

# **Road Investments, Spatial Intensification and Deforestation in the Brazilian Amazon**

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# Question

- We found: new paved roads in a *census tract* ⇒ higher deforestation rate in that specific tract (using 6000+ observations for any point in time)
- Andersen et al.: new paved roads reduce rate of clearing in a highly previously cleared *municipio* (by interaction term, though < 300 observations)
- Could both be true, since these scales differ ? if paving reduces clearing in nearby tracts.
- Question: do new paved roads within a given tract reduce deforestation in neighboring tracts?

# Why might neighboring deforestation change?

- The paving of roads reduces transport costs between regions. This might lead to all of:
  - changes in prices
  - facilitates migration
  - accessibility of new technology.
- The above might affect neighboring areas too:
  - **Reducing** deforestation in those areas is possible
    - Intensification of Agriculture and Migration
  - **Increasing** deforestation in those areas is also
    - Spillovers of Agricultural Profits

# Empirical analysis of roads

## Roads increase deforestation significantly:

- Time to Market, Western Brazil (Vosti et al. 2002)
- Cost of Access to Road, Mexico (Nelson & Hellerstein 1997)
- Dist. to roads, Amazon, (Mertens et al. 2002)
- Dist. to markets in road network, N.Thai. (Cropper et al. 01)
- Review of literature (Angelsen and Kaimowitz 1999)
- Dist. to roads, Ecuador (Greenberg et al. 2005)
- Dist. To markets, road network Mexico (Vance and Geoghegan 02)
- Dis. To roads and then markets, Belize, (Chomitz and Gray 1996)

## Non-significant and/or non-robust results

- ┘ Road Density (Km/h), Mexico, (Barbier 2002)
- ┘ Magnitude of the effect low, Panama, (Nelson et al. 2004)
- ┘ Distance to Roads mixed results Bolivia (Mertens et al. 04)
- ┘ Road Density mixed results Thailand (Cropper et al 1999)
- ┘ Length of Roads, Ecuador (Southgate et al. 1991)
- ┘ Distance to Roads, Vietnam (Muller and Munroe 2005)
- ┘ % of Area (50km from Roads), Amazon (Chomitz and Thomas 03)

# Spatial & Spillover Stories

Intensification might decrease deforestation:

- Roads do not affect efficiency, Amazon (Camargo 2005)
- Roads increase agricultural Intensification, Ghana (Brammoh and Vlek 2005)
- Effects of intensification on deforestation are ambiguous, theoretical (Van Soest et al. 2002)

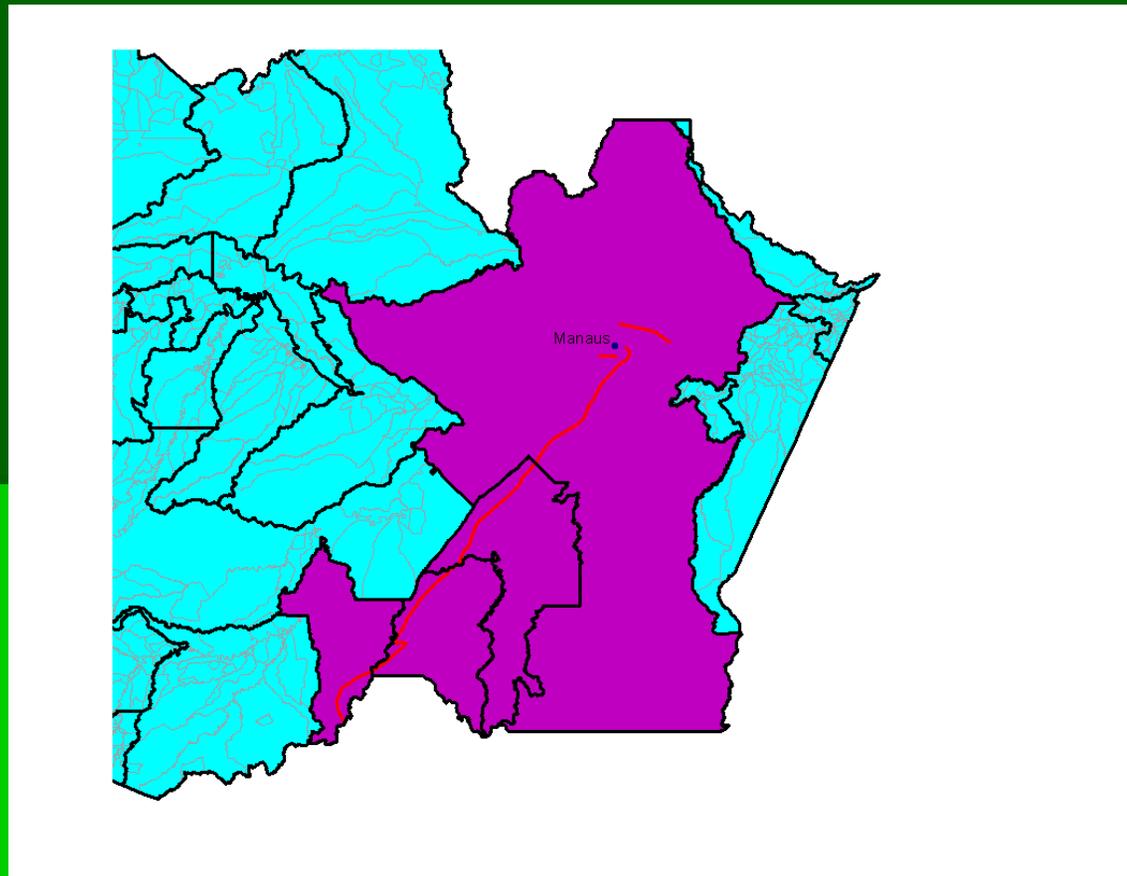
Spillover effects

- ┌ Neighboring Roads increase deforestation Amazon at municipality level (Pfaff, 1999)
- ┌ Neighbors Deforestation increase deforestation, Costa Rica (Robalino and Pfaff 2005)

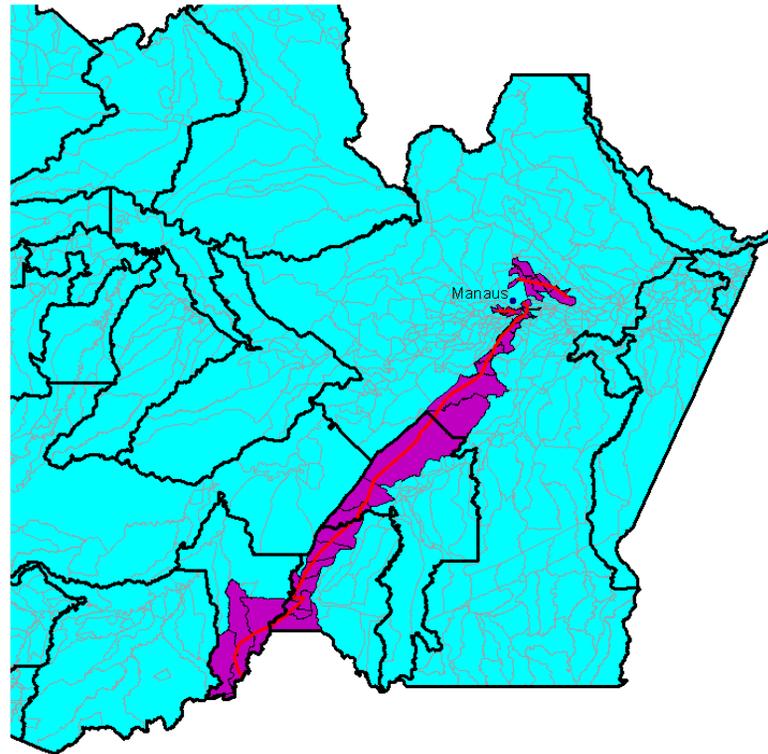
# Strategy

- Empirical Analysis, as theoretical sign of effect unclear
- Null Hypothesis: road paving within one census tract does not affect deforestation rate in neighboring CTs.
- Alternative Hypotheses:
  - paving increases deforestation in neighboring CTs
  - paving decreases deforestation in neighboring CTs
- Basic Approach: measure the density of road paving during 68-75 in each neighborhood & test if it is correlated with deforestation in 76-87.
- Sample: Census Tracts without paved roads

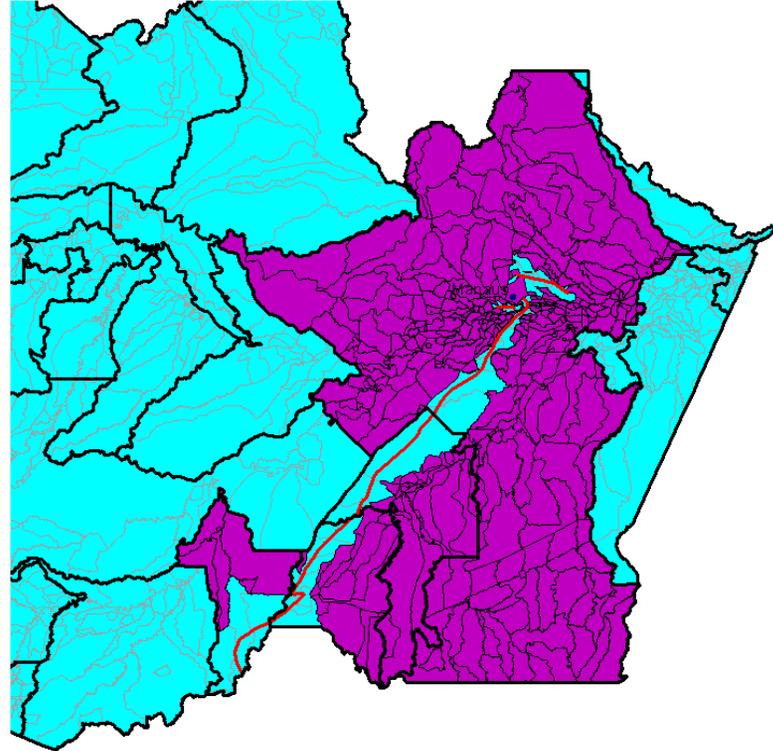
# Roads Viewed As In A Municipio



# Roads Viewed As In A Tract

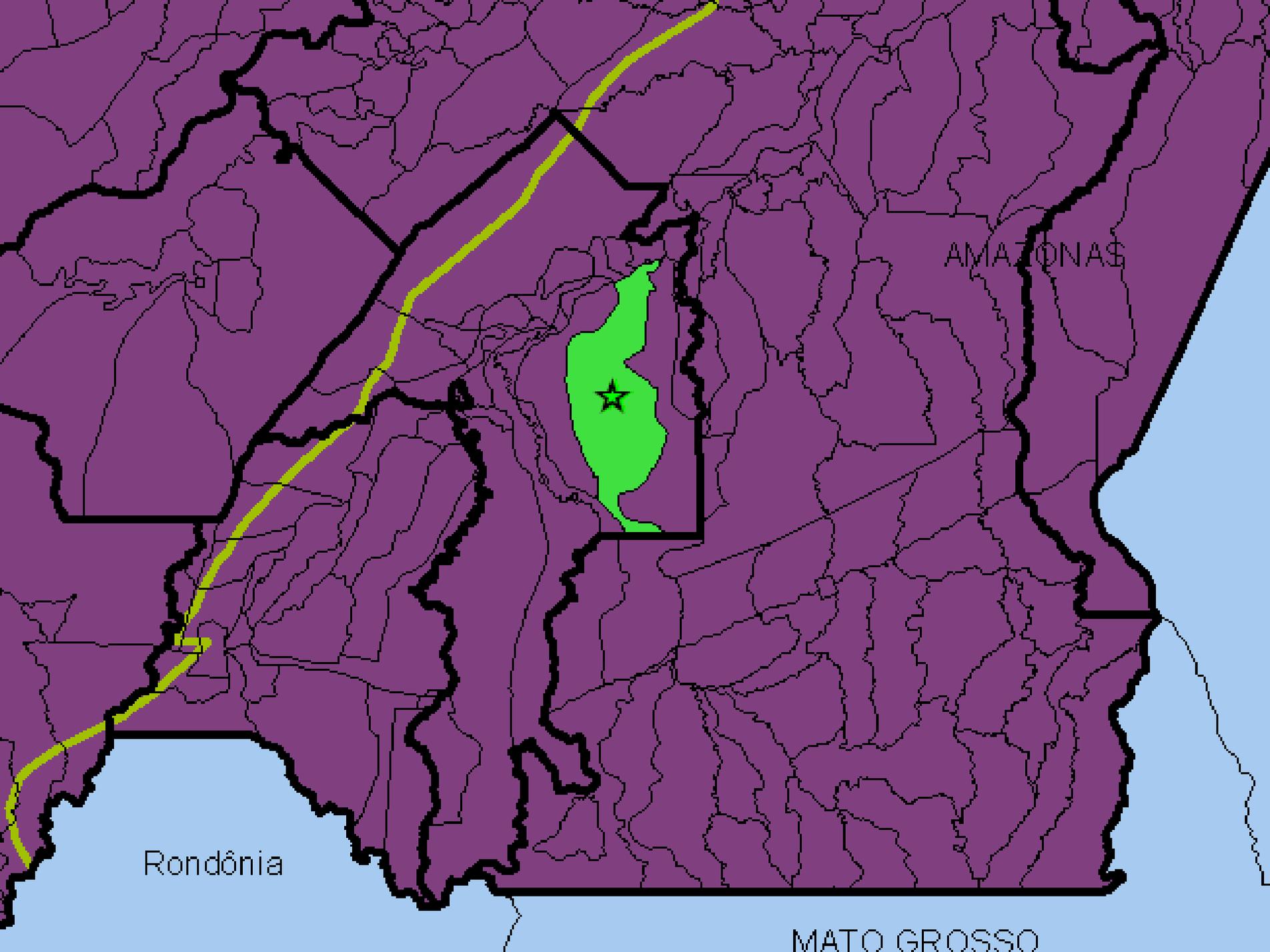


# Roads Viewed As In A Tract & Same-Municipio Tracts These Roads Might Affect



# Regression Analysis

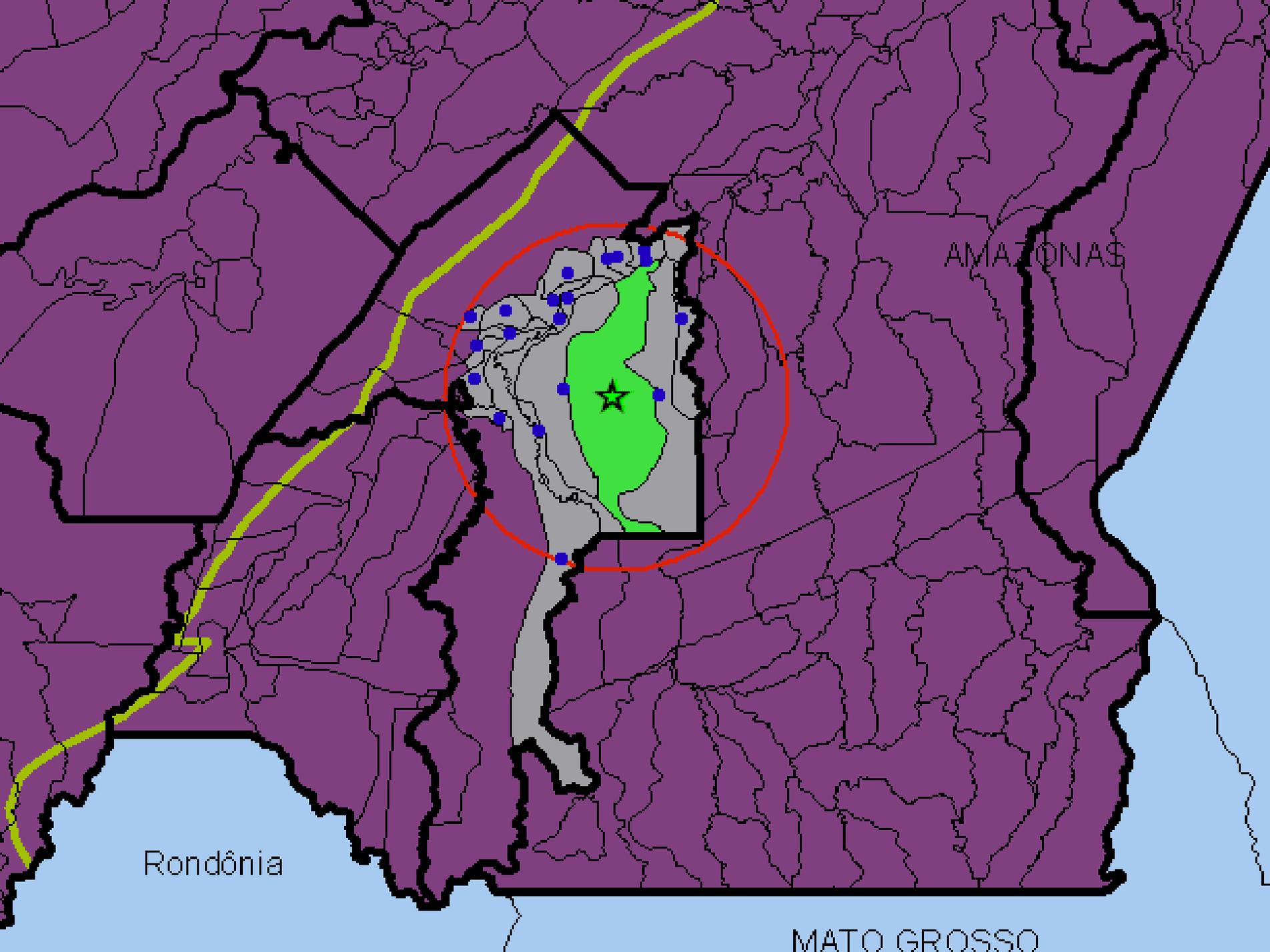
- **Dependent Variable**
  - hazard rate of deforestation in a census track
- **Independent Variables of interest**
  - density of new paved roads in Census Tracks within 100k, 200k, 300k, 400k rings, and more than 500k, all within same municipio (to address prior result)
- **Independent Variables used as controls**
  - └ % of original forest already cleared, distances to significant cities, distance to rivers, total rainfall, land slope category, and an index of soil quality



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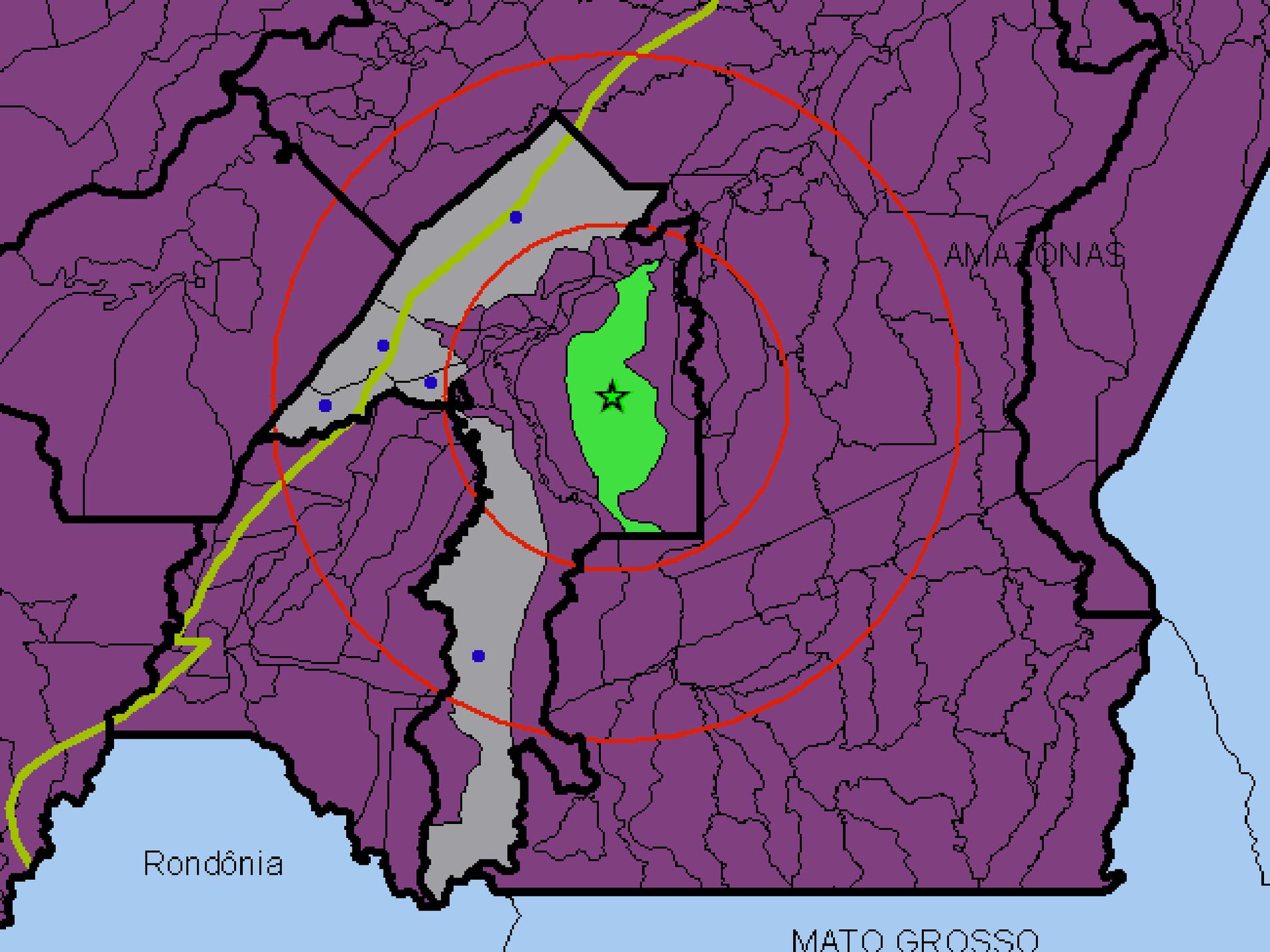
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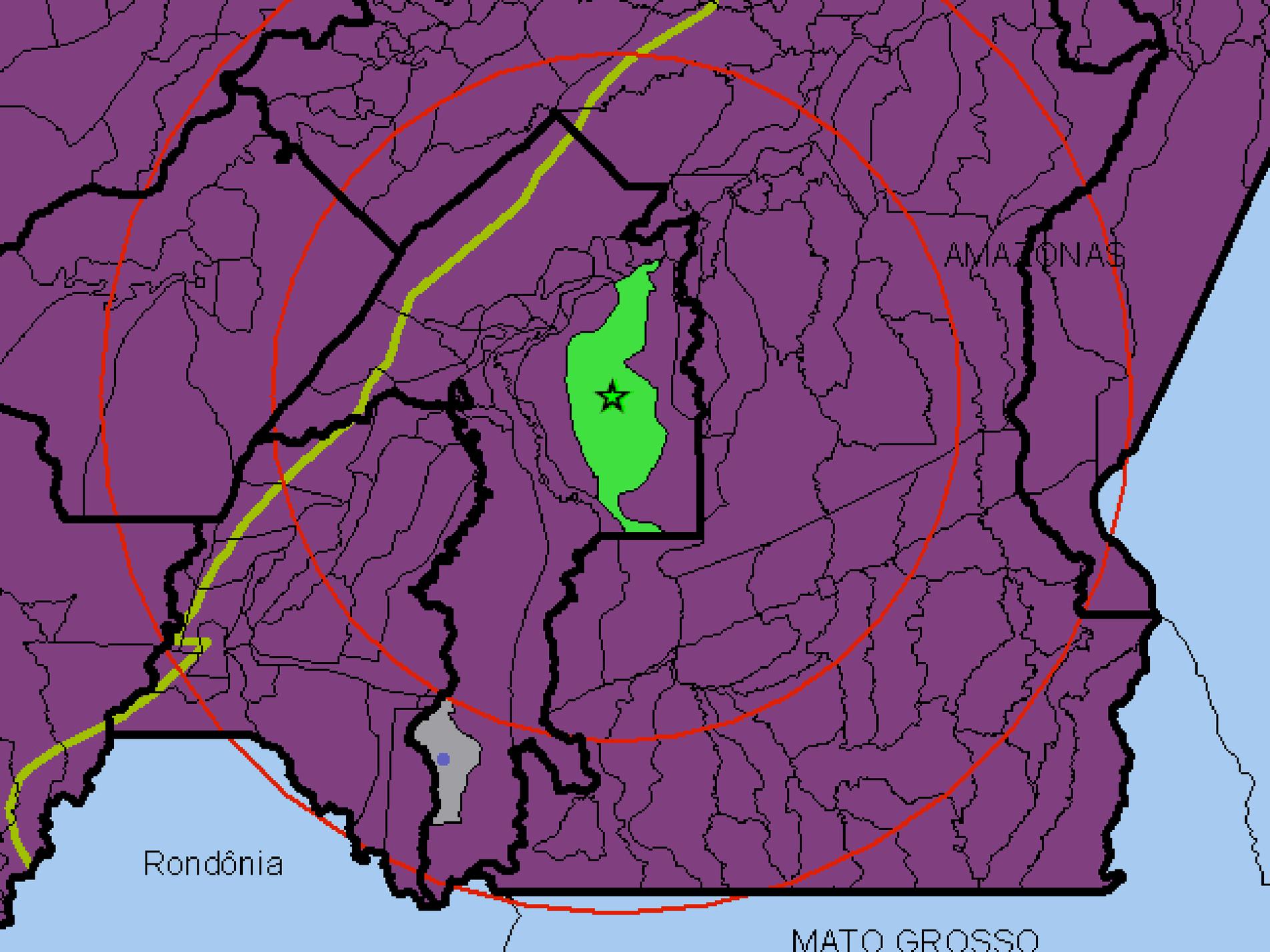


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# Empirical Challenges

## Possible Causality Issues

- endogeneity of roads complicates inference (see various discussions, e.g. Chomitz and Gray 1996, and at micro/household level, Arima et al. 2005)
- spatial correlation can also confound inference

## Helping to address these issues:

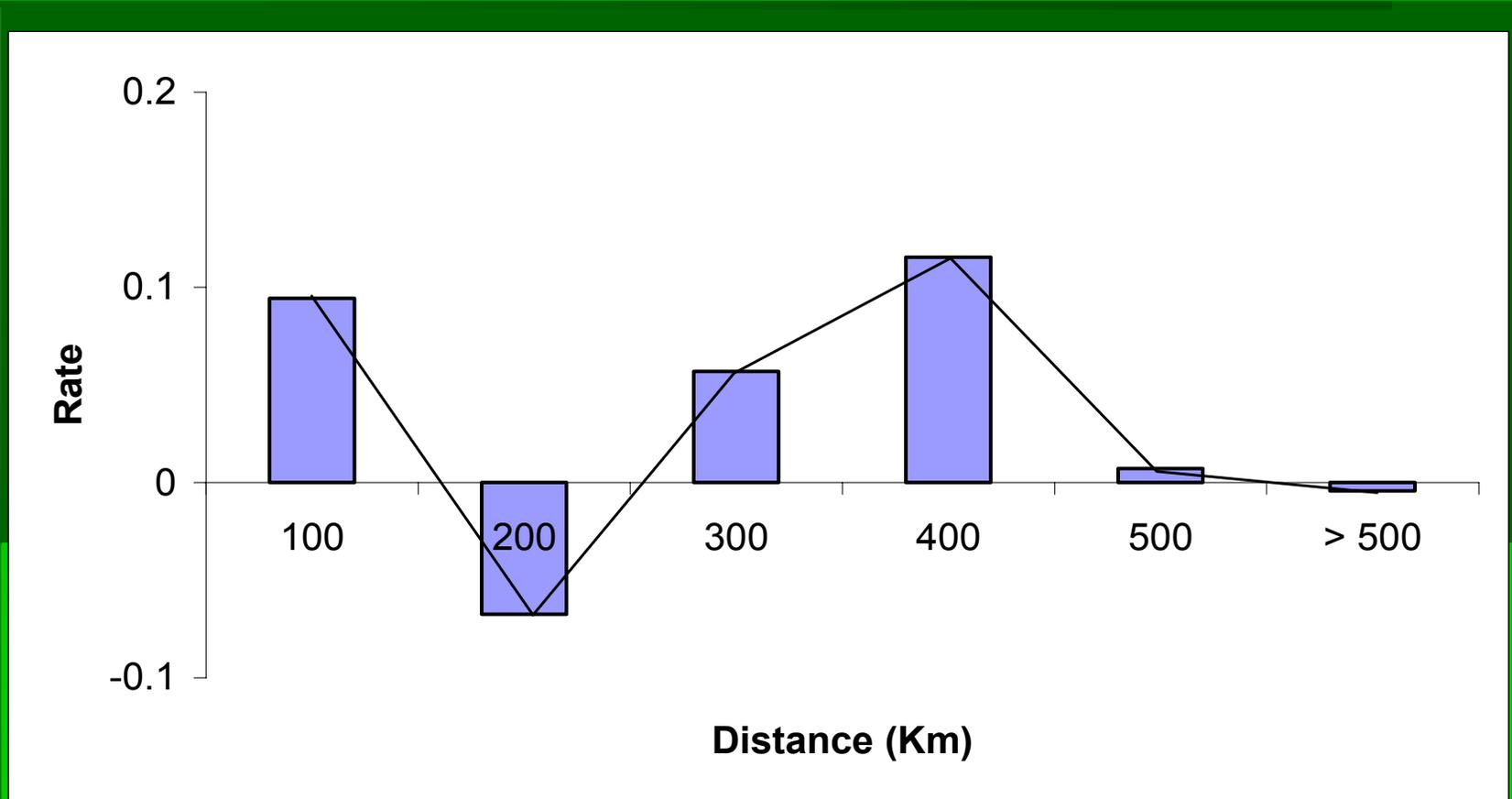
- ┌ use a lagged measure of road changes
- ┌ inclusion of spatial controls

# Results

New Paved Roads	
Distance	Beta
0-100	124.8***
100-200	-137.6**
200-300	198.8***
300-400	519.8***
400-500	21.1
➤500	-7.9

\*\*\* and \*\* represent 99% and 95% of significance respectively

# New paved Road Net Effect on Neighboring CT Positive



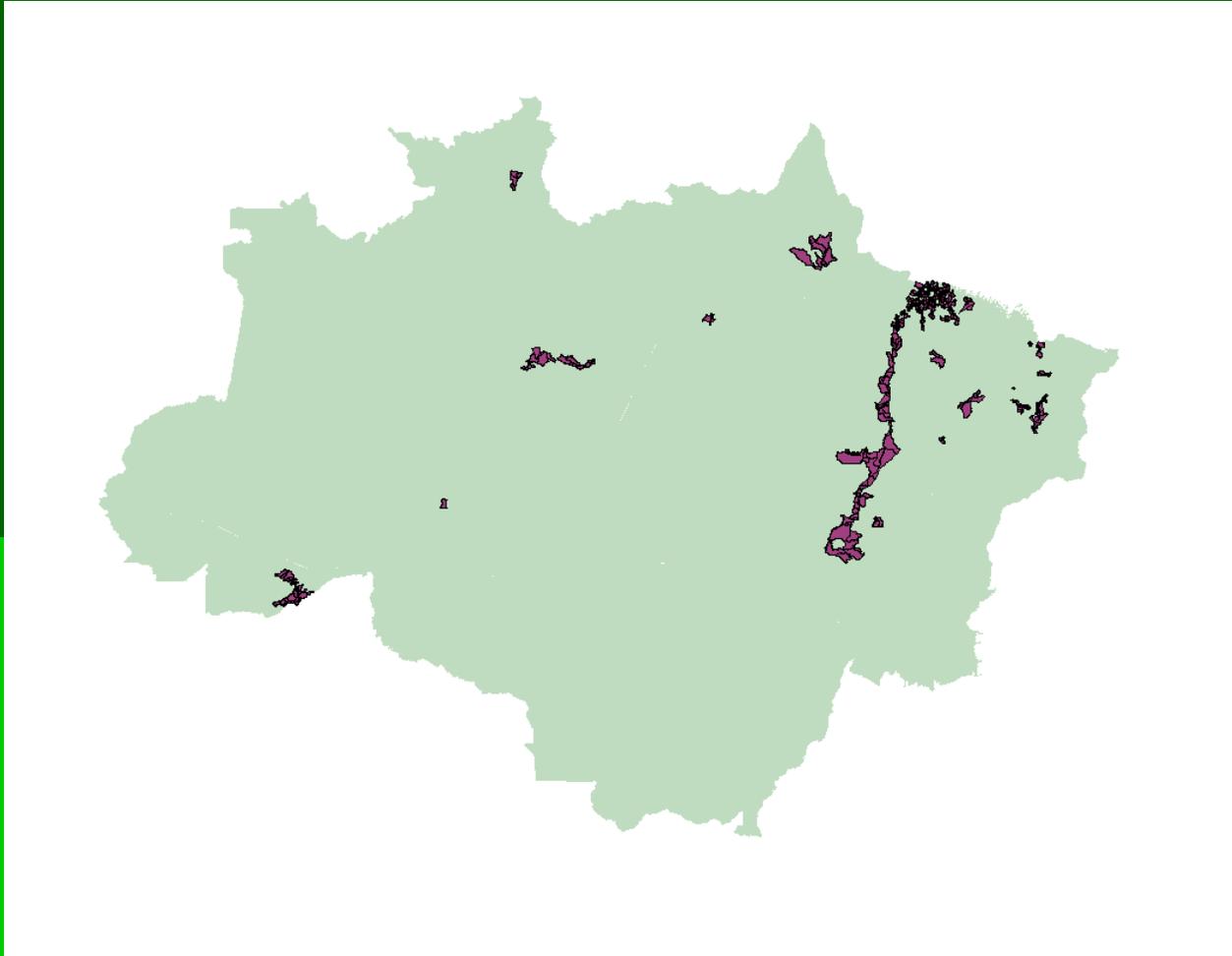
# Projections

- We have two results:
  - New Roads (68-75) affected deforestation (75-86) in own Census Tracts
  - New Roads (68-75) affected deforestation (75-86) in neighboring Census Tracts.
- We estimate possible deforestation scenarios with the first result

$$Y_{(76-87)} = \beta_1 * NPR_{75} + \beta_2 * X_2 + \beta_3 * X_3 + \dots$$

$$Y_{(87-98)} = \beta_1 * NPR_{87} + \beta_2 * X_2 + \beta_3 * X_3 + \dots$$

# Places where deforestation (87-98) would have been projected due to new paved roads (75-87)



# Summary

- Roads have spillover effects.
  - These effects depend on distance
  - The net effect is positive within Municipios
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- We can create deforestation scenarios using many dynamic factors.

# Future Work

- For Spillover effects from Roads
  - Spatial Correction and endogeneity
  - Paving effects measured by distances
- For Projection of Scenarios
  - Update other important dynamic variables such as population
  - Adding more years