Estrutura

- Perguntas Centrais
- Metodos
- Perguntas e Resultados
- Conclusões

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Forest Code

1996 – mudanca do Codigo Florestal
1999
2005

Legal Reserve

Riparian Zone

Central Questions

- Does current legislation to regulate land-use (esp. forest clearing) reach its stated objective in practice?
- Does current legislation balance public and private interests in conservation and agricultural production on private lands in theory? If not, could it be adapted to be more effective?
- How are future land-use/land-cover trajectories likely to vary in response to a suite of plausible future policy scenarios derived from the Forest Code?
- What are the environmental and economic trade-offs associated with those scenarios?

Methods (I): Landscape Model

- Dinamica EGO modeling platform
- High resolution (100 m)
- Calibrated and run at nested sub-basin levels
- Regrows forests and cerrado

Sub-regions

Variable types for calibration

clearing

roads

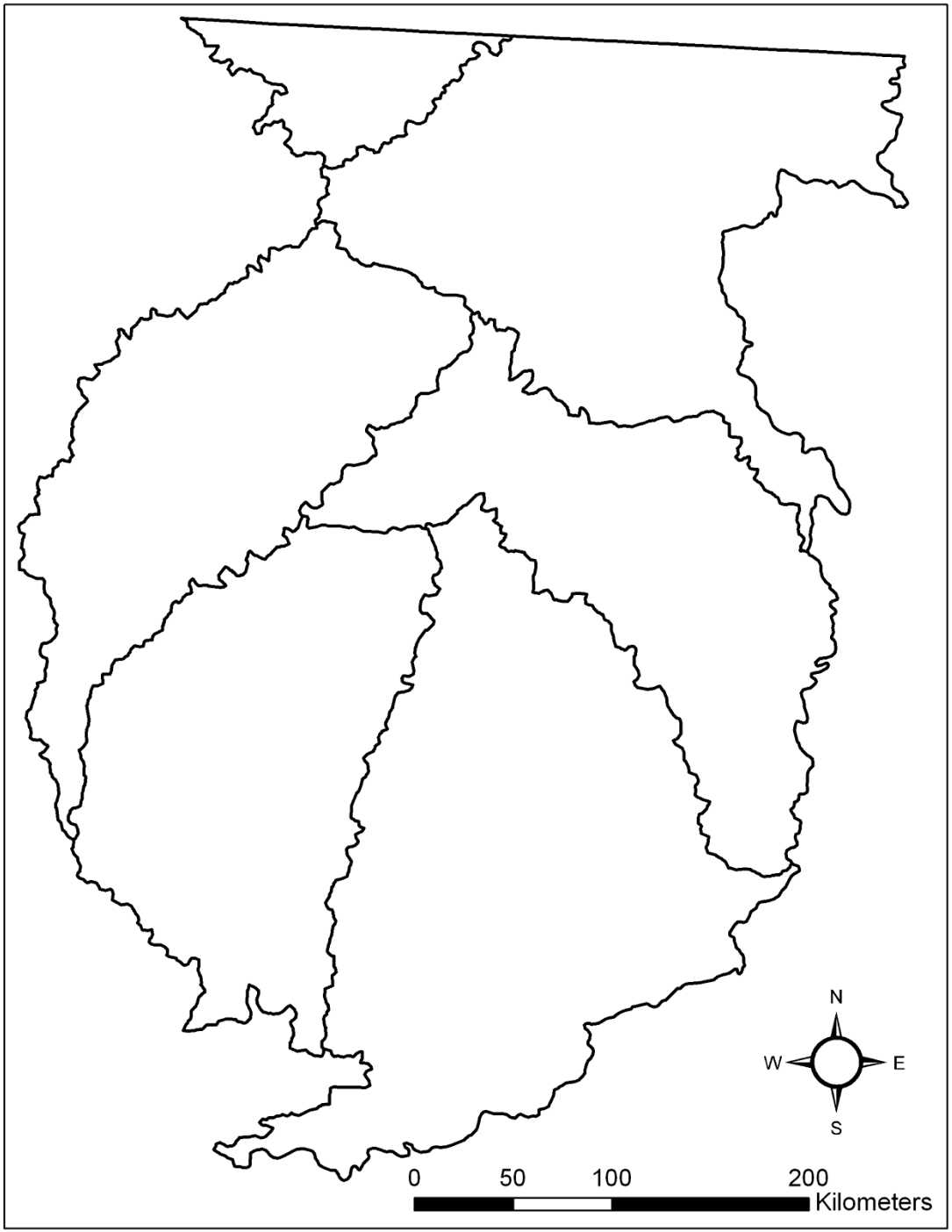
topography

population centers

streams

protected areas

soils



Unit of analysis

Microbasins outside PAs

2881 sub-basins

$\bar{x}$ = 5981 ha

range: 1 – 70,766 ha

Mn % clearing (2005): 62%

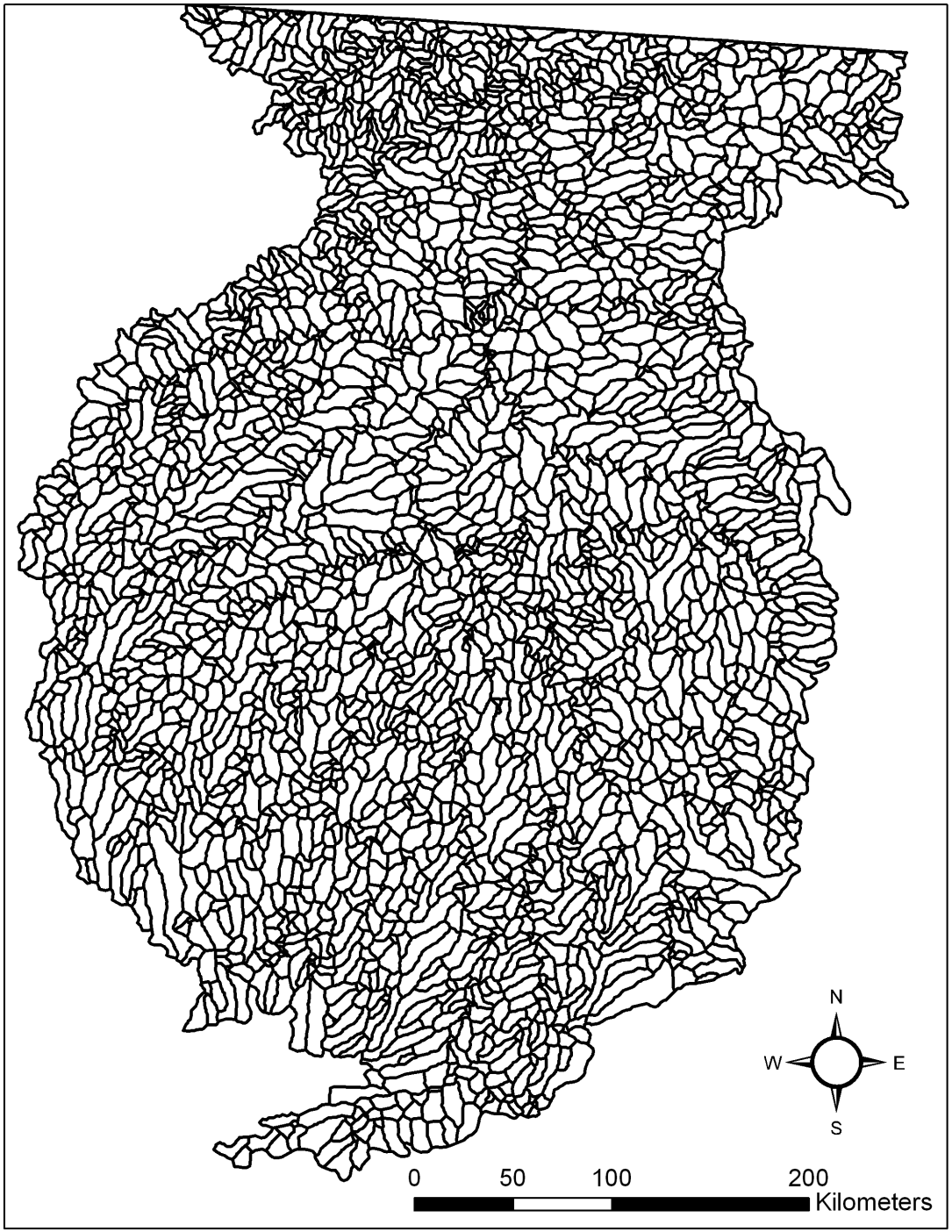
Properties in SLAPR

1735 properties

$\bar{x}$ = 2592 ha

range: 2 – 57,943 ha

Mn % clearing (2005): 60%



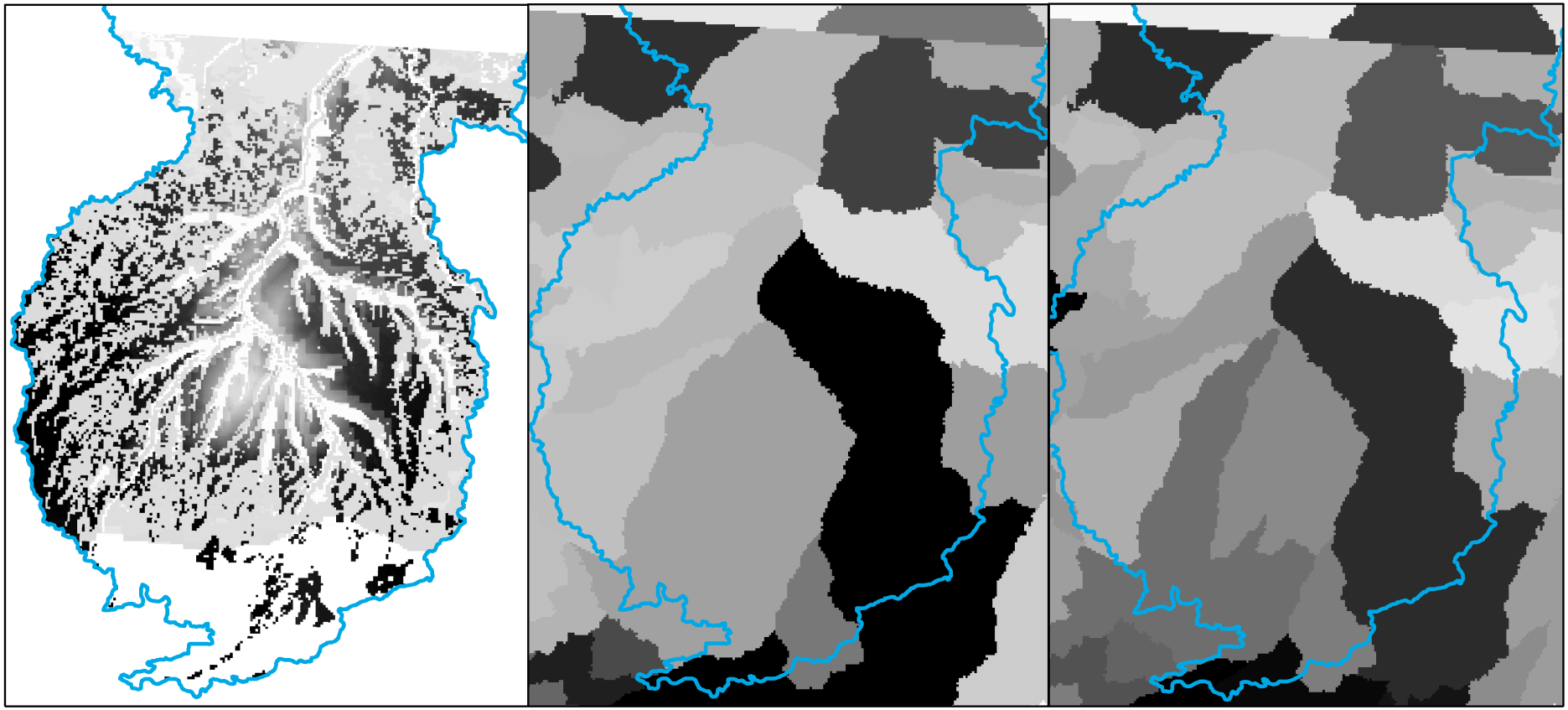
Scenarios

- *Current Forest Code* (x2)
  - 80% legal reserve (RL) in forest biome; 35% RL in cerrado; 100% forest in riparian zone
- *Reduce Legal Reserve*
  - 50% RL in forest biome; 35% RL in cerrado; 100% forest in riparian zone
- *State Zoning Plan*
  - 4 zones: 80% forest RL in 2 zones; 50% forest RL in 1 zone; 35% cerrado RL in 3 zones; 100% forest in riparian zone
- *Business as Usual* (x3)
  - historical rate of deforestation continues
  - historical level of compliance with environmental legislation continues

Methods (II): Economic Assessment

- Net present value
  - Proxy for land values
  - Range: $0 - $10,142 per hectare
- Restoration costs
  - Based on range of field-derived estimates for different levels of intervention
  - Range: $0 – $3217 per hectare

Net Present Value vs. Land Values



Net Present Value	Land Values, Low	Land Values, High
$0 – 10,142	$50 – 7650	$130 – 11,000

Methods (II): Ecological Assessment

- Hydrology/Discharge
  - THMB surface hydrology transport model (Coe et al. 2000, 2009)
- Climate
  - Evapotranspiration (ET = P – R)
- Water Quality
  - Basic indicators (Neill et al. 2006, Nepstad et al. 2007)
- Habitat Quality
  - Landscape metrics

Landscape Metrics

- Vegetation cover
- No. of fragments
- Mean distance to nearest neighbor fragment
- Mean fragment size
- Total core habitat area
- Total edge habitat area

Part I: Questions

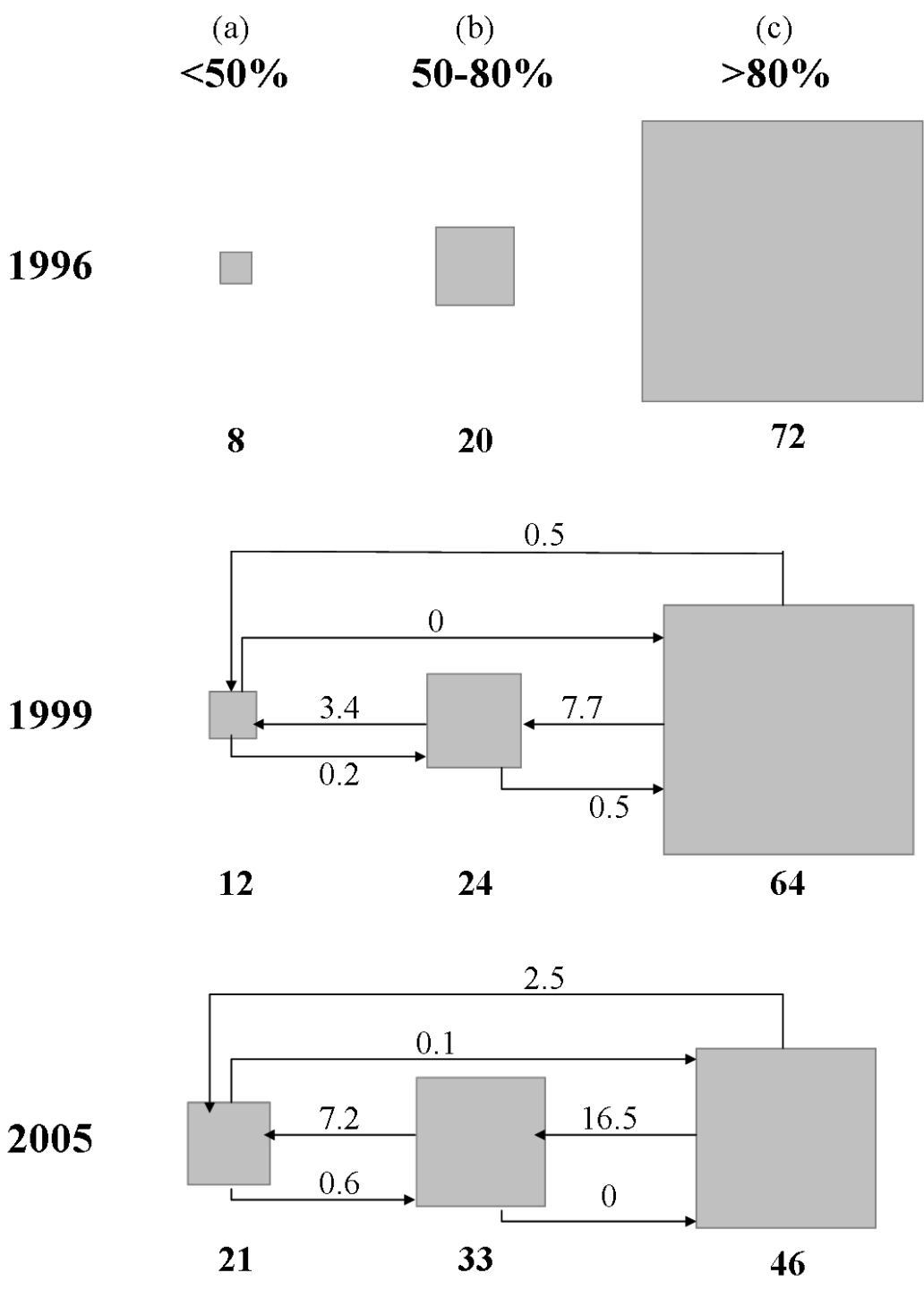
Defending public interests in private forests

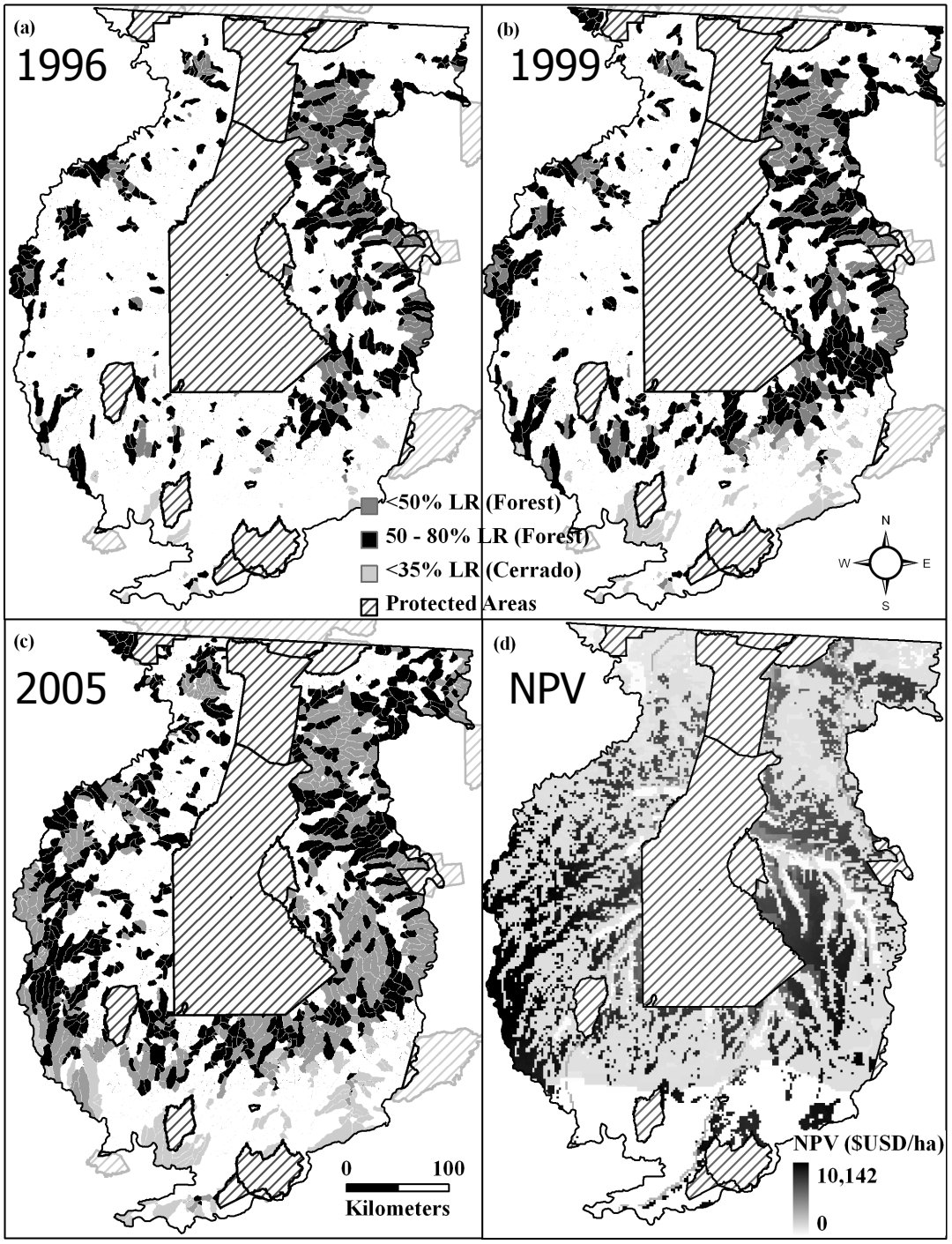
- How has change in Forest Code affected compliance?
- How effective has change in legal reserve for Amazon forest biome of Forest Code been in slowing deforestation *and* illegal deforestation?
- What does change in Forest Code imply in terms of costs for landholders?
- How has change in legal reserve affected ecosystem services protection/provision?

Part I: Results

- With change in RL, 20% of microbasins became illegal overnight
- Compliance with new RL fell from 72% to 46% of microbasins between 1996 & 2005

Under new RL, illegal deforestation represented 74% (3603 km^2) of clearing in 1996-1999 period, 85% of clearing in 1999-2005 (11,178 km^2) period




(a)
1996
(b)
1999
<50% LR (Forest)
50 - 80% LR (Forest)
<35% LR (Cerrado)
Protected Areas
N
W
E
S
(c)
2005
(d)
NPV
0
100
Kilometers
NPV ($USD/ha)
10,142
0

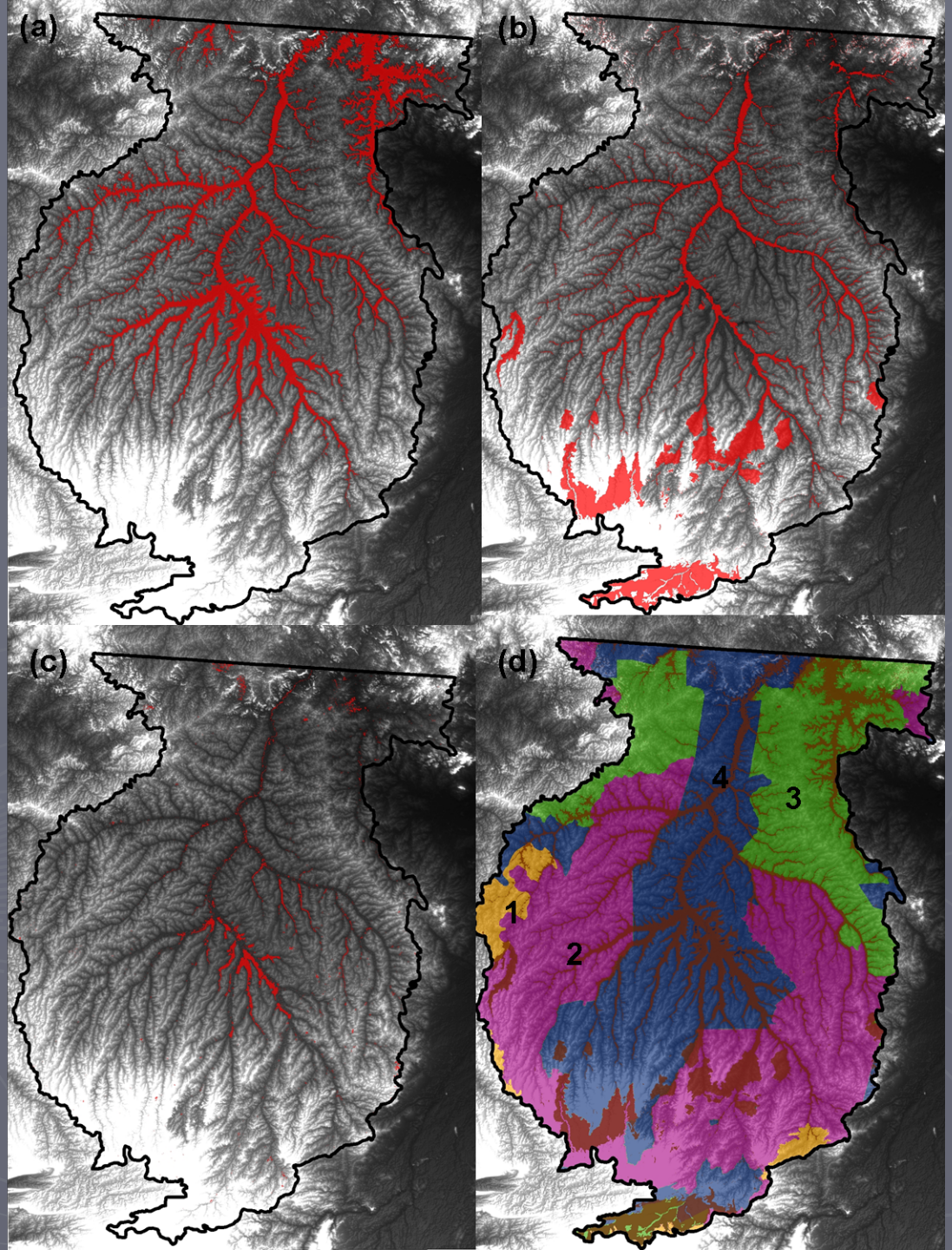
Part I: Results

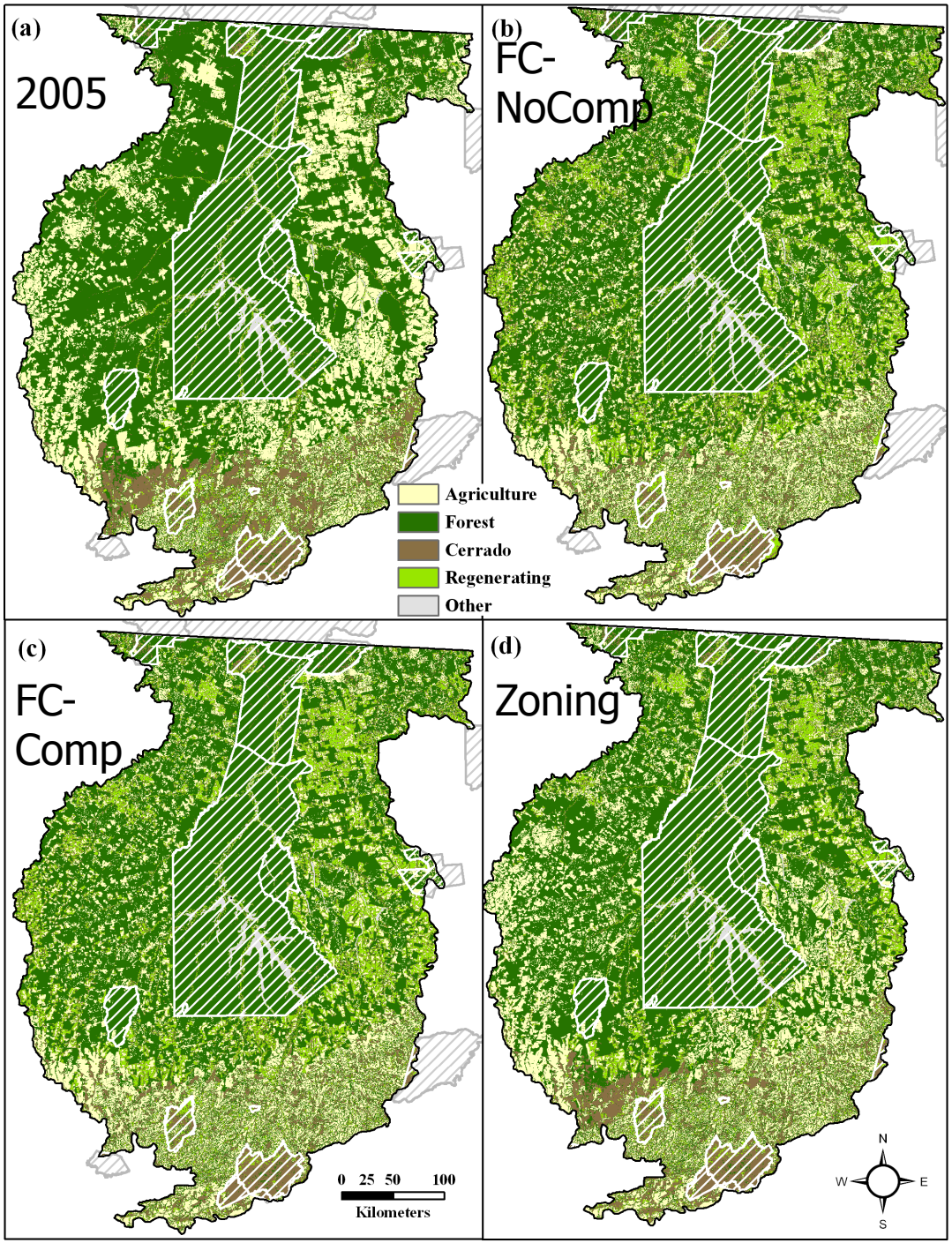
- Change in RL signified loss of 23,658 km^2 of potential agricultural land and nearly $9 billion reduction in NPV
- Restoration costs to come into compliance increased by ~ $500 million
- By 2005, many ecological indicators still more similar to theoretical 80% RL landscape but loss of ecosystem quality since 1996 and 1999

Part II: Questions

Hybrid regulatory-economic policy instruments

- Other policy instruments to achieve forest/ ecosystem service protection on private lands?
- How do these instruments compare with the Forest Code in terms of economic costs and ecosystem services?


(a)
(b)
(c)
(d)
1
2
3
4

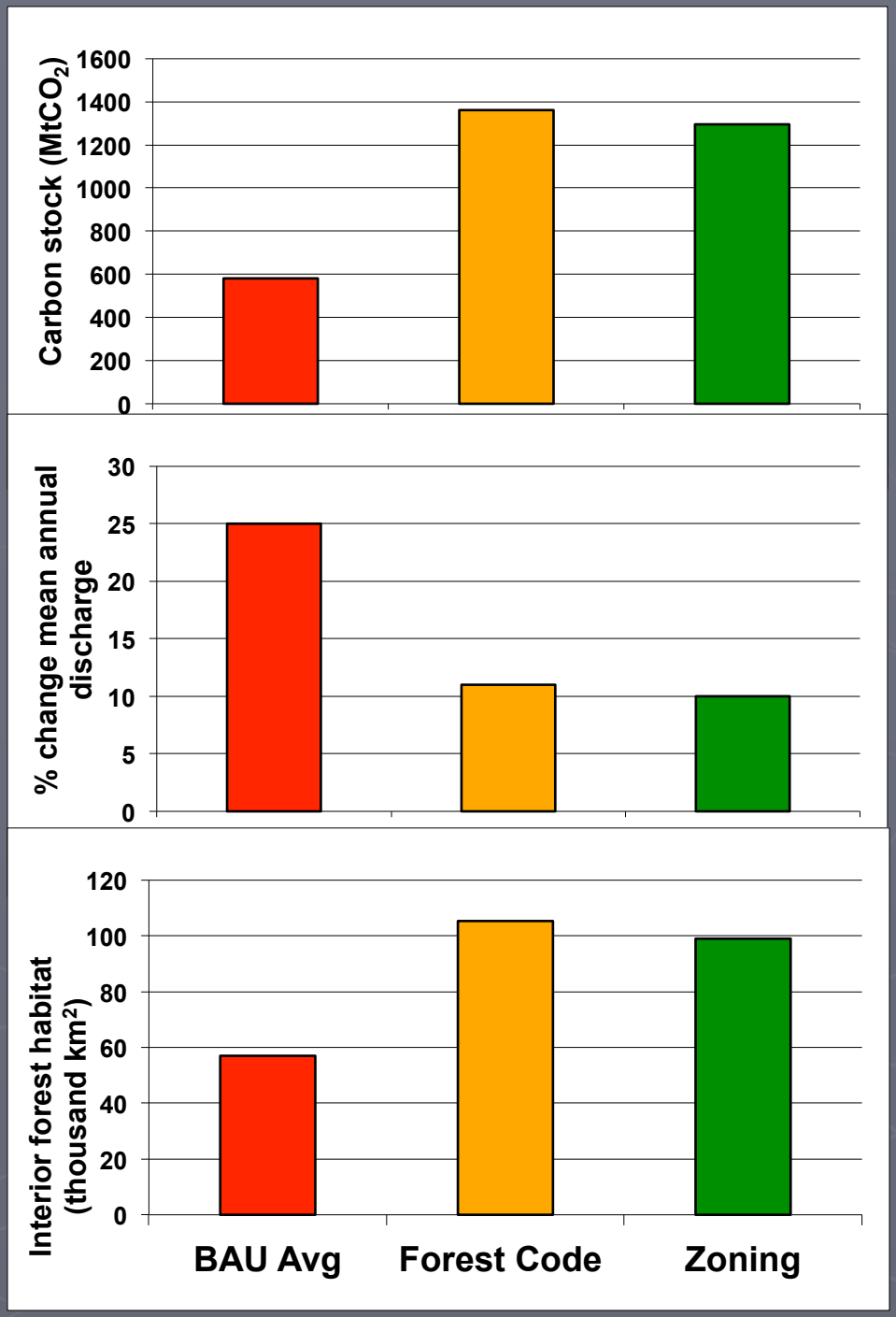

(a)
2005
(b)
FC-
NoComp
(c)
FC-
Comp
(d)
Zoning
Agriculture
Forest
Cerrado
Regenerating
Other
0 25 50 100
Kilometers
N
W
E
S

Part II: Results

- Zoning plan allows agricultural expansion to take place on 3500 km^2 more than the current Forest Code, reducing opportunity cost by $2.5 billion
- Zoning plan requires less reforestation (7300 km^2 less, at $730 million less)
- Exercising “compensation” option of Forest Code does not increase flexibility enough to markedly decrease foregone opportunity costs

Comparing ecological indicators:

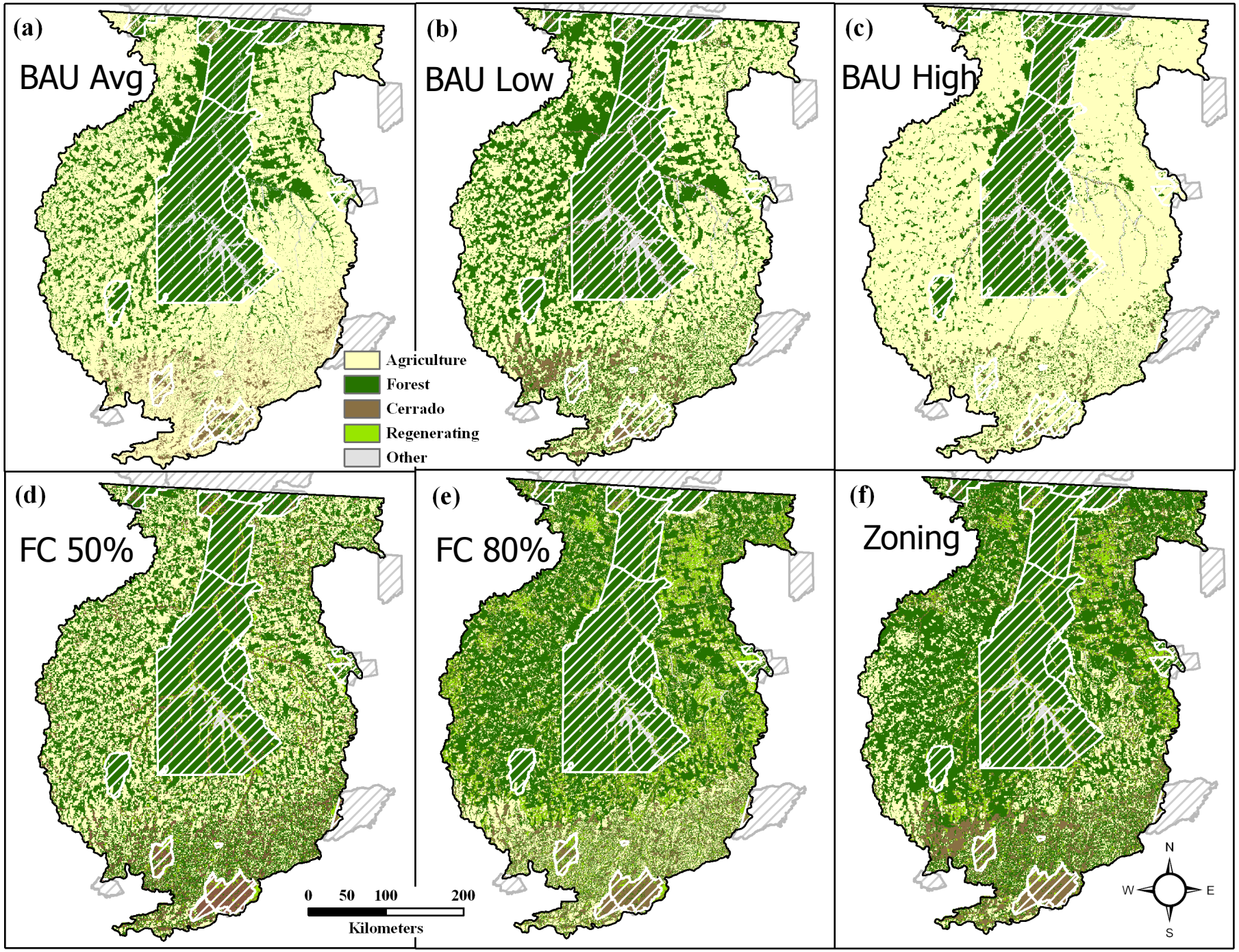
Zoning plan protects ecosystem services at a similar level as more uniformly restrictive land use code (current Forest Code)



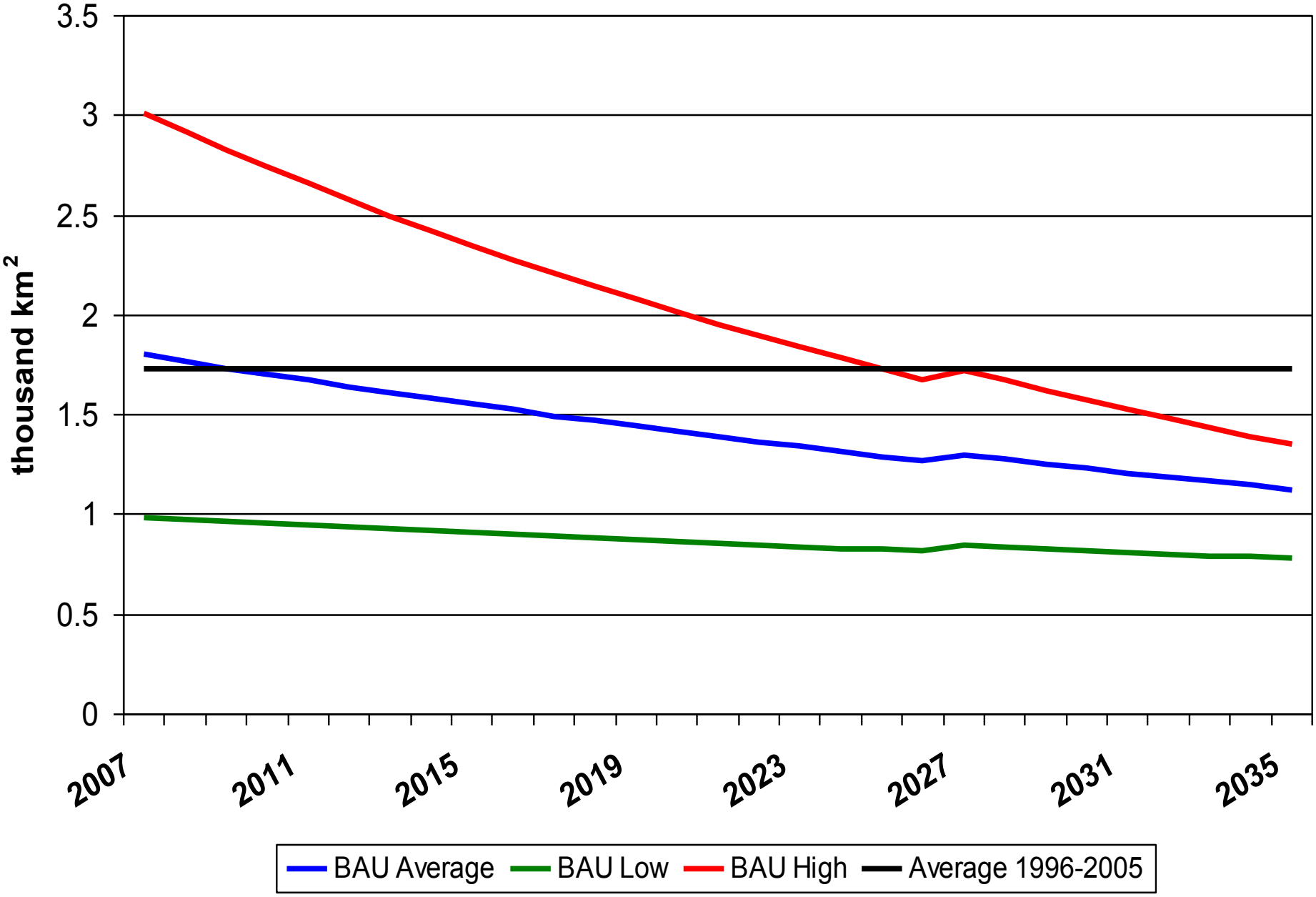
Part III: Questions

The cost of reducing carbon emissions under alternative policy frameworks

- How can existing forest and land-use policies be used as basis for effectively applying REDD or other carbon credits in the region?
- What volume of emissions reductions could be achieved on private lands in the region under 3 alternative legal frameworks?
- Price of carbon needed to offset opportunity costs incurred by private landholders to achieve emissions reduction target under each alternative framework?
- Ecological co-benefits that can be achieved under each alternative framework?


(a)
BAU Avg
(b)
BAU Low
(c)
BAU High
Agriculture
Forest
Cerrado
Regenerating
Other
(d)
FC 50%
(e)
FC 80%
(f)
Zoning
0 50 100 200
Kilometers
N
W
E
S

Comparison of reference levels



Part III: Results

- Zoning would achieve similar emissions reductions (~550 $MtCO_2e$) for similar price ($18/$tCO_2e$)
- ~3500 km^2 more would be available for agricultural expansion
- Restricting C to be compensated to microbasins having <50% forest cover would reduce price to $14-$15/tCO_2e
- Even in this highly lucrative agro-industrial frontier region, carbon price needed to compensate expansion is within range of current market (ETS now at $21/$tCO_2e$)

Conclusions (I)

- Change in legal reserve signified $9 billion USD potential opportunity cost
- Zoning plan protects many of the ecosystem services at a similar level as a more uniformly restrictive land use code, but reduces the overall opportunity cost by $2.5 billion
- Cost of compliance on private lands could be achieved for $18/t$CO_2$e
- FC (80%) performs best in most ecological indicators, but Zoning protects cerrado more evenly

Conclusions (II)

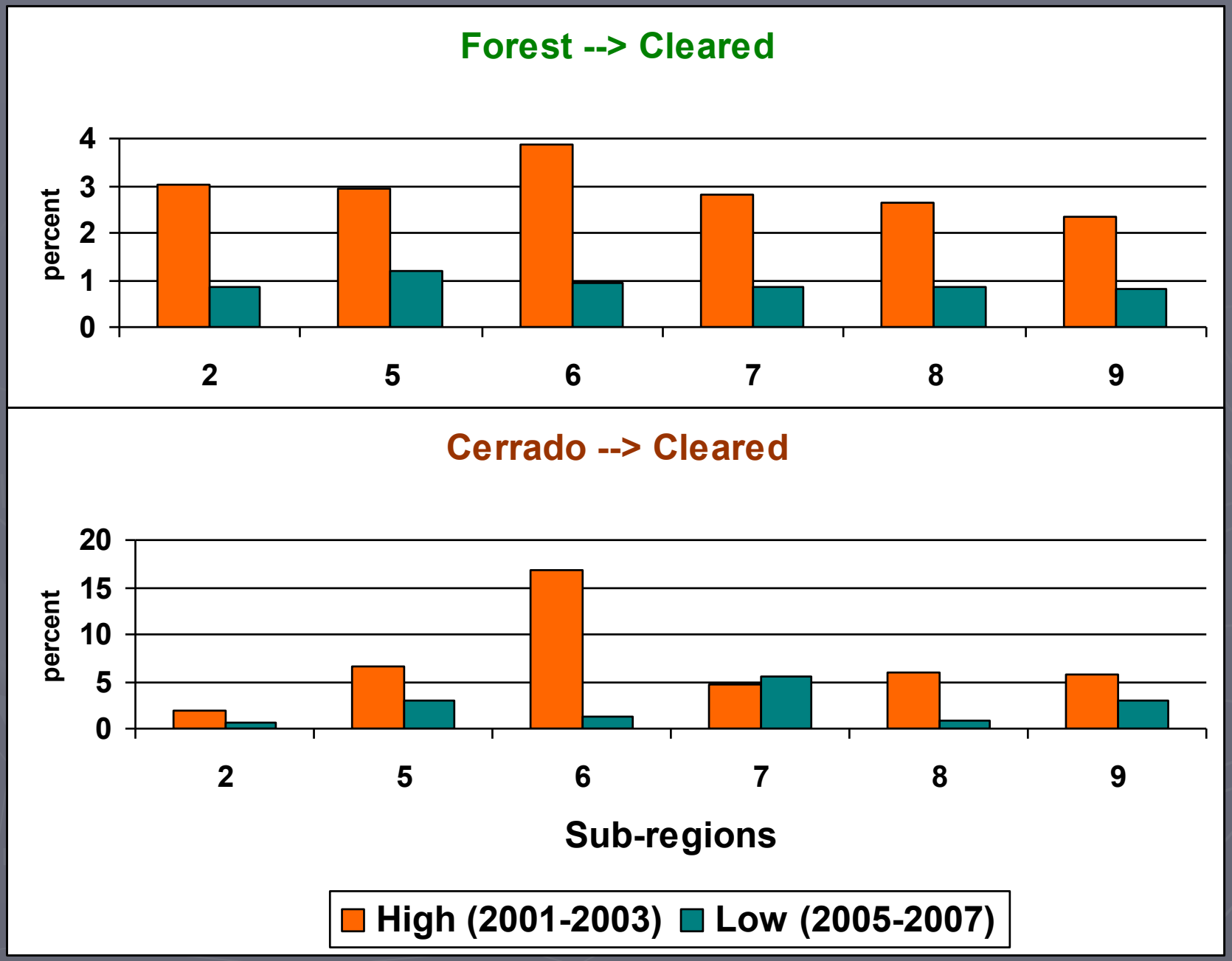
- Change in FC, accompanied by lack of assistance to and uncertainty for landholders, may have created perverse incentives to clear more
- Little room for agricultural expansion under current FC (80%) requirements
- FC (80%) likely leads to leakage to cerrado
- FC easy to define (uniform), but expensive and ineffective as a policy tool
- Zoning more complicated b/c requires stakeholder buy-in/process

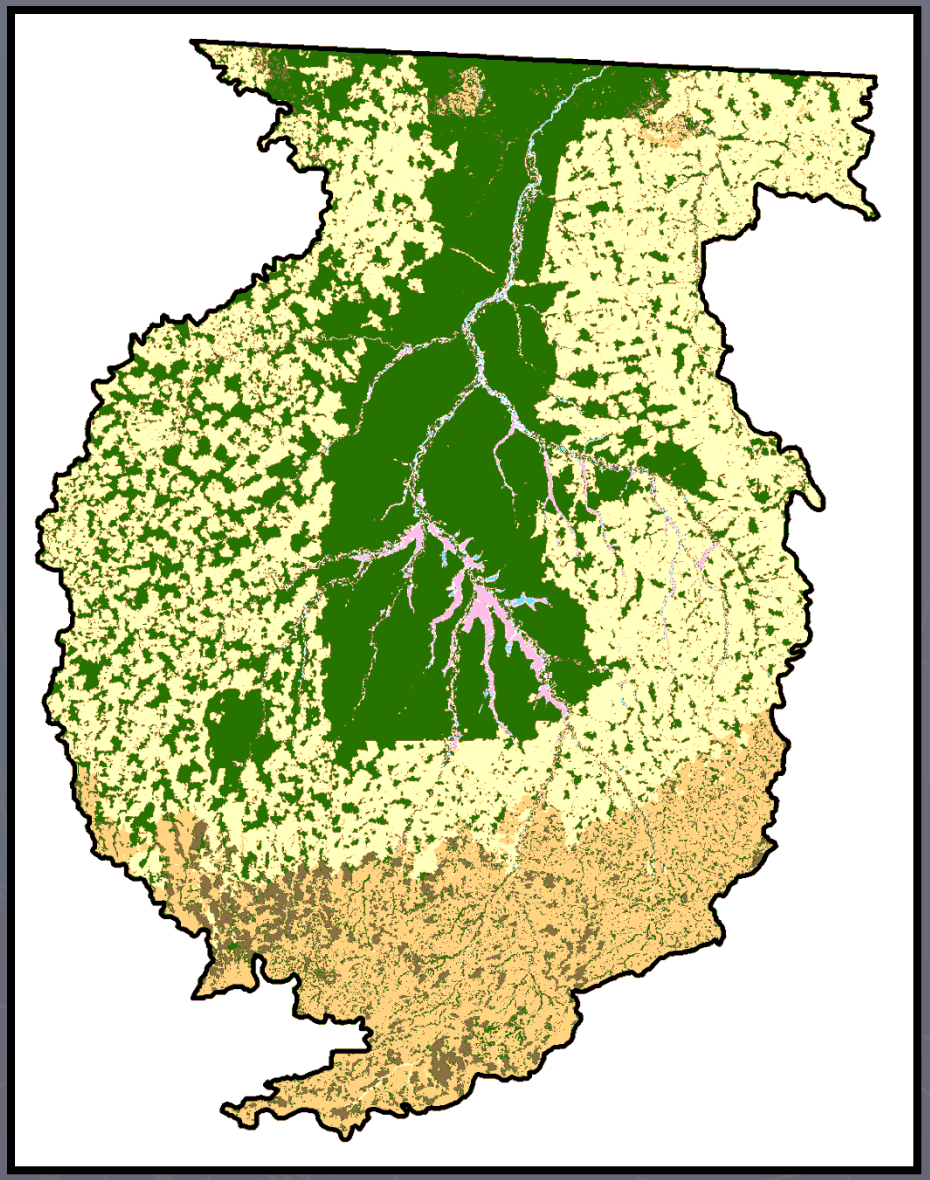
Implications

- No perfect solution to balancing economic and ecological benefits
- Carbon market could provide portion of incentives to lower cost of compliance with land use regulations
- Carbon funds could potentially favor much greater level of ecosystem service conservation (beyond carbon stocks)

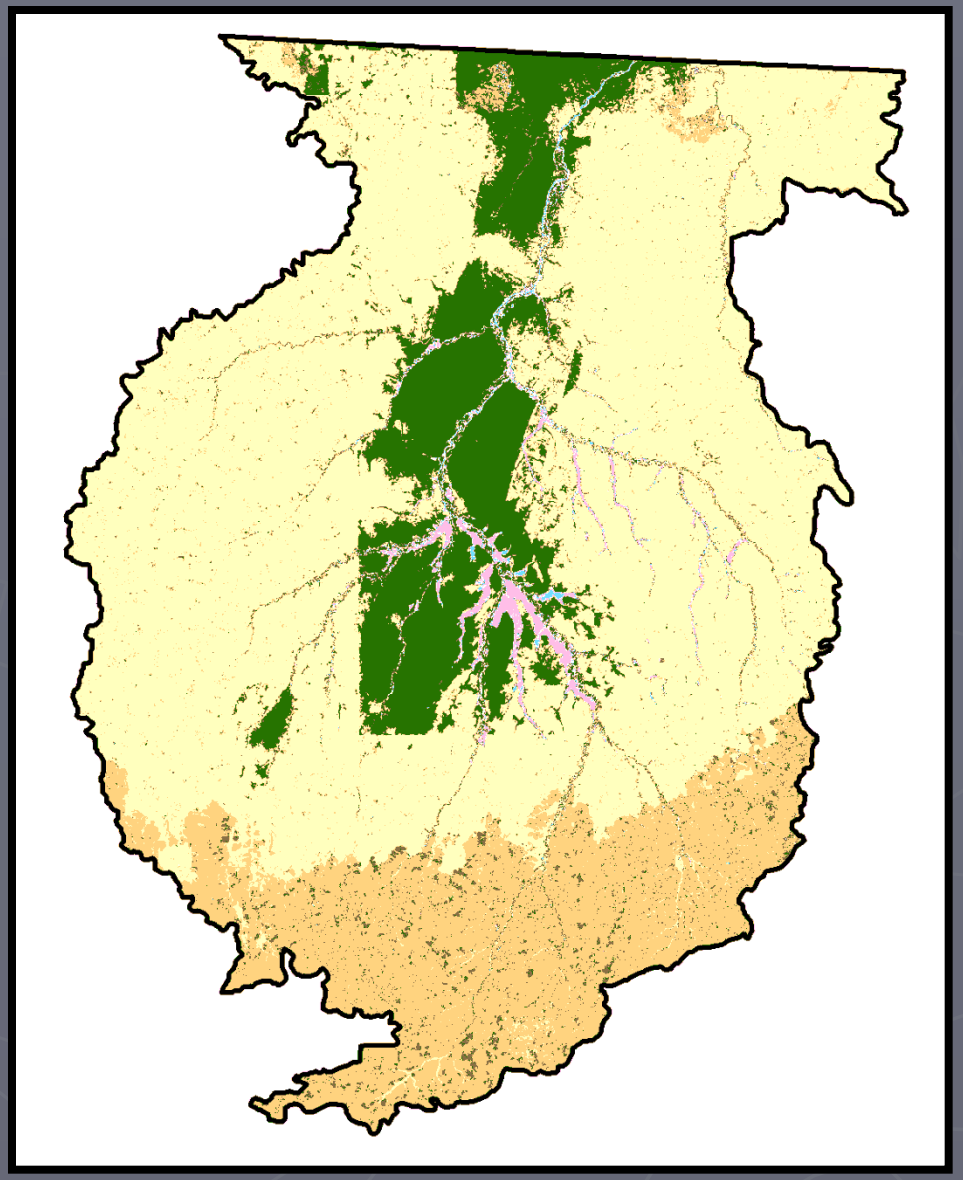

N
NE
E
SE
S
SW
W
NW

Transition Rates

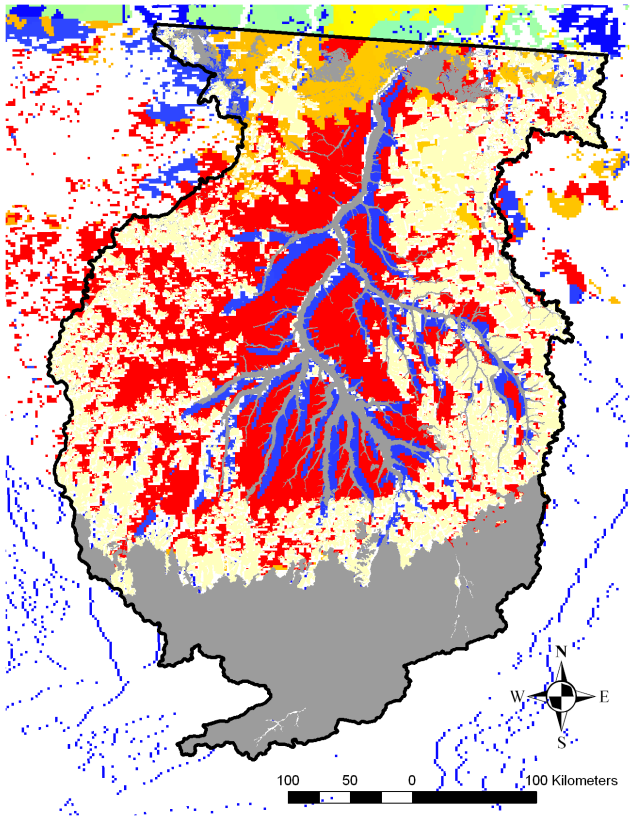


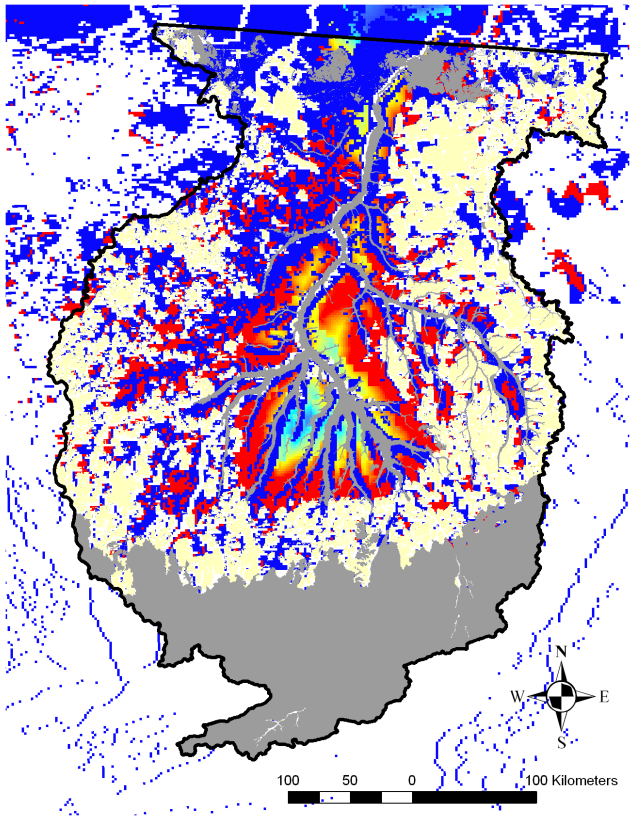


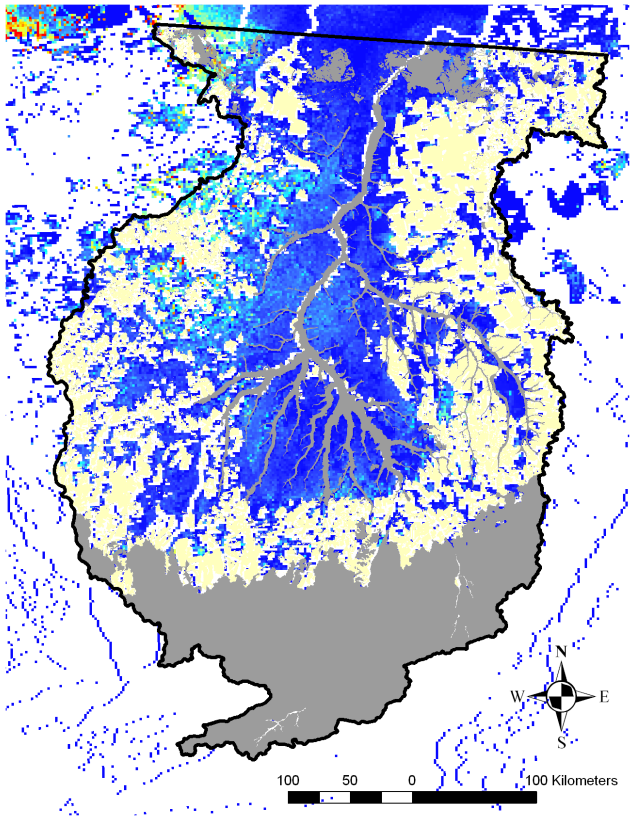
BAU Low deforestation rate; no restrictions



BAU High deforestation rate; no restrictions







Cattle*

NPV = $0-1172

Soy*

NPV = $0-13,113

Logging*

NPV = $0-624

$$NPV_{combined} = (\max(NPV_{soy}, NPV_{cattle}) - NPV_{logging})$$

**NPV for 30-yrs with schedule of highway paving*

Soares et al. 2006,Vera-Diaz et al. 2007, Merry et al., 2009

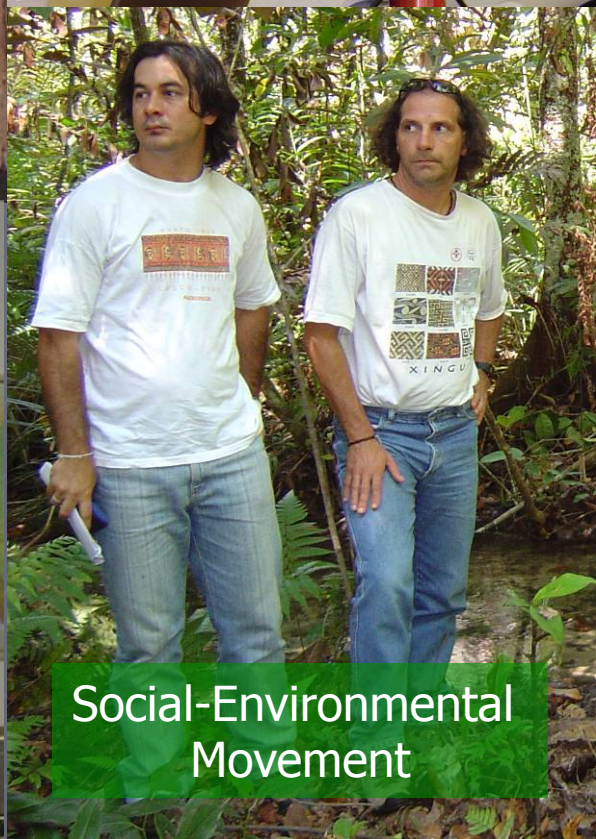

Indigenous Peoples


Smallholders/Family Farmers


Local Government


Agro-industrialists


2050 Cenario Tendencial:
33 Pg C
Scientists


Social-Environmental Movement


N
NE
E
SE
S
SW
W
NW