Projecting Future Amazonian Landscapes: An Econometric Approach

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IMAZON

NASA: "A Basin Scale Model for Projecting Amazonian Landscapes"

LBA questions….

How does the Amazon function

…….as an ecological-hydrological system?

What does the future hold for the Amazon?

Question 1:

SCIENCE

Question 2:

crystal ball
tarot cards
GIS
CA models
econometrics

Earlier Answers to Question 2

Laurance et al.	**28% by 2020** **Deforested or heavily degraded** ***OPTIMISTIC SCENARIO***	**42% by 2020** ***De*forested or heavily degraded** ***NON-OPTIMISTIC SCENARIO***
Soares-Filho et al.	**28% by 2050** **Deforested** ***GOVERNANCE SCENARIO***	**47% by 2050** **Deforestated** ***BUSINESS AS USUAL SCENARIO***
Andersen et al.	**441,550 Km^2 in 10 years** **Accumulated cleared land** ***NO ROAD INVESTMENTS***	**425,970 Km^2 in 10 years** **Accumulated cleared land** ***ROAD INVESTMENTS (AB)*** **-3.6%**

Our Approach

1) Econometric model (Reis, Pfaff, Andersen et. al)

NOT A BUFFERING FUNCTION…….NOT A "CA" approach

2) Data rich

observations…….Data used
3 time steps for deforestation, 3 "lags" in roads

3) Focused just on Closed Forest area

versus "urbanized" or heavily *cerrado* tracts

4) Treatment of demographics in projections

use of 2000 micro-data from the census

- The Model
- The Data
  deforestation, roads
- The Scenarios
  roads, demography, governance
- The Projections

The Data

DEFORESTATION

1976-1987 – Antropismo map, Diagnóstico Ambiental (IBGE), 1:2,500,000 scale

1986-1992 – TRFIC-MSU Land Cover (pixel size reduced to 200m)

1992-2000 – TRFIC-MSU and PRODES-INPE (2000) Land Cover digital maps (pixel size reduced to 200m)

ROADS

IBGE Instituto Brasileiro de Geografia e Estatistica. 2004. Mapas interativos de Transportes

1968-75
1975-83
1987-93

DNER Department Nacional de Estradas de Rodagem (DNER). Mapa Rodoviario. Republica Federativa do Brazil, Ministerio dos Transportes

The Model

1) First, fit the regression model, $Y_t = f(X, X_t X_{t-1} \ldots..)$, where Y in the estimation is % yearly deforestation.

2) Project to 2010, using scenario data.

3) Update forest and scenario data, as necessary.

4) Project to 2020.

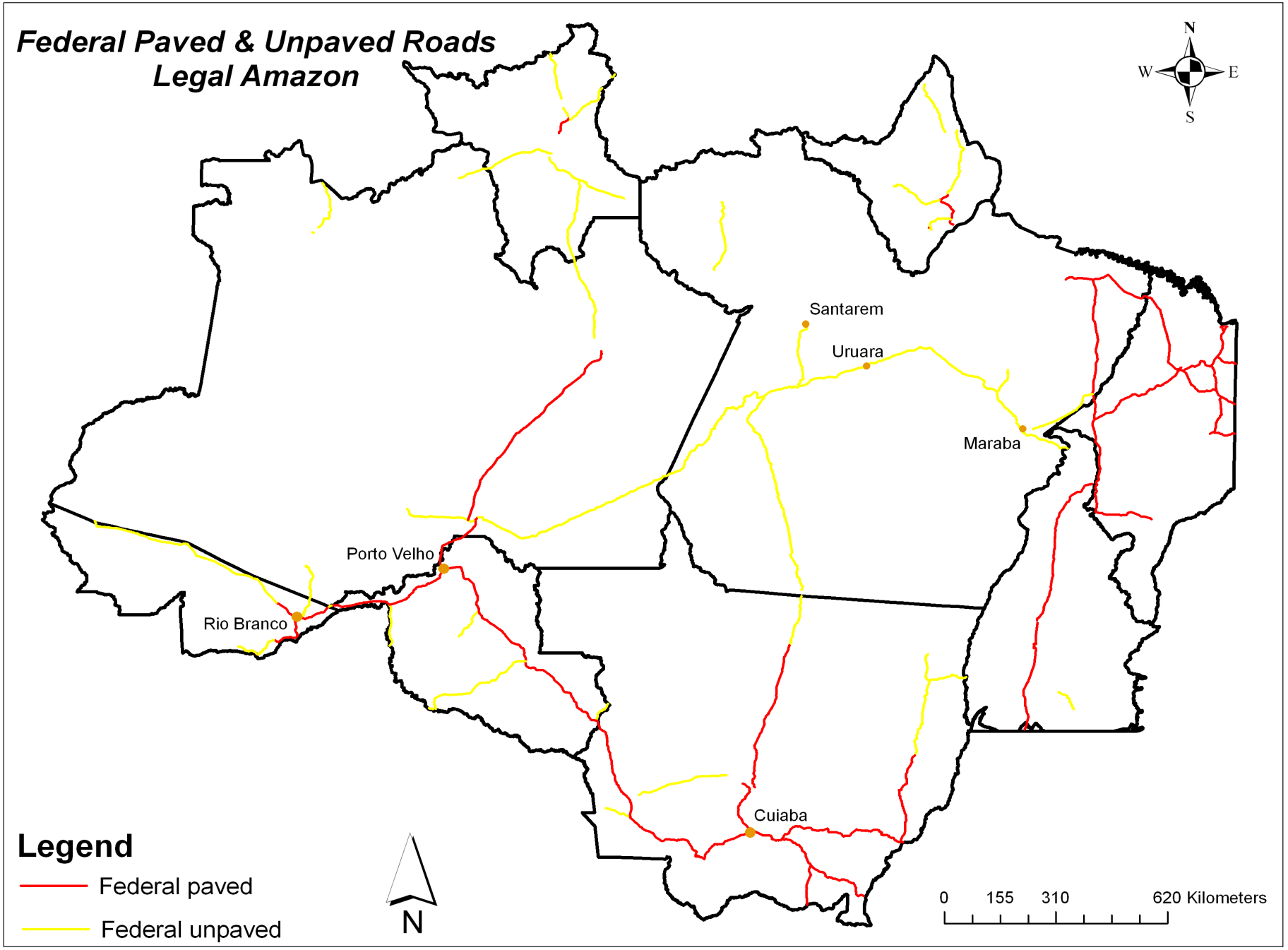
Scenarios, to date.....

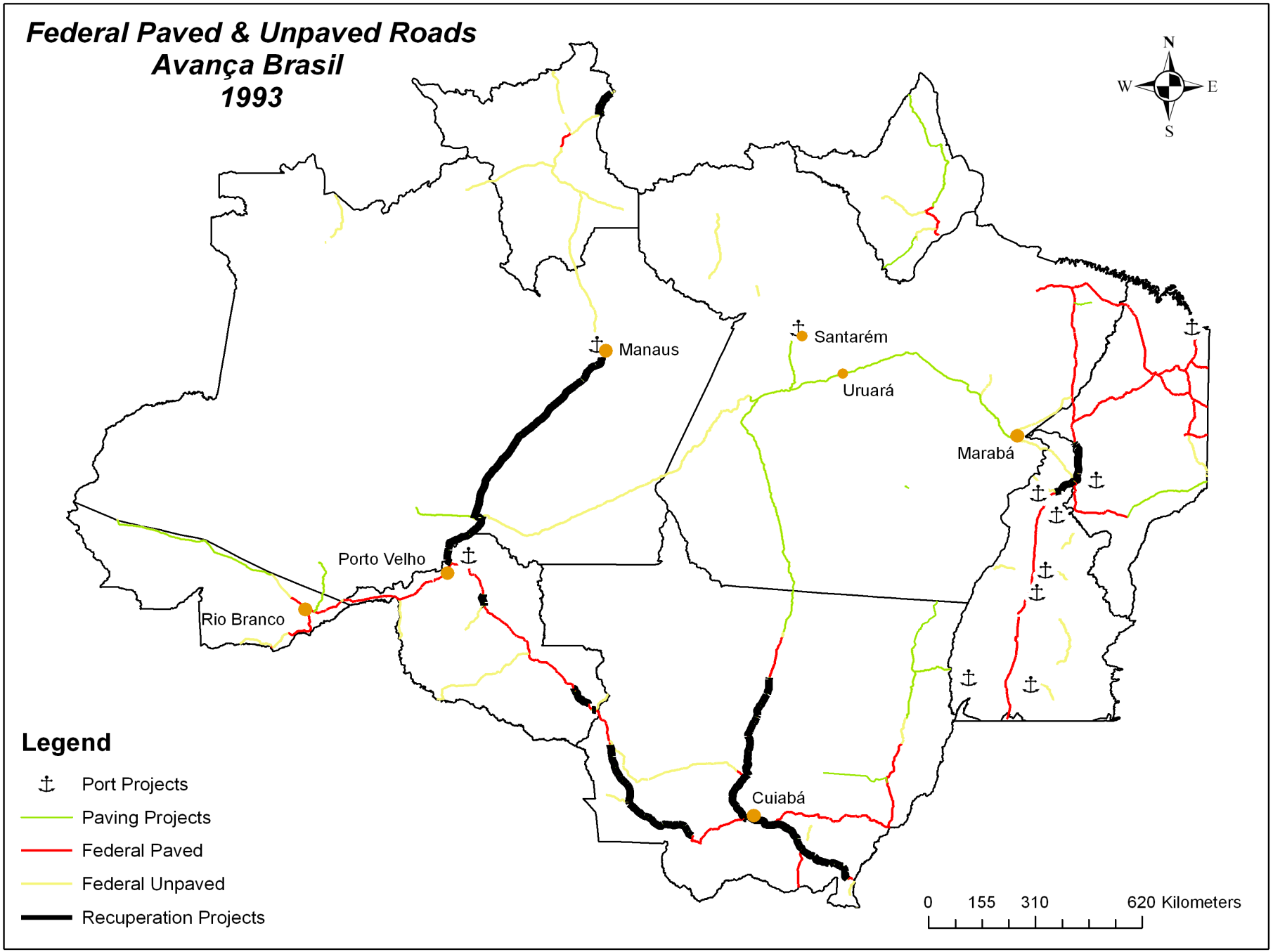
1) AB - Expected Pop growth - No Governance

2) AB - Expected Pop growth - Partial Governance

3) No AB – Expected Pop growth - Partial Governance

4) No AB - Increased Out-migration - Hi Governance


Federal Paved & Unpaved Roads
Legal Amazon
N
W
E
S
Santarem
Uruara
Maraba
Porto Velho
Rio Branco
Cuiaba
Legend
Federal paved
Federal unpaved
N
0
155
310
620 Kilometers


Federal Paved & Unpaved Roads
Avança Brasil
1993
N
W
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Manaus
Santarém
Uruará
Marabá
Porto Velho
Rio Branco
Cuiabá
Legend
Port Projects
Paving Projects
Federal Paved
Federal Unpaved
Recuperation Projects
0
155
310
620 Kilometers

Demographic Scenarios

Microdata files of Brazil's 2000 demographic census

.

-- Age structures for males and females

-- In- and out-migration 1995-2000 (yielding net migration)

-- Fertility rates and child survival figures for life expectancies

Population projections, from 2000 to 2020

(with moderate fertility declines and slight increases in life expectancy)

Two demographic scenarios:

“Expected population growth"

“Increased out-migration"

Two “city” population scenarios for every Amazon municipality

The Aggregate Story

population in 2000: **21,073,967** 68% urban, leaving ~**6,700,000** in rural areas

Fertility: **5.26**
Life expectancy: **70** for men, **71** for women

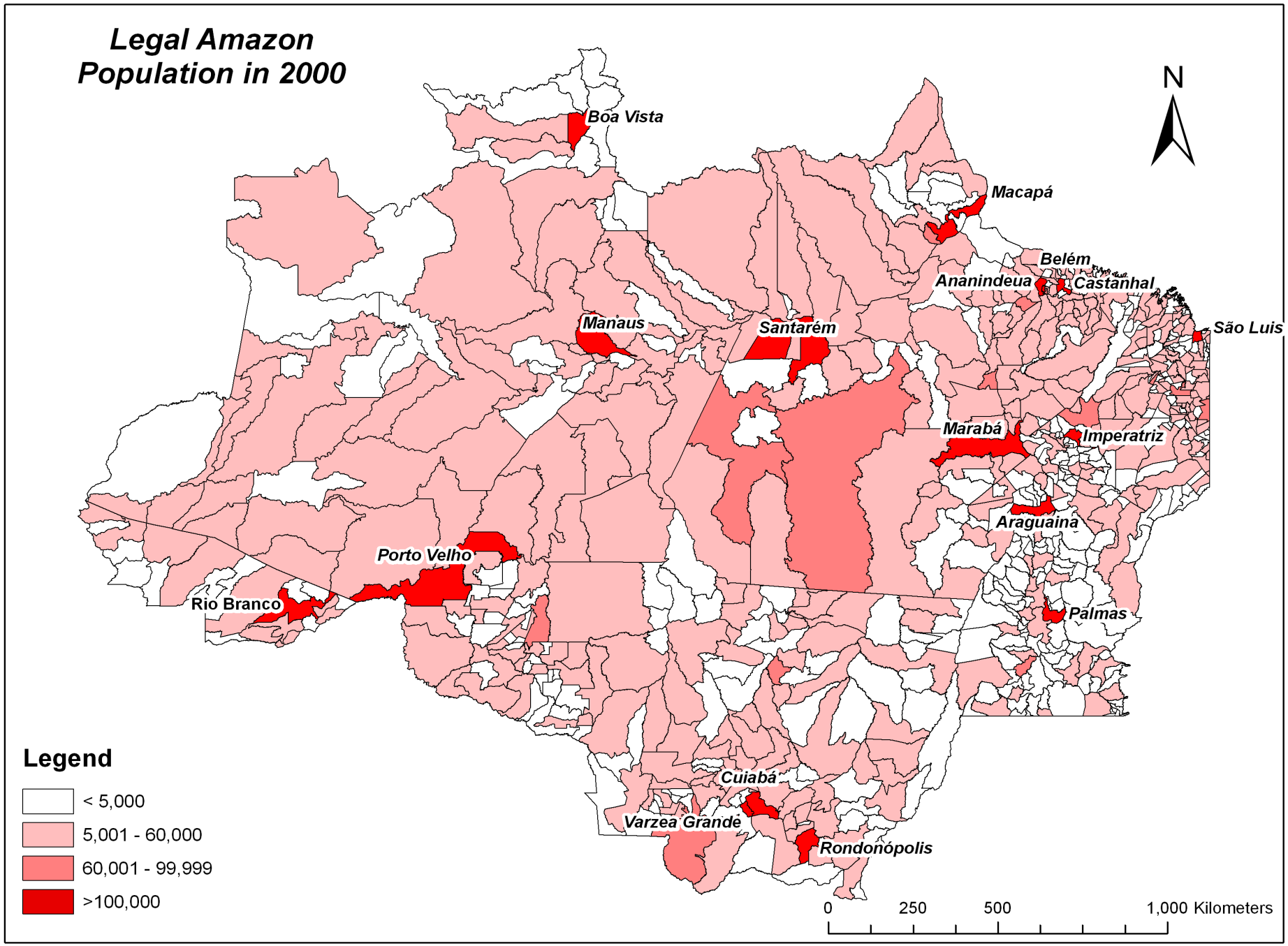
High birth rate, low death rate

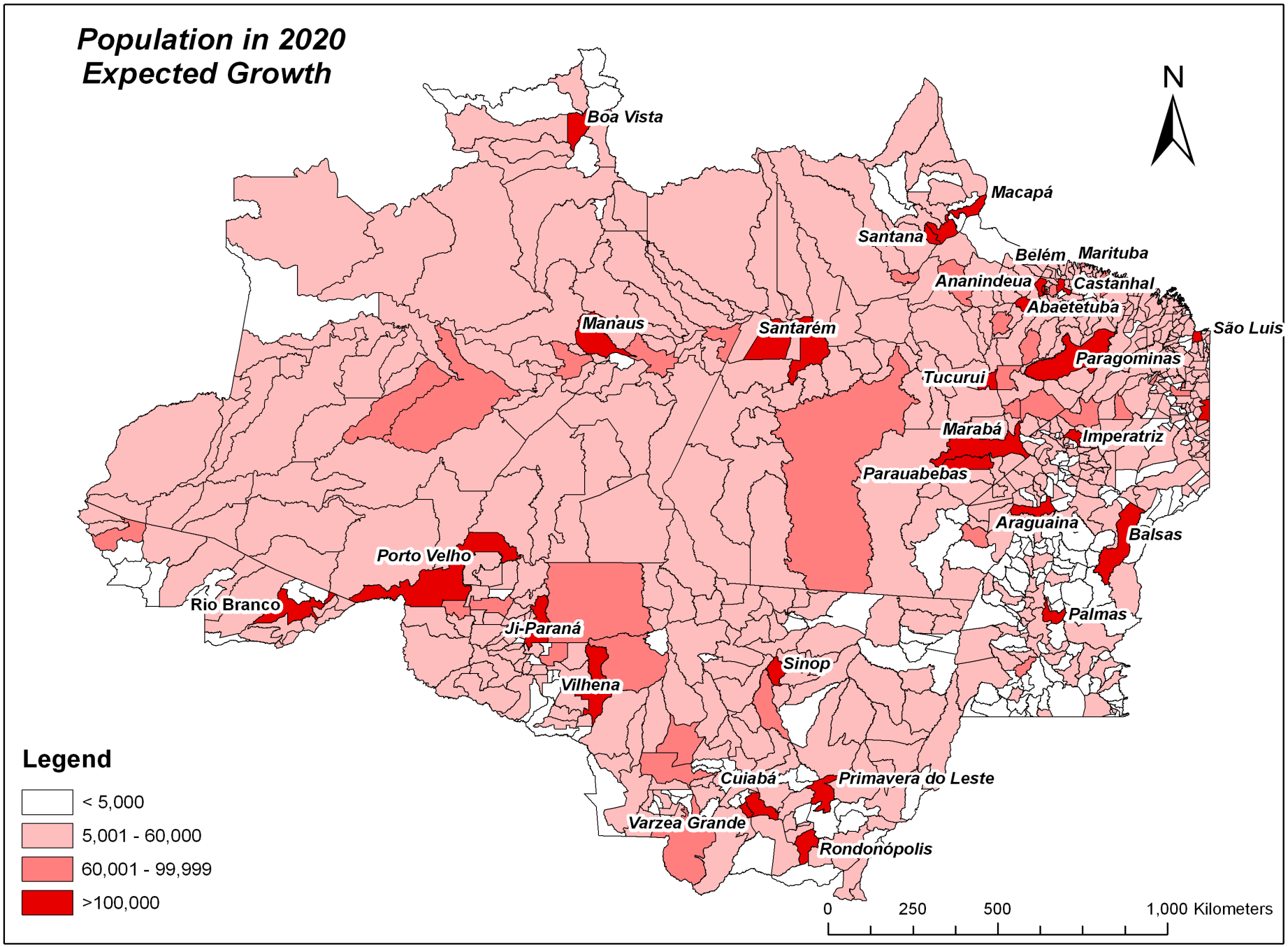
Out-migration, but low: **-2595** per year between 1995 and 2000

PROJECTED AMAZONIAN POPULATION

Expected Population growth: **35,409,282**
Increased Out-migration: **32,678,238**

The Amazon has NOT gone through a demographic transition
Out-migration is not compensating natural increase of the regional population


Legal Amazon
Population in 2000
N
Boa Vista
Macapá
Belém
Ananindeua
Castanhal
São Luis
Manaus
Santarém
Marabá
Imperatriz
Araguaina
Porto Velho
Rio Branco
Palmas
Cuiabá
Varzea Grande
Rondonópolis
Legend
< 5,000
5,001 - 60,000
60,001 - 99,999
>100,000
0
250
500
1,000 Kilometers


Population in 2020
Expected Growth
N
Boa Vista
Macapá
Santana
Belém
Marituba
Ananindeua
Castanhal
Abaetetuba
São Luis
Manaus
Santarém
Paragominas
Tucurui
Marabá
Imperatriz
Parauabebas
Araguaina
Balsas
Porto Velho
Rio Branco
Palmas
Ji-Paraná
Sinop
Vilhena
Cuiabá
Primavera do Leste
Varzea Grande
Rondonópolis
Legend
< 5,000
5,001 - 60,000
60,001 - 99,999
>100,000
0
250
500
1,000 Kilometers

Governance Scenarios

Low governance

No protection in PA's, no control on private holdings

Partial governance

Indigenous areas and Fed Protected: 100%

Fed Sustainable Use and State Protected: 75%

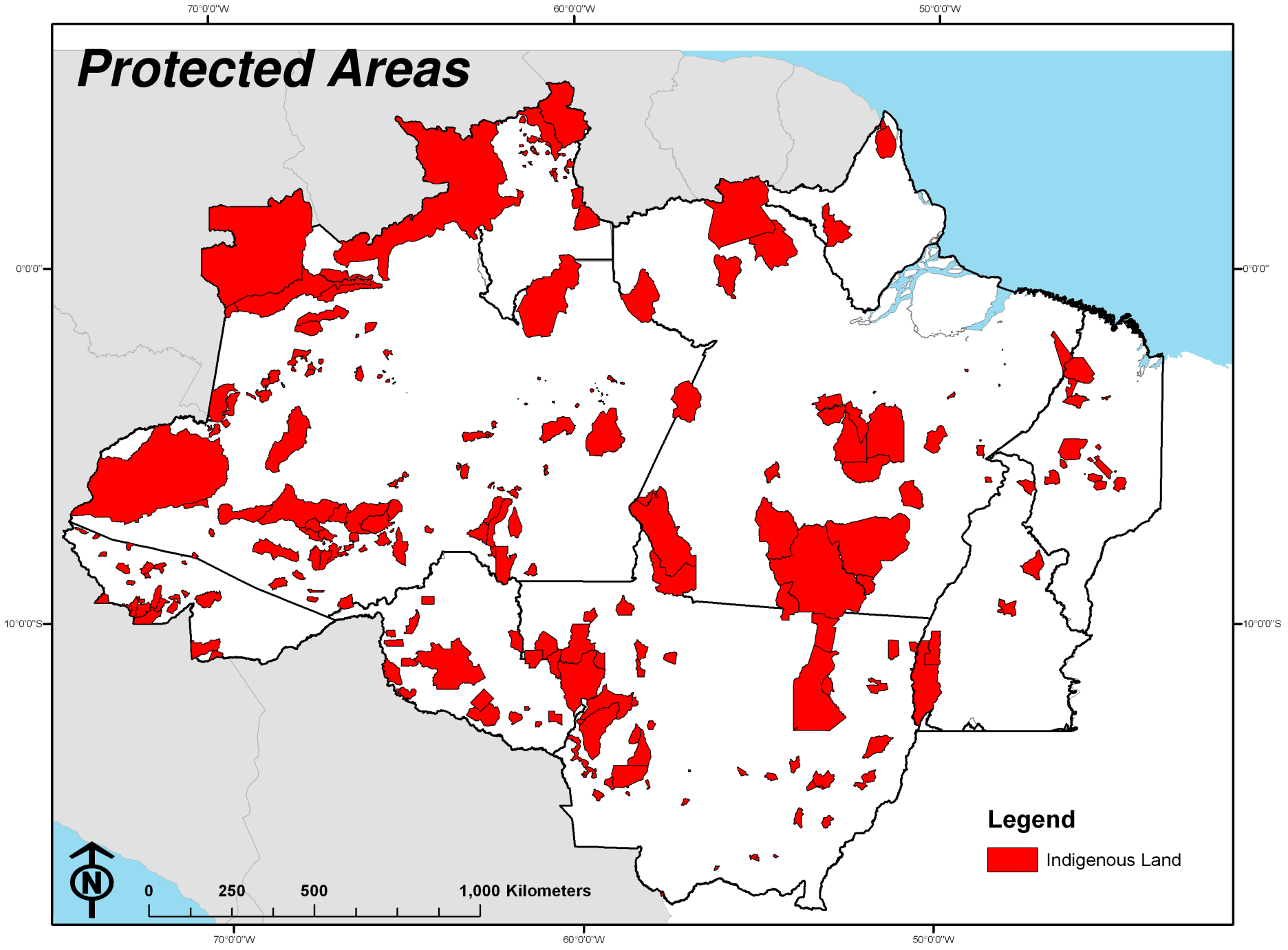
State Sustainable Use: 50%

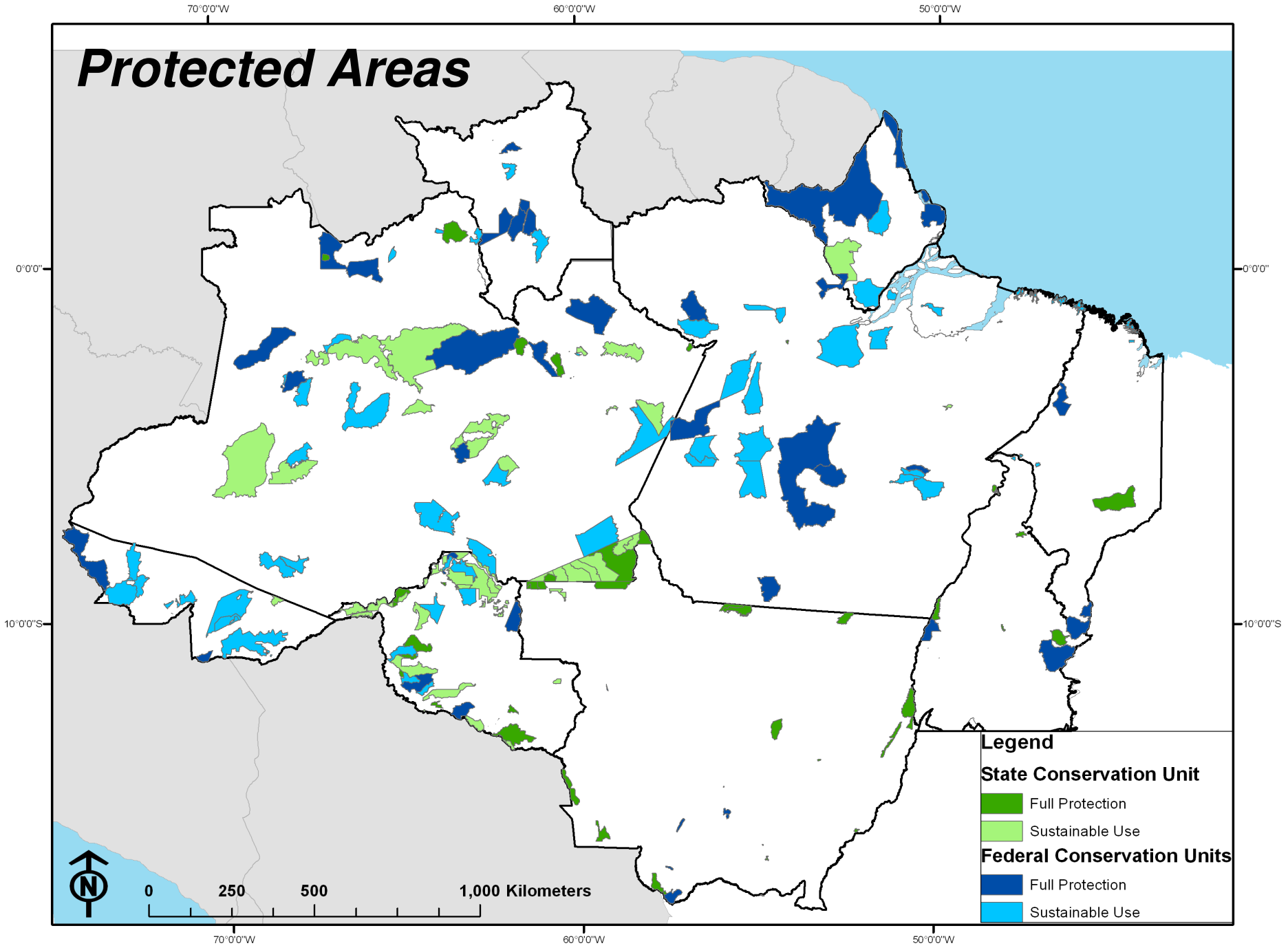
Private Holdings: 50% rule

High Governance

100% protection in all PA's

Private Holdings: 20% rule


Protected Areas
70°0'0"W
60°0'0"W
50°0'0"W
0°0'0"
10°0'0"S
Legend
Indigenous Land
N
0
250
500
1,000 Kilometers


Protected Areas
70°0'0"W
60°0'0"W
50°0'0"W
0°0'0"
10°0'0"S
Legend
State Conservation Unit
Full Protection
Sustainable Use
Federal Conservation Units
Full Protection
Sustainable Use
N
0
250
500
1,000 Kilometers

Scenarios enable us to consider.....

Governance effects

controlling for pop growth & investment (1 & 2)

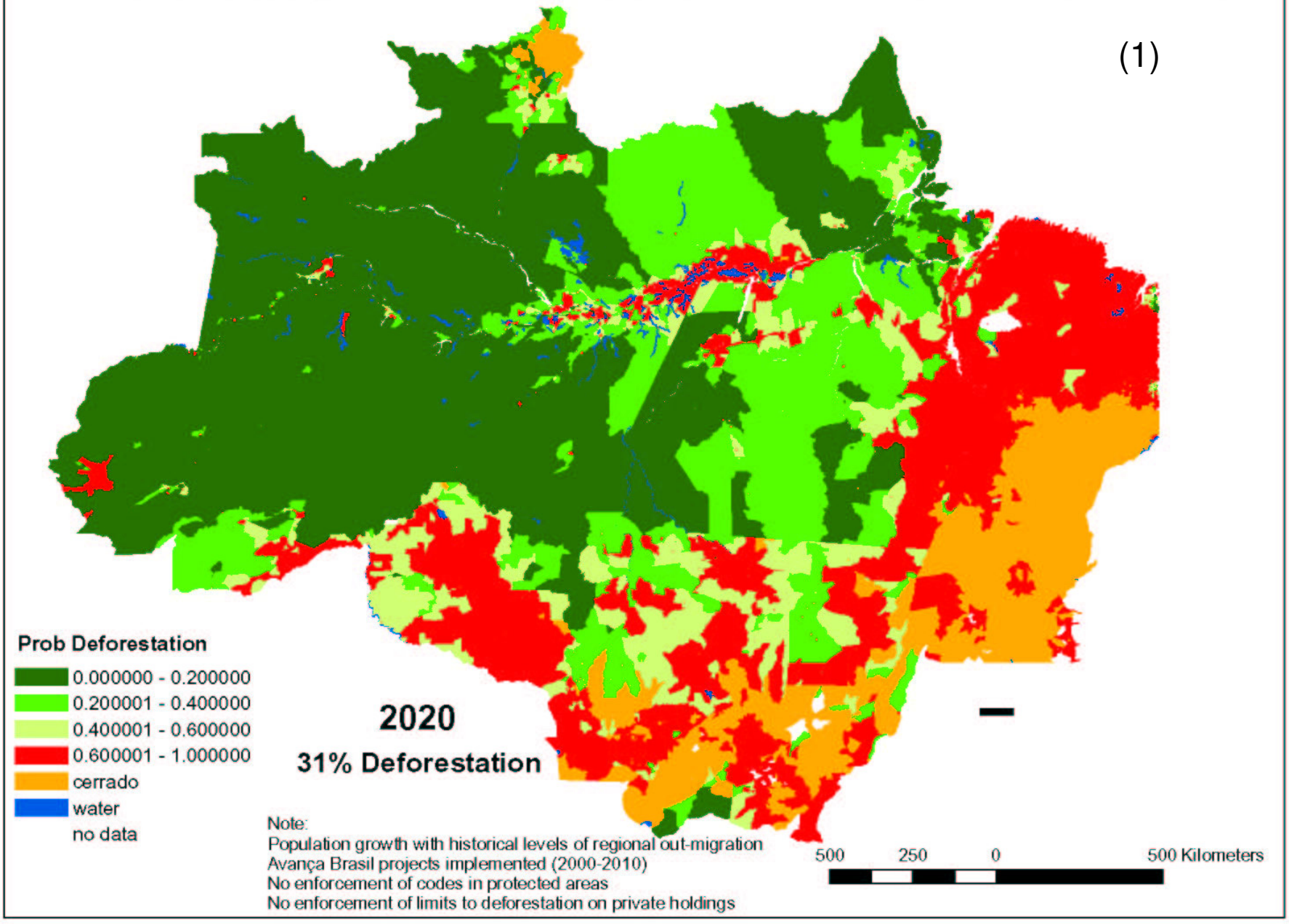
Road Investment effects

controlling for pop growth & governance (2 & 3)

Best and Worst conservation cases *(1 & 4)*

Expected Population Growth, Road Investments, and Low Governance

(1)



Preliminary Findings

Partial Governance effects	**31% vs. 19%**
Road Investment effects	**19% vs. 19%**
Worst vs Best	**31% vs 16%**

Where to from here?

- Model improvements and refinements
- Further work on the demographics
- Infrastructure effects