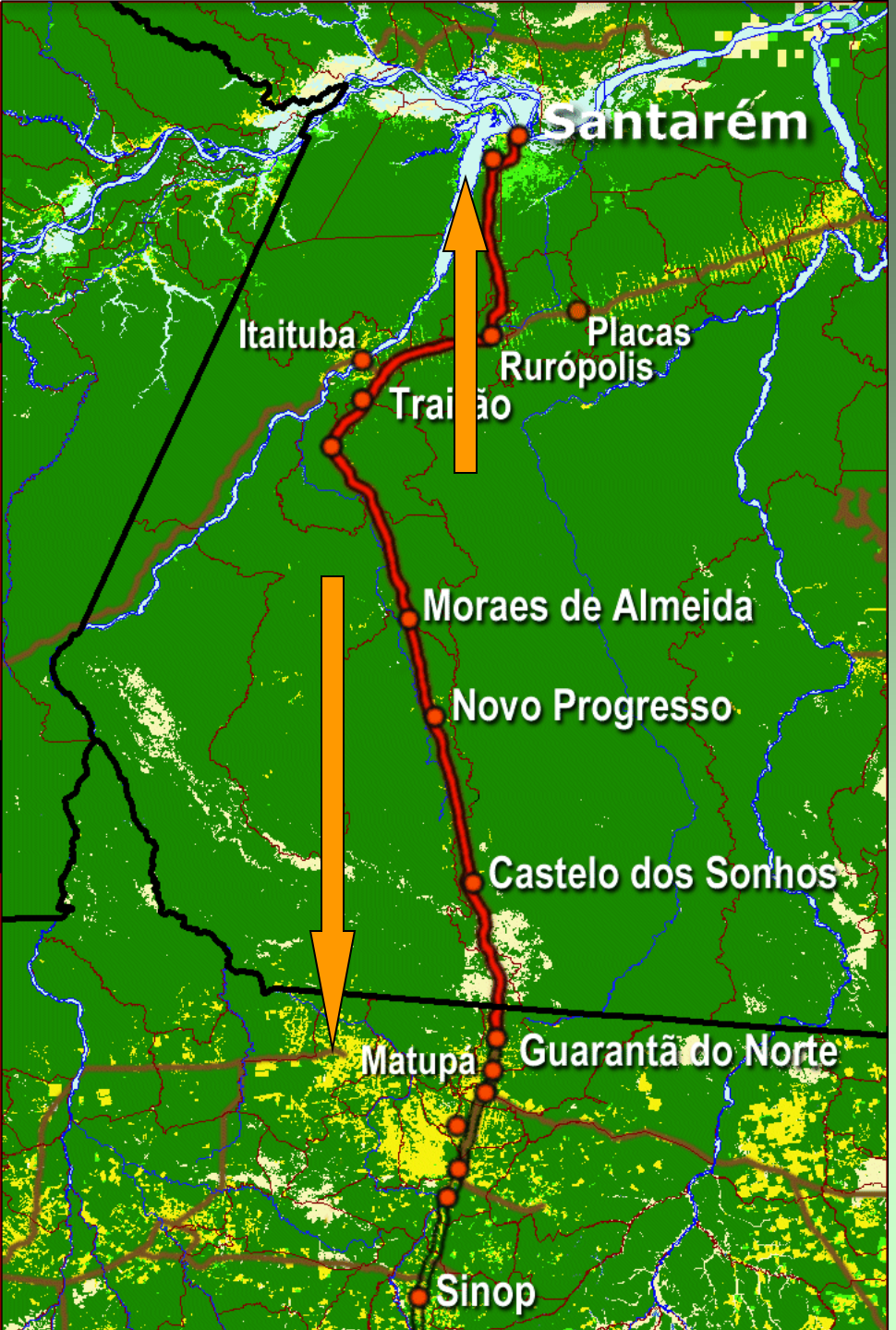
Colonization Projects &
Secondary Roads



Frontier Typology



Public Forests &
Indigenous Reserves
Slow Deforestation



Logging:

Export of 5-6 species

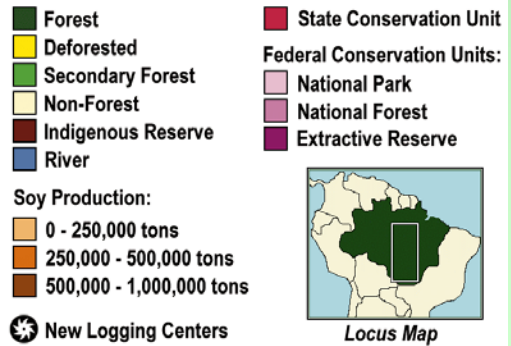
Domestic market: 15 spp

~1,000,000 ha/yr

Large potential for regulation.

Logging Near Novo Progresso

Cuiaba-Santarem Corridor



- 990 km being paved
- 3% deforested
- Sawmill industry shifting to domestic markets
- Transport savings for Mato Grosso soybean ($70 M/yr)
- 27% protected areas

Regional Environmental Planning Workshop

GIS Databases

Calibration

Stratified Empirical Functions

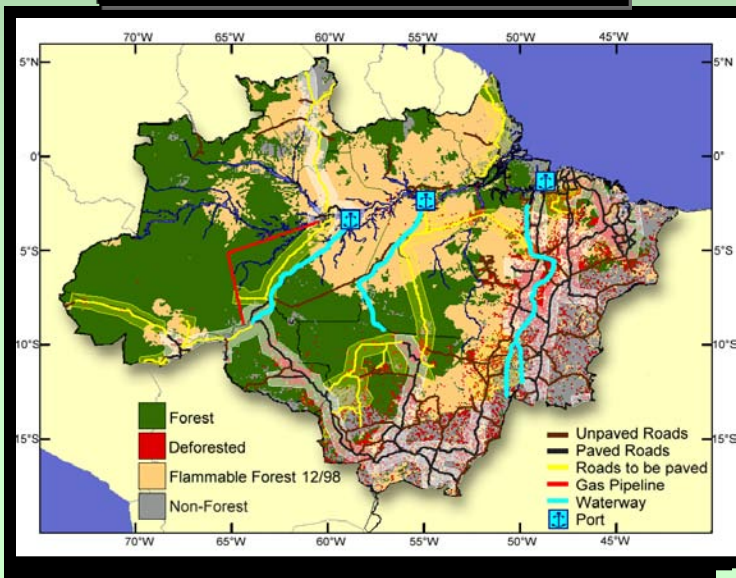
RisQue Fire-Model

Cellular Automata

Scenarios Simulator

Transition Matrices

Amazon Scenarios



Economic Models

Validation

Problems:

- Rainfall data

Program Summary:

- Land use change is structured along economic corridors; need for meso-scale analyses
- LBA coincides with policy experiment; meso-scale analyses policy-relevant
- Fire is important and our understanding is rudimentary; still no wall-to-wall estimates
- Logging is important; still large discrepancies in estimates