

*Reporting on NASA - LBA project:*

***A Basin-Scale Econometric Model for Projecting  
Future Amazonian Landscapes***

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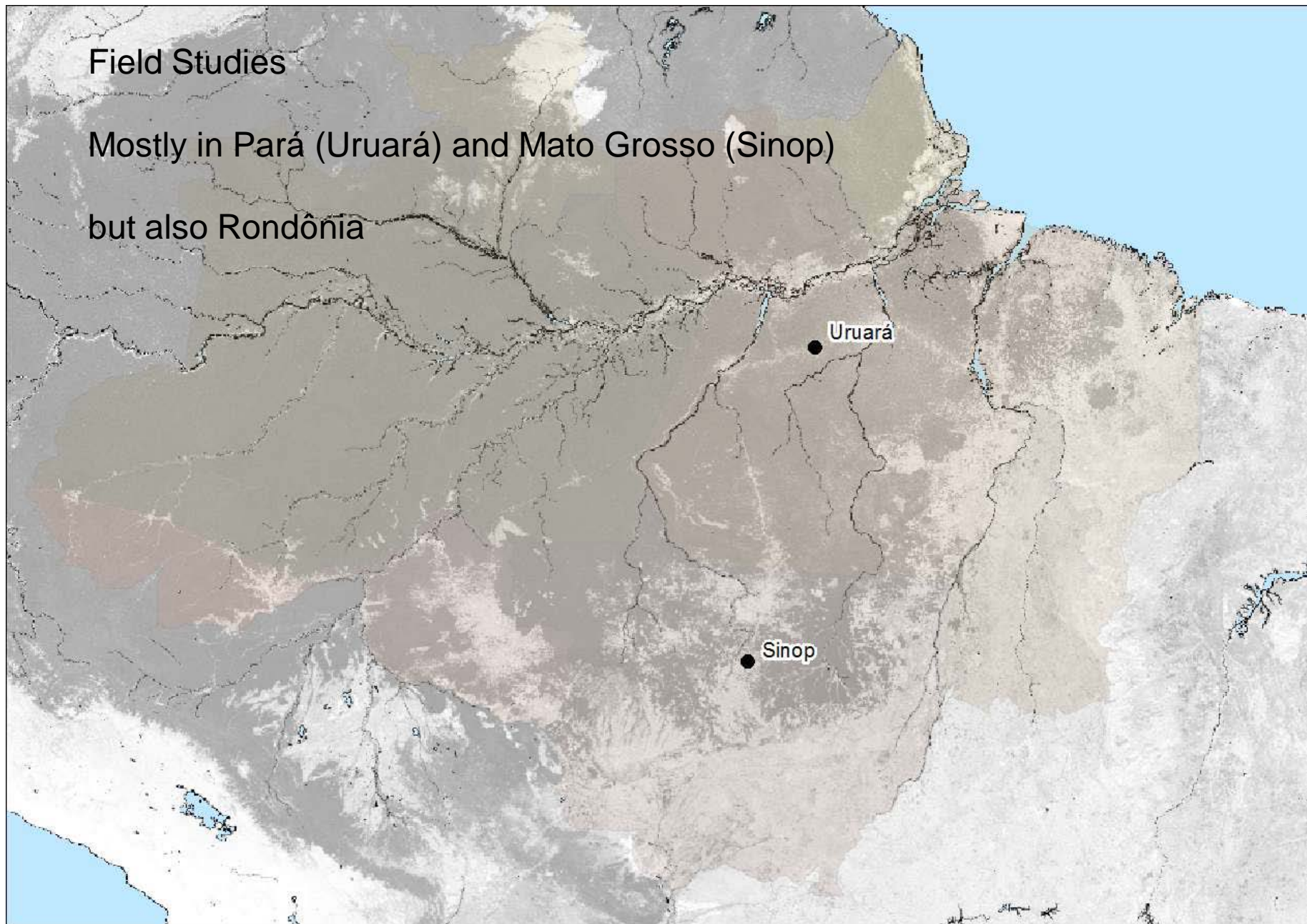
Carlos Souza, Jr. IMAZON

- **Project goals**

- Develop a basin-scale econometric model of land cover change
- Use to analyze impacts of policy, through projections
- Equip an earlier model with greater realism  
(better data, better specification)
- Spatially explicit modeling

# Research Activities 2004

- Econometric model, with expanded data
- Field studies of road building
  - understanding the link between road building and deforestation
  - understanding patterns of fragmentation
- Behavioral modeling of deforestation and road extensions



Location of Uruará, PA & Sinop, MT

# Significant Results

Econometric Modeling

Field studies

social processes and fragmentation  
the “endogeneity issue”

Modeling

spatial patterns of deforestation  
road building

## *Significant Results* Econometric modeling

Details presented in Pfaff, A, Reis, E, Walker, R, Laurance, W, Perz, S., Bohrer, C., Robalino, J., Aldrich, S., Arima, E., Caldas, M., Kirby, K., “Roads and Deforestation in the Brazilian Amazon.”  
[submitted to *Science* (?)]

### **Regression analysis explaining 1976-87 deforestation at the basin scale:**

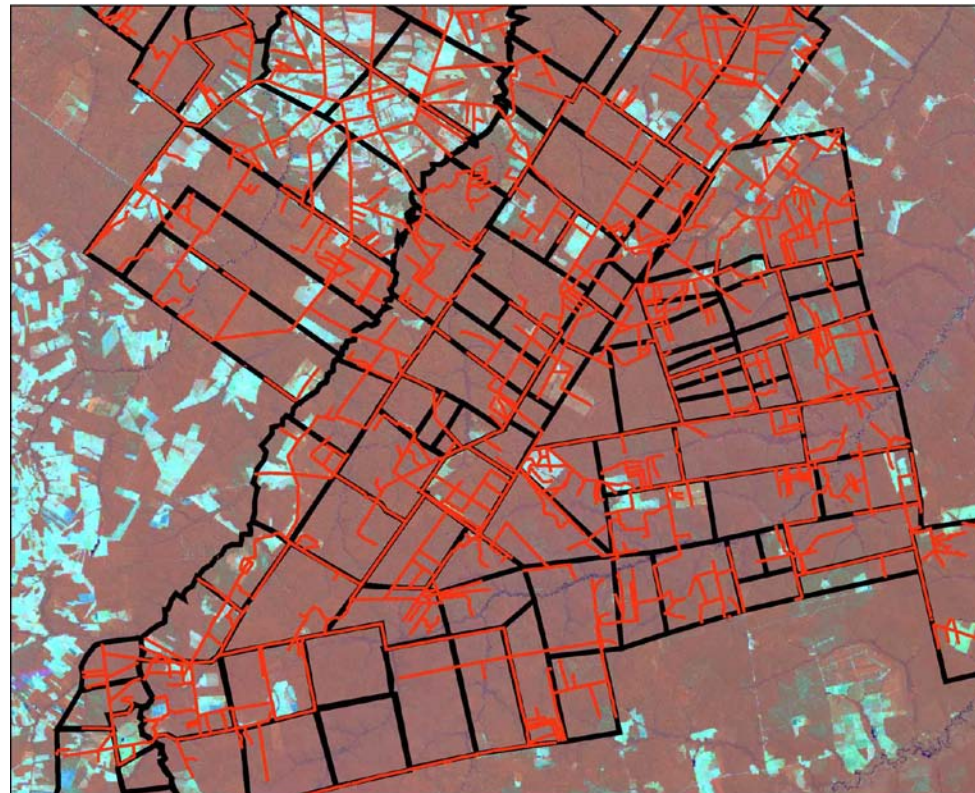
- observations (over 6800) are census tracks, i.e. greatly disaggregated data relative to the previous basin-scale analysis (but aggregates of households)
- controlling for effects of market access and a set of biophysical factors (confirms earlier results on distance, soil quality, slope, and rain)
- focus on roads using 1968-1975 data on paved and unpaved roads to help avoid inference problem (when road construction follows clearing)
- now extending to later periods

### **Results, in particular relative to recent claims regarding roads:**

- confirm: in pristine and areas of little initial clearing (the majority), roads increase deforestation
- disagree: we find that in highly cleared tracts, paved effects are even greater
- disagree: we find that road investments never reduce deforestation rates (only for extremely cleared tracts is their effect reduced to insignificance)

Details in Perz, S., Caldas, M., Walker, R., Arima, E., Souza, C. Socio-spatial Processes of Road Building in the Amazon: A Comparative Analysis of Local Heterogeneities and Implications for Forest Fragmentation. In draft for submission to *Conservation Biology*.

“rectilinear” fragmentation tracks cadastral pattern



All Roads and Property Boundaries  
Mato Grosso, Brazil

— Roads 1987 - 2000  
□ Lot Boundaries ca. 1976



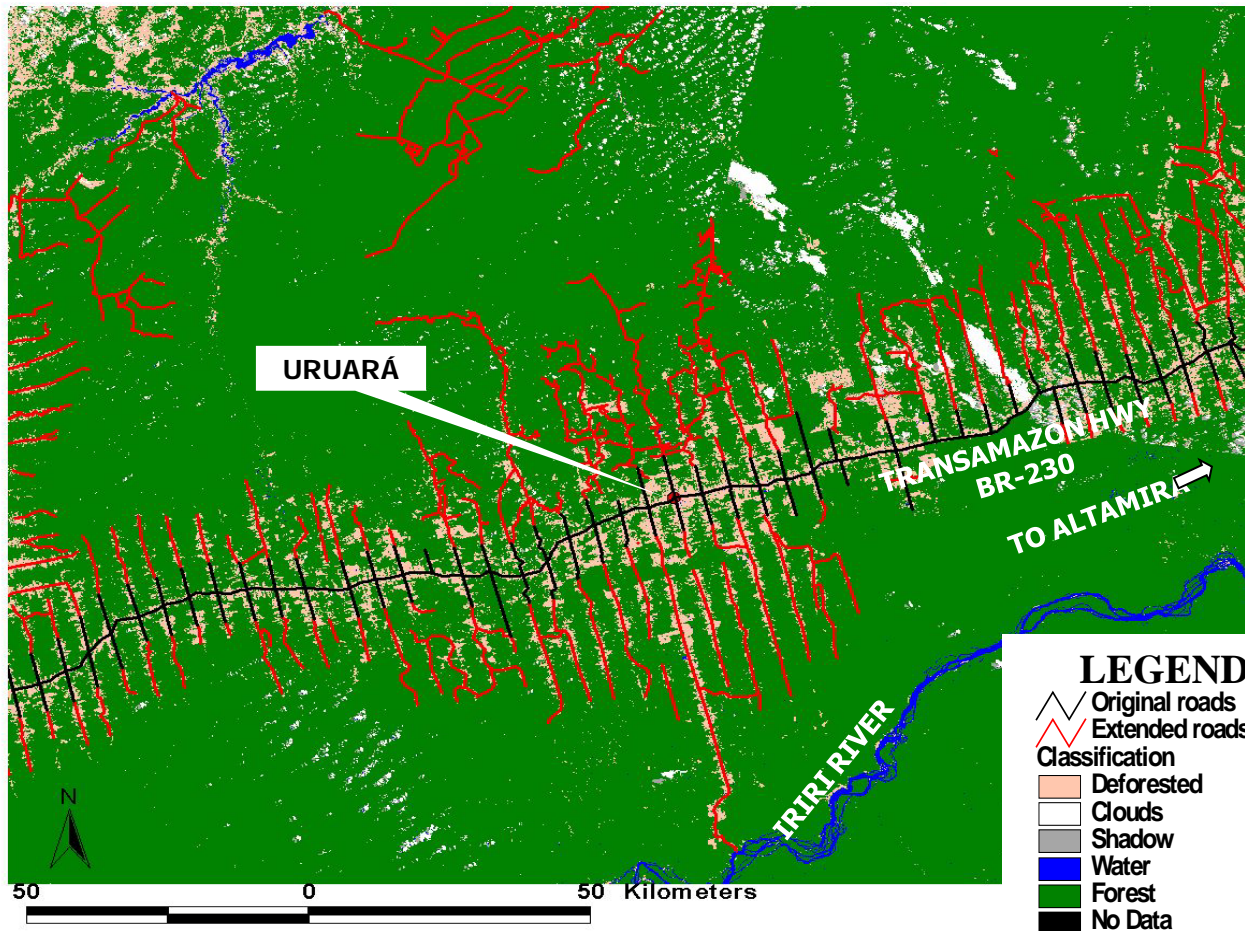
0 5 10 20 30 40 Kilometers

Projection: UTM, Zone 21 South, WGS 1984 Datum  
Landsat ETM+ Bands 4,3,2 - June 18, 2000

## Significant Results Field Studies

Details in Perz, S., Caldas, M., Walker, R., Arima, E., Souza, C. Socio-spatial Processes of Road Building in the Amazon: A Comparative Analysis of Local Heterogeneities and Implications for Forest Fragmentation. In draft for submission to *Conservation Biology*.

“fishbone” pattern emerges from colonist desire to regularize holdings



From four Landsat ETM+ images, rows/paths 226/62, 227/62, 227/63, and 226/63 (1999). Visual interpretation used to detect roads and screen digitized, using bands 4,3,2 and 5,4,3 (RGB).





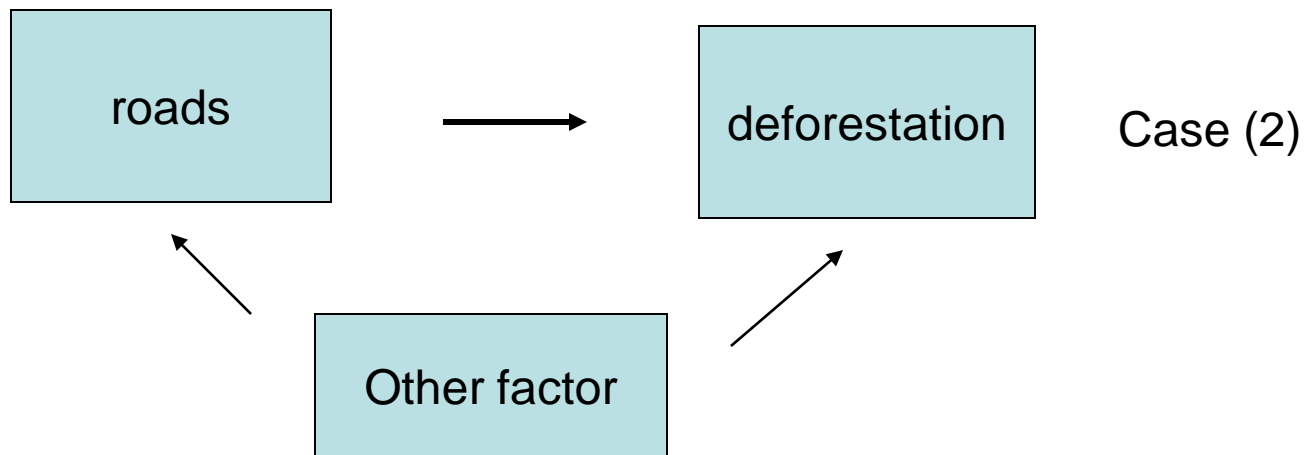
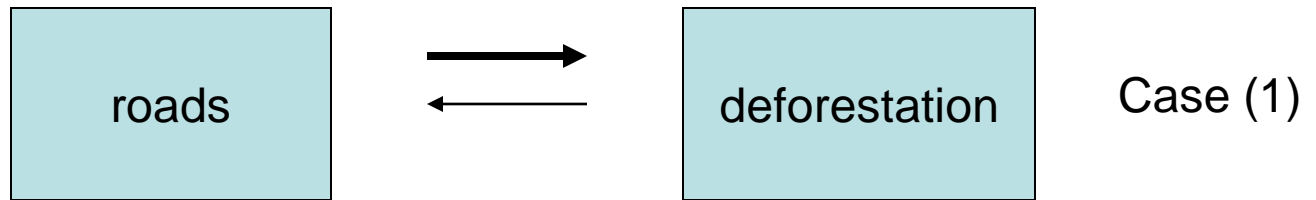
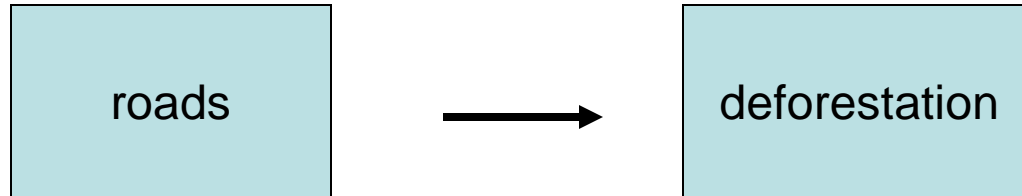
Addressing road causality at micro and macro scale

**Do roads cause deforestation  
or does deforestation cause roads?**

Micro-scale studies at household scale, and from old map archives

Basin scale statistical analysis

# The endogeneity issue

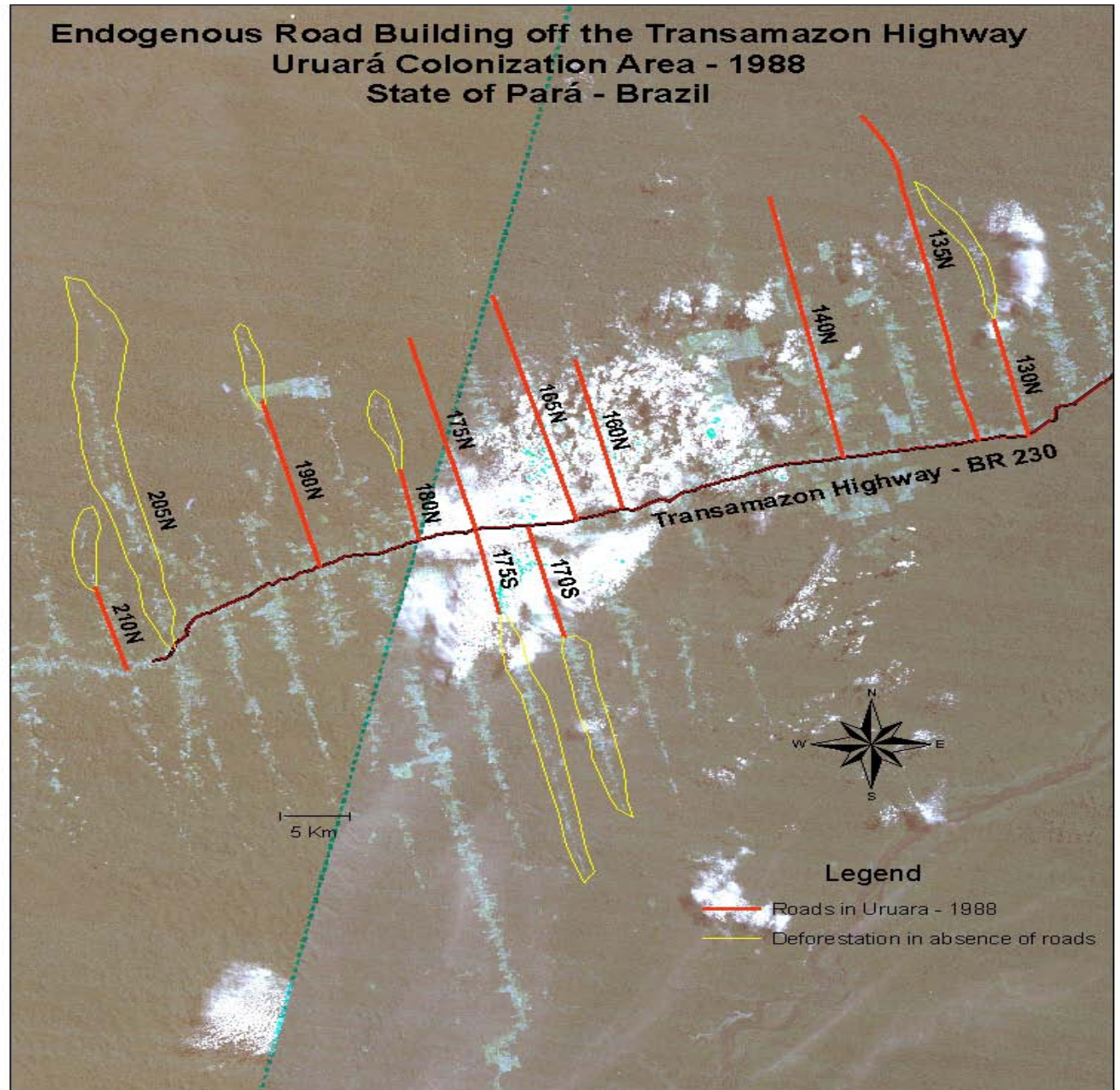


**Endogenous Road Building off the Transamazon Highway  
Uruará Colonization Area - 1988  
State of Pará - Brazil**

**Significant  
results**

Empirical  
evidence

endogeneity  
case (1)



*Significant results*      empirical evidence, endogeneity case (1)

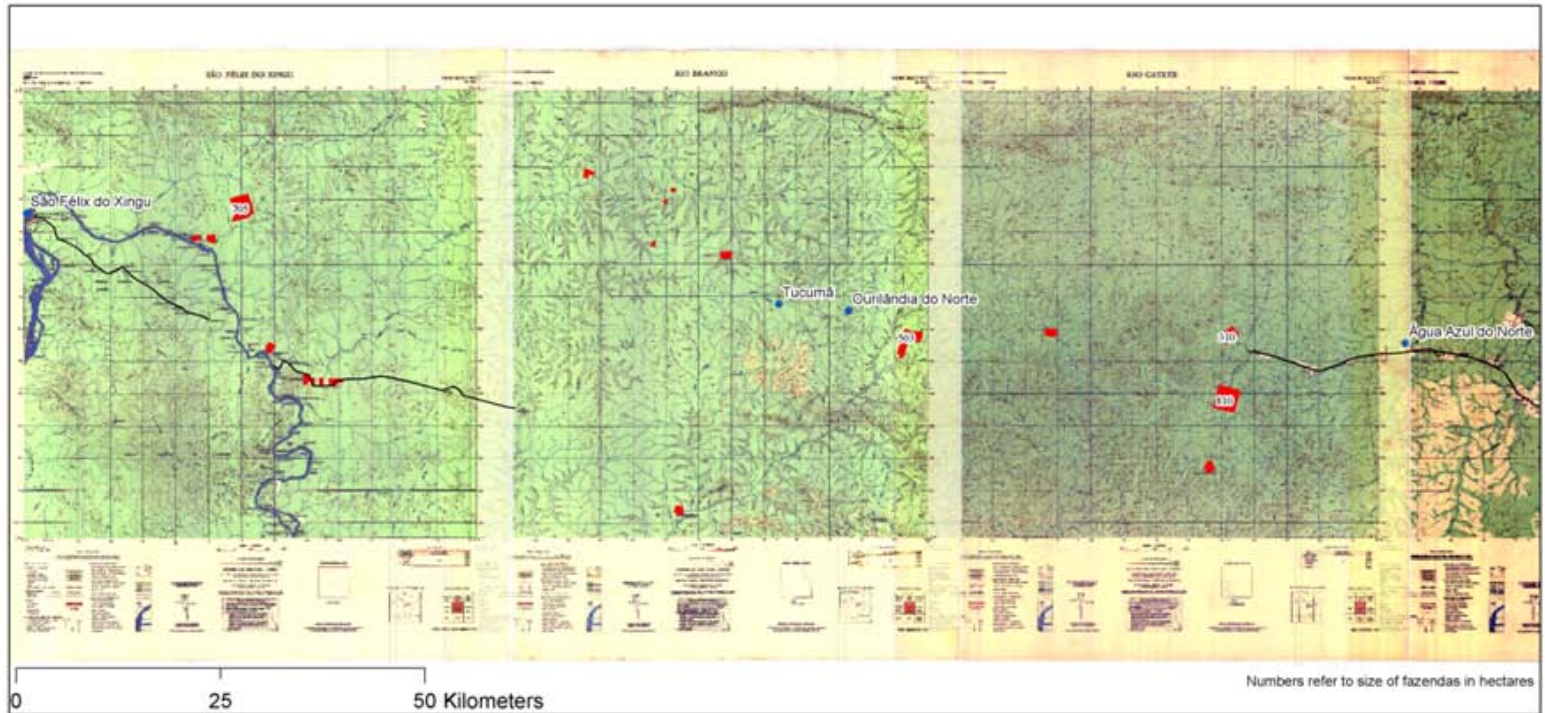


Figure from four IBGE 1:100,000 quad sheets (1981)



## **Significant Results**      **Econometric analysis**

endogeneity case (2)

All tracts with roads in 1968:      27.95%      deforestation (1976-1987)

All tracts without roads in 1968:      19.32%      deforestation (1976-1987)

*8.62 % more deforestation in tracts with roads*

Controlling for factors affecting both road location and deforestation  
(e.g., distance to markets, etc.)

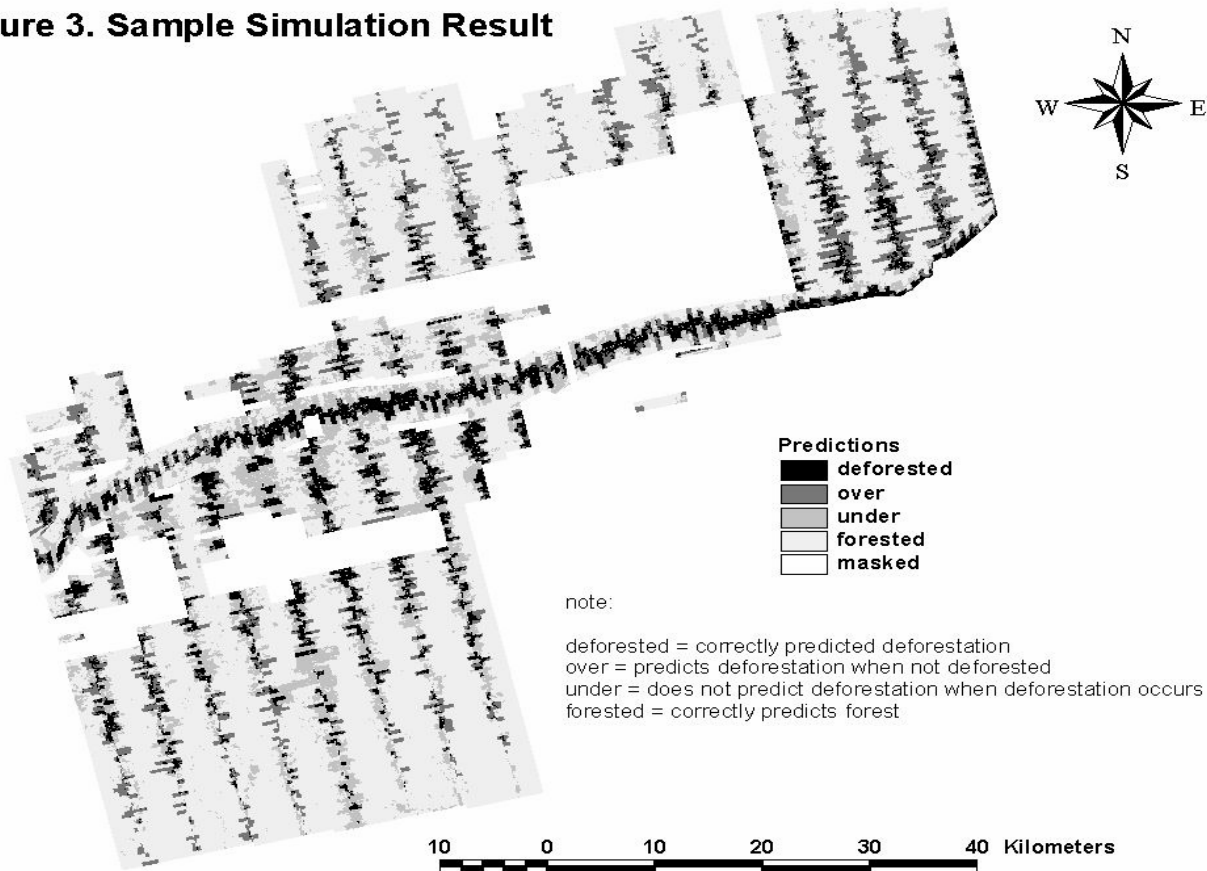
deforestation in tracts with roads:      27.95%      deforestation (1976-1987)

deforestation in tracts without roads:      20.99%      deforestation (1976-1987)

*6.95 % more deforestation in tracts with roads*

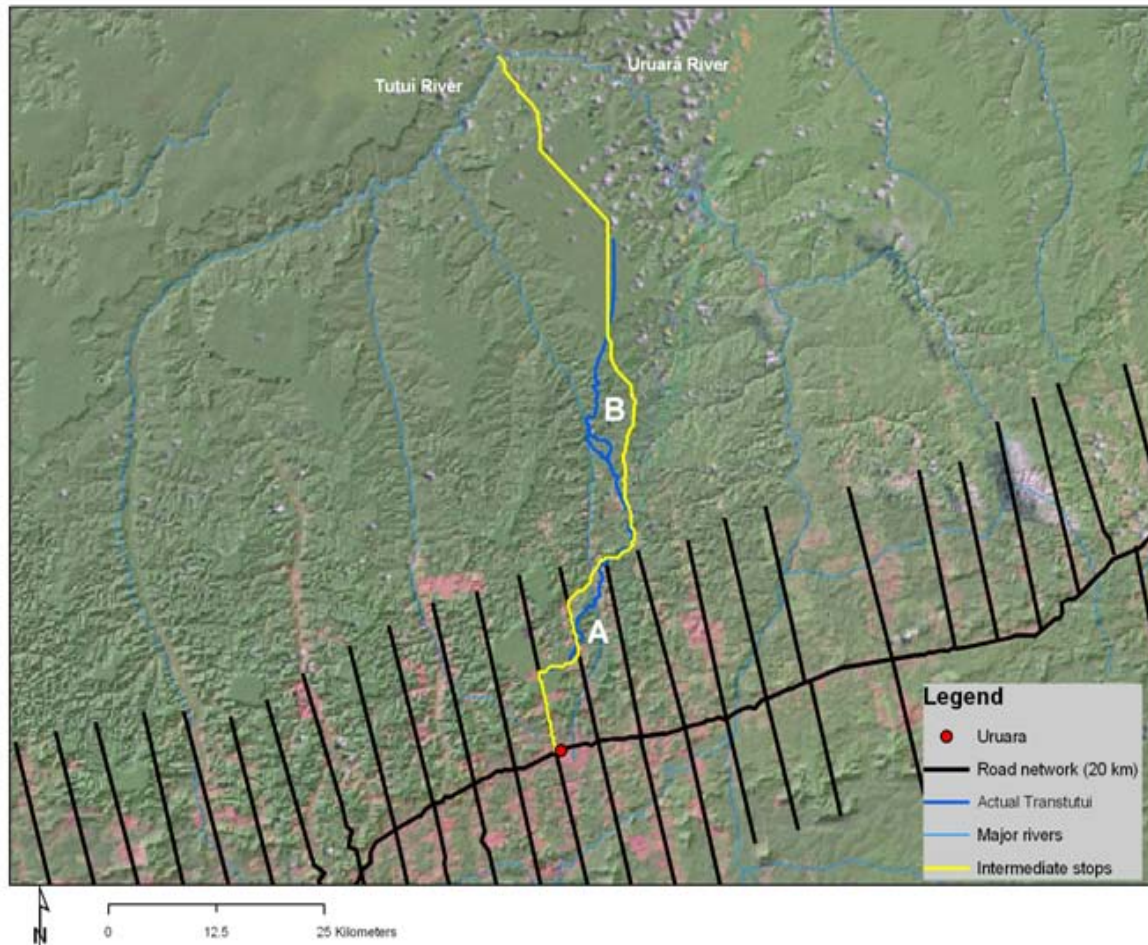
Details presented in Walker, R.T., Drzyzga, S., Li, Y., Qi, J., and Caldas. M., Qi, J., Arima, E., and Vergara, D. 2004. A Behavioral Model of Landscape Change in the Amazon Basin: The Colonist Case. *Ecological Applications*. Vol. 14 (4) Supplement: S299-S312.

Figure 3. Sample Simulation Result



## Significant Results Behavioral Modeling: Road Building

Details in Arima, E., Walker, R.T., Perz, S., and Caldas, M. (accepted for publication) *Loggers and Forest Fragmentation: Behavioral models of road building in the Amazon basin*, *Annals of the Association of American Geographers*.





[http://www.lbaeco.org/lbaeco/data/data\\_lba.htm](http://www.lbaeco.org/lbaeco/data/data_lba.htm)

Brazil: <http://lba.cptec.inpe.br/beija-flor/>

US: <http://beija-flor.ornl.gov/lba/>

Beija-flor User's Guide: [english](#) [790K], [portuguese](#) [240K] pdf

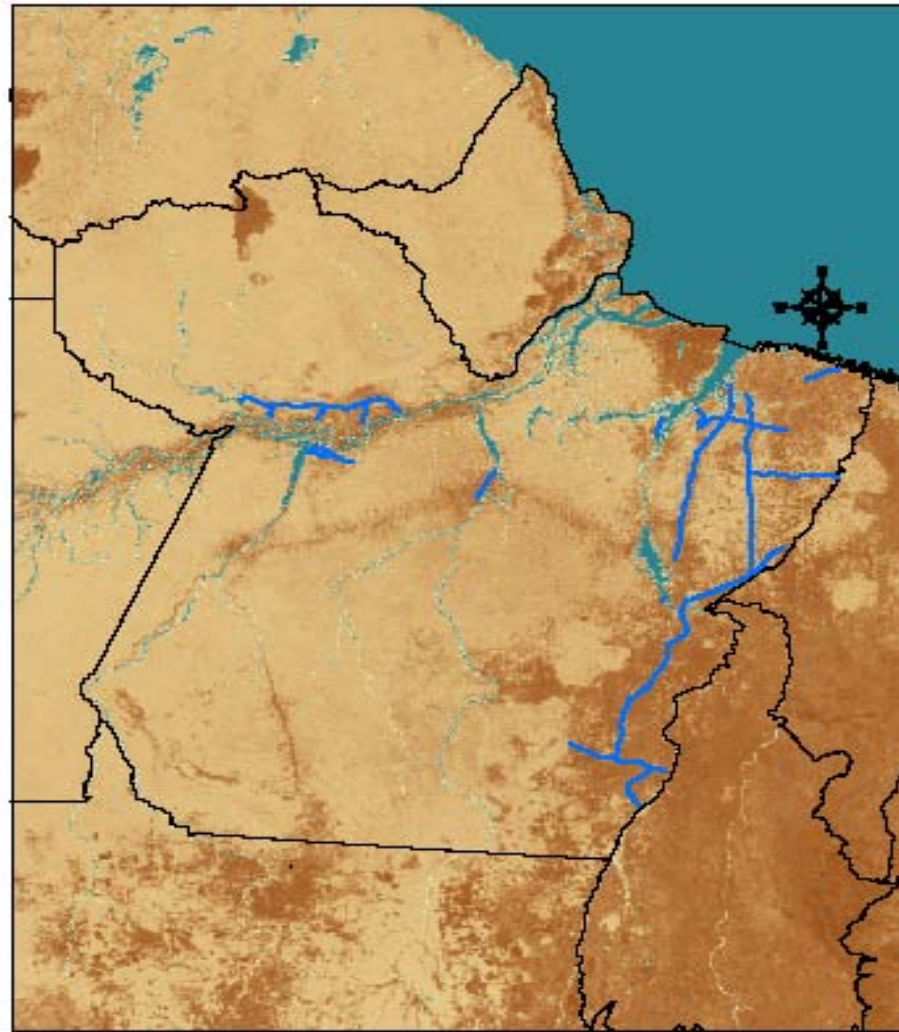
welcome to  
Beija-flor  
Search Engine for the LBA Project

- Search under “roads”
- Data sets 8, 9, 10, 11, 12, 13, 14, 15, 16
- Acre, Amapa, Amazonas, Maranhao, Mato Gross, Para, Rondonia, Roraima, Tocantins

FOR EXAMPLE:

- **13. Data Set Title:** Historical Roads of the Amazon - Para [Access data and documentation...](#) **Abstract:** This PDF displays federal or state road locations for various years. Please refer to the dataset title for more information.

# Para State Roads 1975



0 115 230 460 690 920 Kilometers

State Roads



State Border



# Para Federal Roads 1991



Federal Roads



State Border



# publications

- Arima, E., Walker, R.T., Perz, S., and Caldas, M. (accepted for publication) Loggers and Forest Fragmentation: Behavioral models of road building in the Amazon basin, *Annals of the Association of American Geographers*.
- Walker, R.T., Drzyzga, S., Li, Y., Qi, J., and Caldas, M., Qi, J., Arima, E., and Vergara, D. 2004. A Behavioral Model of Landscape Change in the Amazon Basin: The Colonist Case. *Ecological Applications*. Vol. 14 (4) Supplement: S299-S312.
- Walker, R.T. 2004. Theorizing Land Cover and Land Use Change: The Case of Tropical Deforestation. *International Regional Science Review*. Vol. 27(3): 247-270.
- Caldas, M., Walker, R.T., Shirota, R., Perz, S., Skole, D. 2003. Ciclo de Vida da Família e Desmatamento na Amazônia: Combinando Informações de Sensoriamento Remoto com Dados Primários. *Revista Brasileira de Economia*. Vol. 57(4): 683-711.
- Walker, R.T. 2003. Evaluating the Performance of Spatially Explicit Models. *Photogrammetric Engineering and Remote Sensing*, Vol. 69(11): 1271-1278.
- Walker, R.T. 2003. Mapping Process to Pattern in the Landscape Change of the Amazonian Frontier. *Annals of the Association of American Geographers*, Vol. 93(2): 376-398.

# Submitted and draft manuscripts

- Pfaff, A, Reis, E, Walker, R, Laurance, W, Perz, S., Bohrer, C., Robalino, J., Aldrich, S., Arima, E., Caldas, M., Kirby, K., Roads and Deforestation in the Brazilian Amazon. Submitted to *Science* (?).
- Aldrich, S., Walker, R., Arima, E., Caldas, M., Browder, J., and Perz, S. Land Cover and Land Use Change: Processes of Social Stratification in Agricultural Expansion. Submitted to *Economic Geography*.
- Perz, S., Caldas, M., Walker, R., Arima, E., Souza, C. Socio-spatial Processes of Road Building in the Amazon: A Comparative Analysis of Local Heterogeneities and Implications for Forest Fragmentation. In draft for submission to *Conservation Biology*.
- Perz, S., Arima, E. Brandao, A., Caldas, M., Souza, C., and Walker, R. The dilemma of secondary roads in Amazonia. In draft for submission to *Ciencia Hoje*.