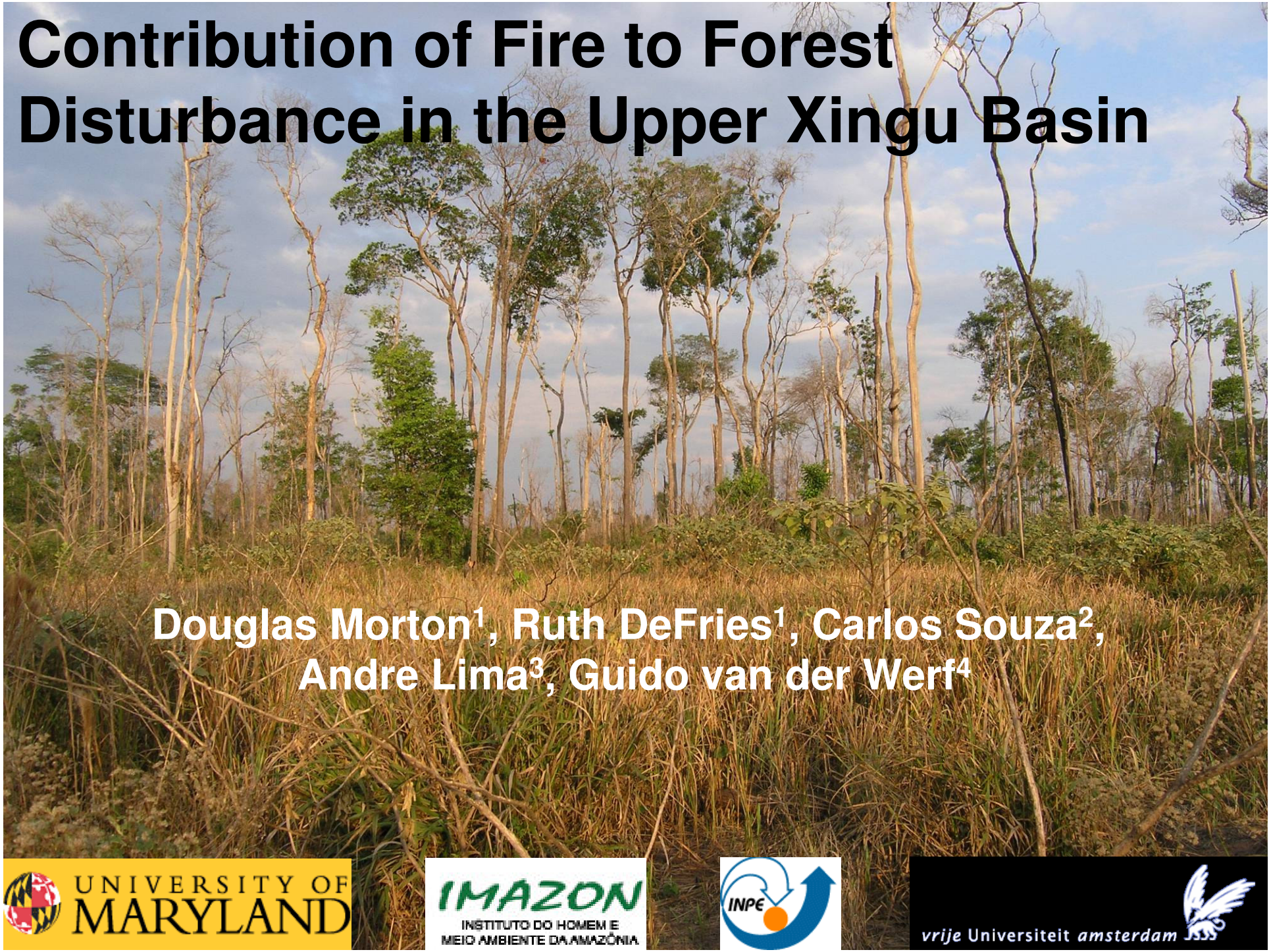
Contribution of Fire to Forest Disturbance in the Upper Xingu Basin



Douglas Morton[1], Ruth DeFries[1], Carlos Souza[2], Andre Lima[3], Guido van der Werf[4]

UNIVERSITY OF MARYLAND

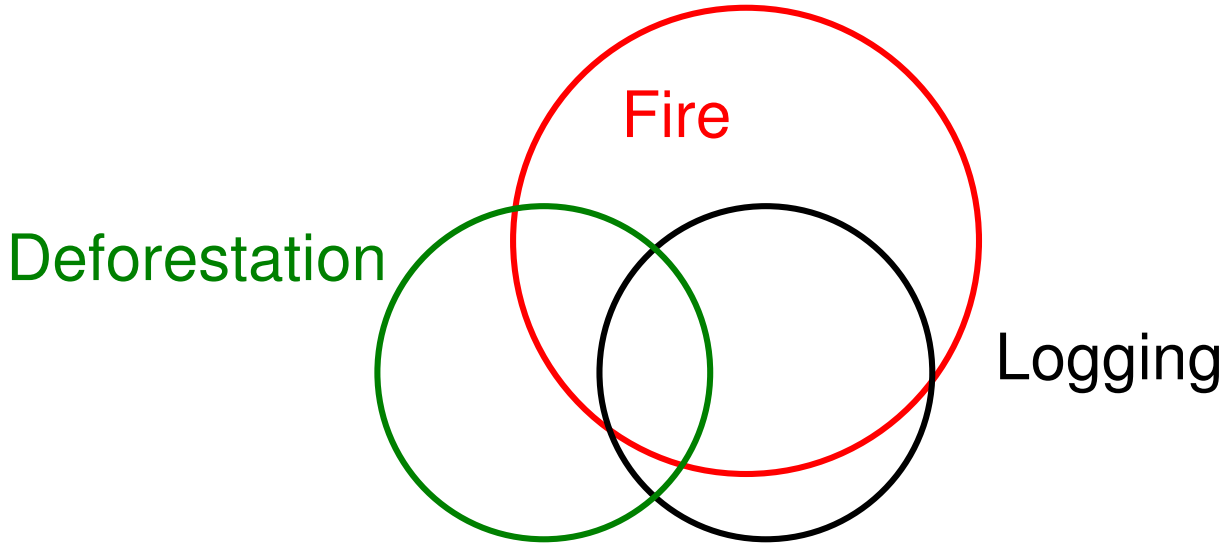
IMAZON
INSTITUTO DO HOMEM E MEIO AMBIENTE DA AMAZÔNIA

INPE

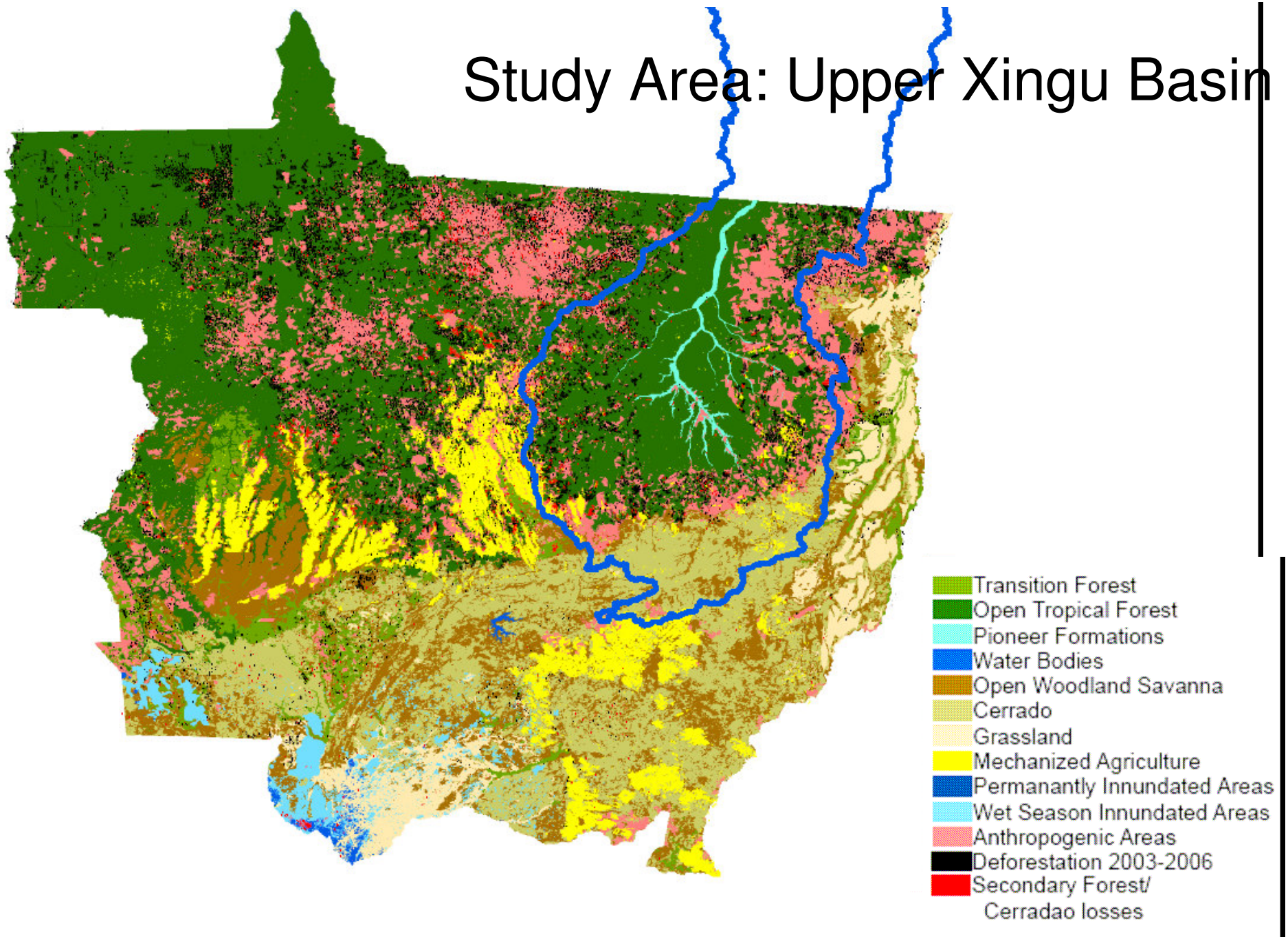
vrije Universiteit amsterdam

What are the unique contributions from fire, logging, and deforestation to forest disturbance in Amazonia?

What are the spatial and temporal relationships among these disturbances?



Study Area: Upper Xingu Basin

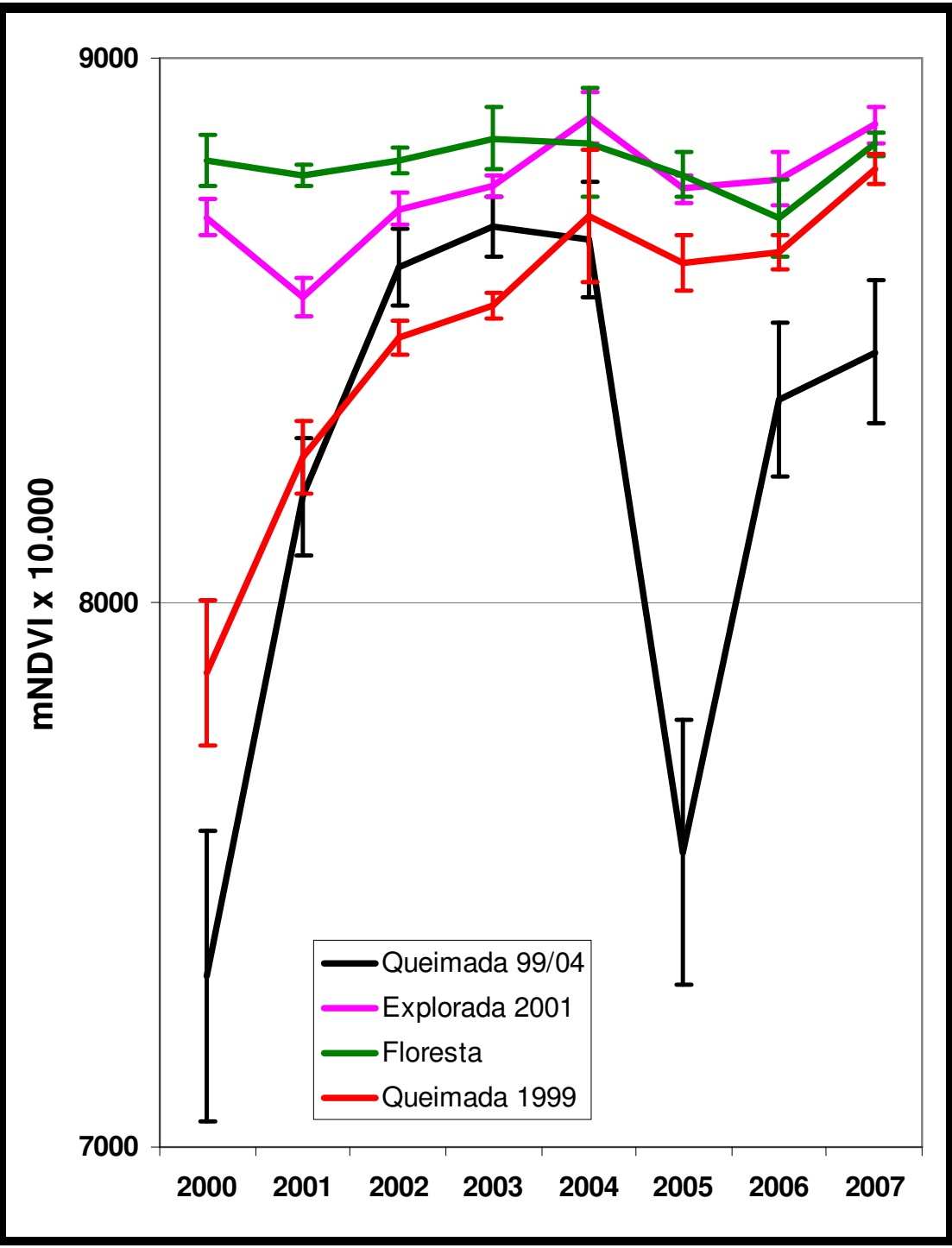


Morton *et al.*, 2007 Ambi-Agua

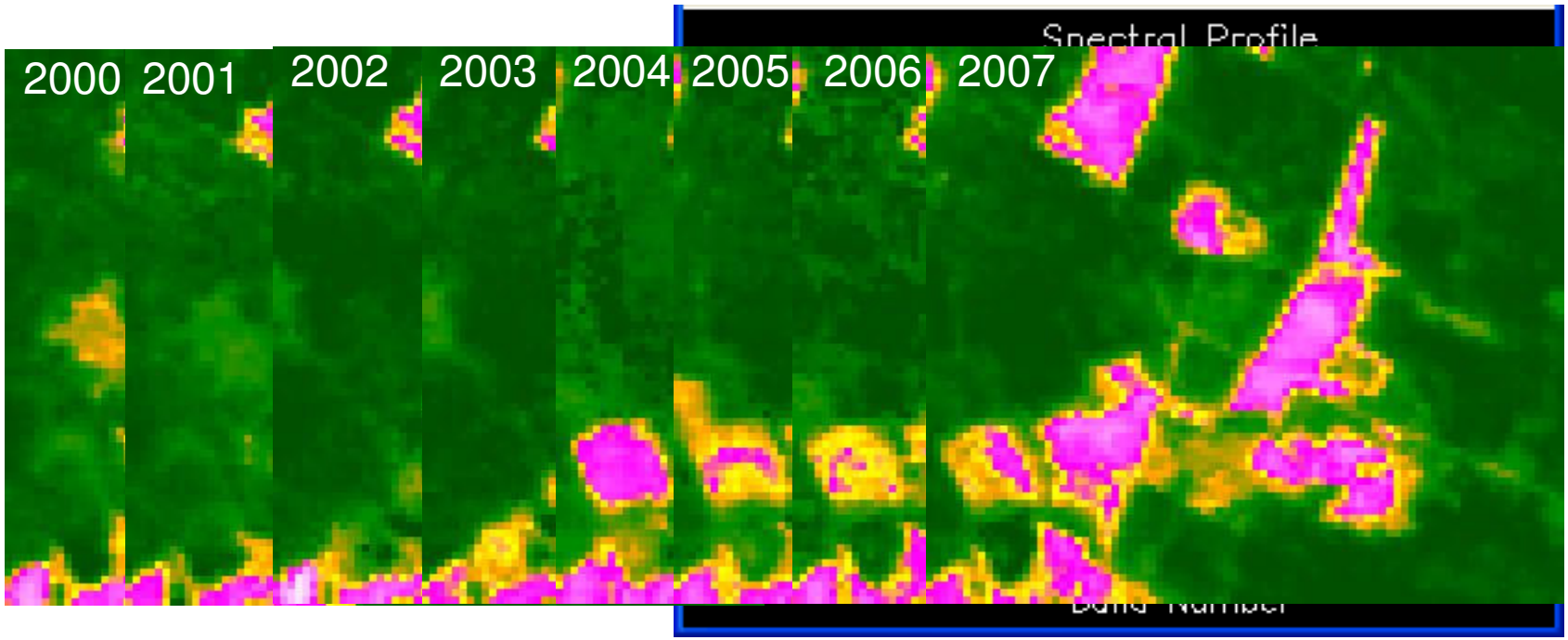
Method

Time series of MODIS dry season mean NDVI:

- NDVI saturation is an advantage, disturbance signal homogenous at 250m
- Disturbance, recovery, and fate of burned forests are visible
- Intermediate disturbance from fire is distinguishable from either logging or deforestation



MODIS images for 1999, 2004 fires



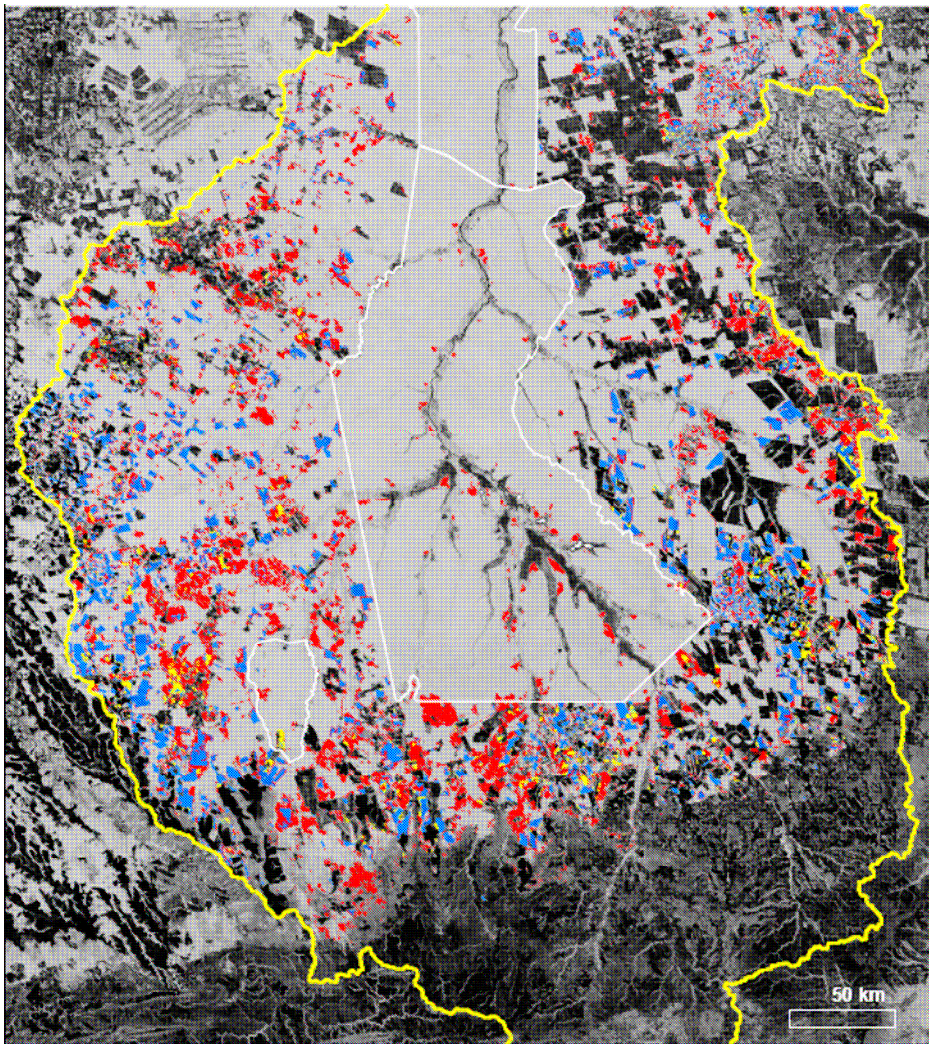
3 km

Deforested Forest Canopy Damage

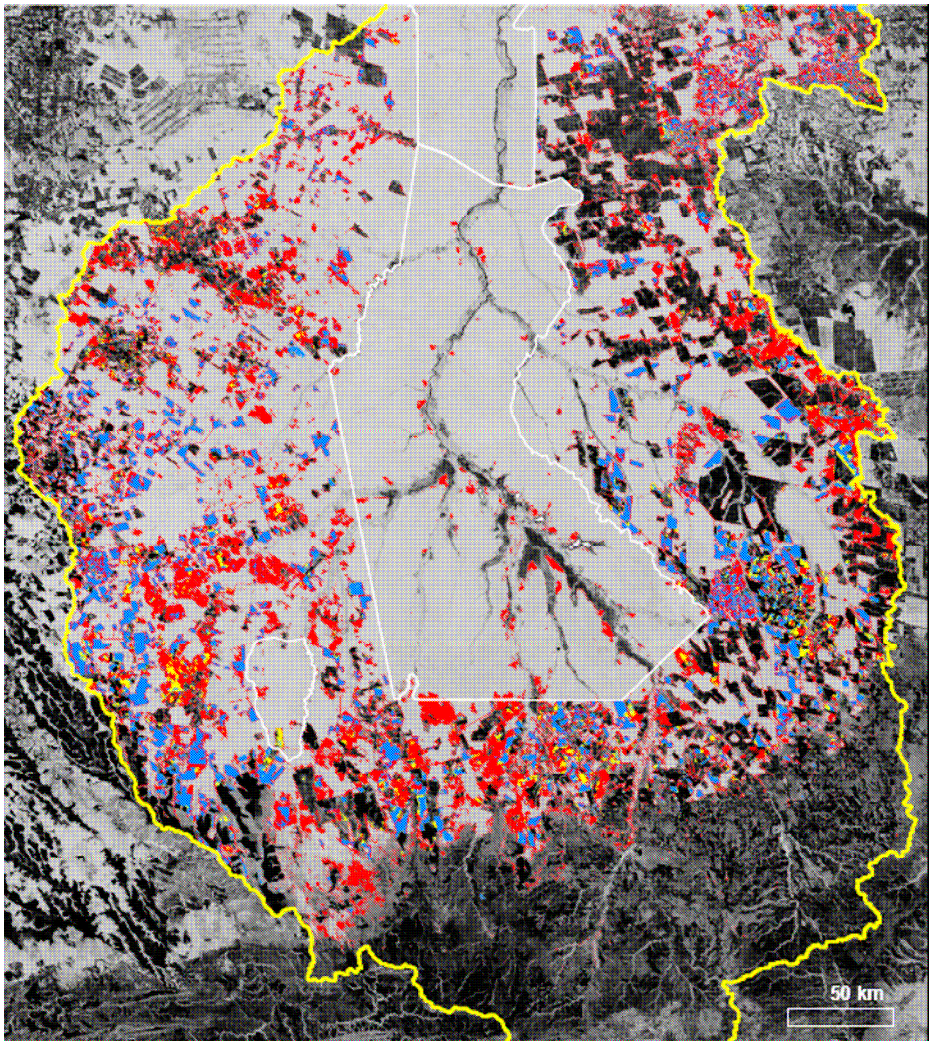
Preliminary Results

- Burned Area Estimates
- Annual contribution of fire to new areas of forest degradation
- Frequency of fire occurrence following first fire exposure (1999-2005)
- Comparison with Logging, Deforestation

Low estimate: 14,300 km^2



High estimate: 25,600 km^2



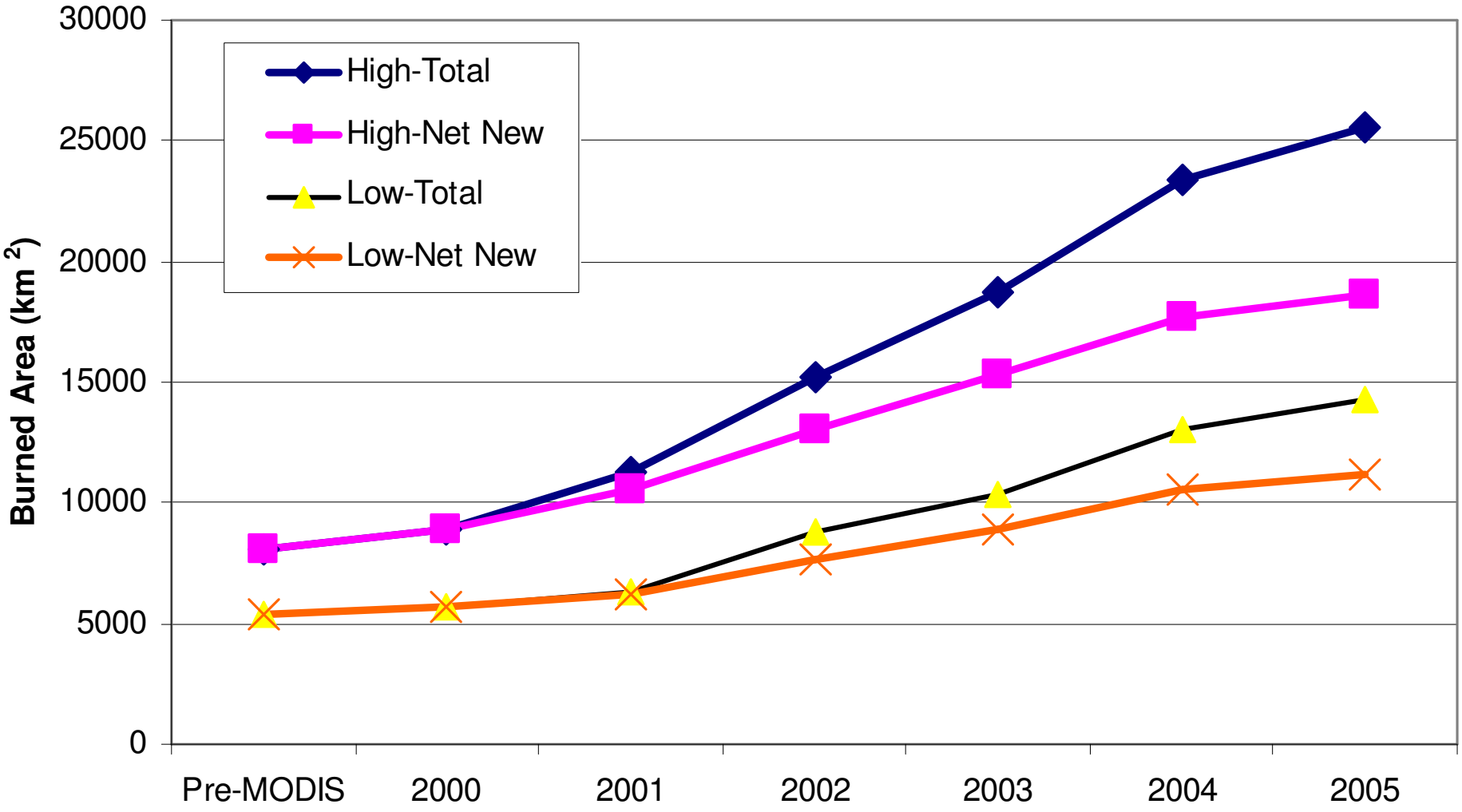
Burned

Deforested

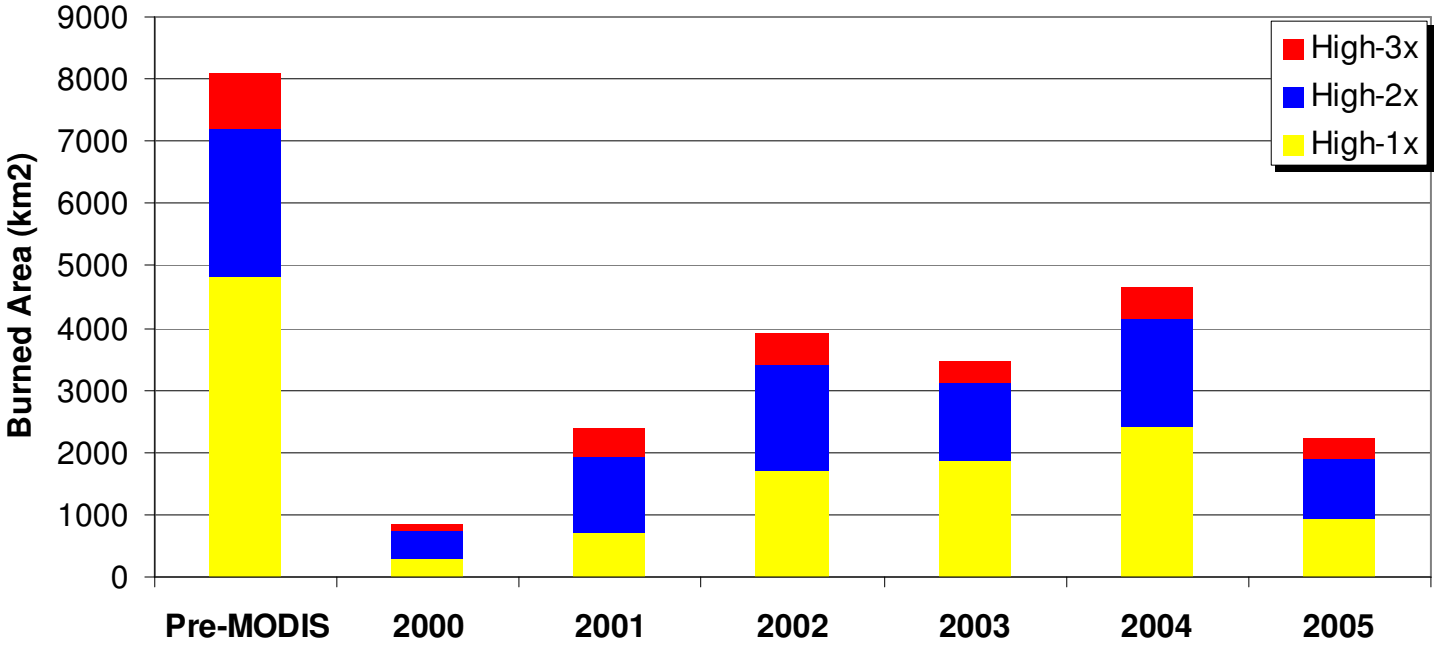
Burned and Deforested

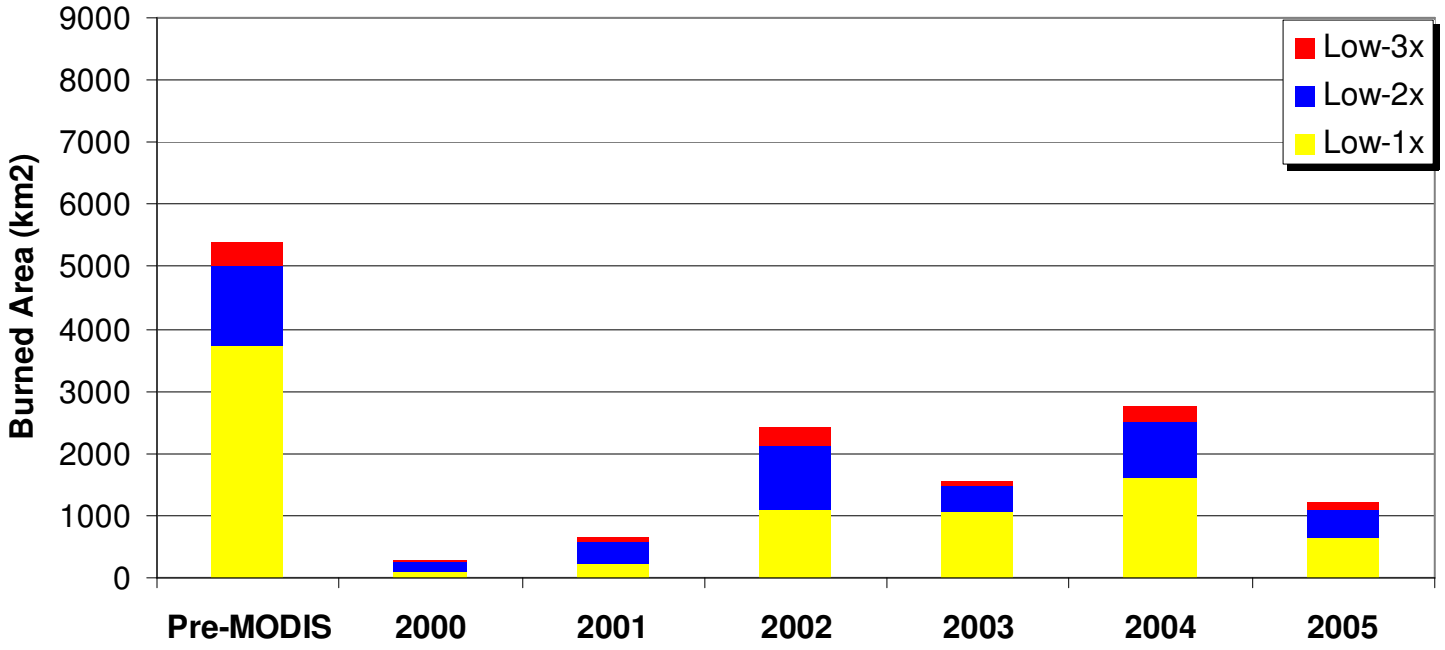
Morton, *unpublished data*

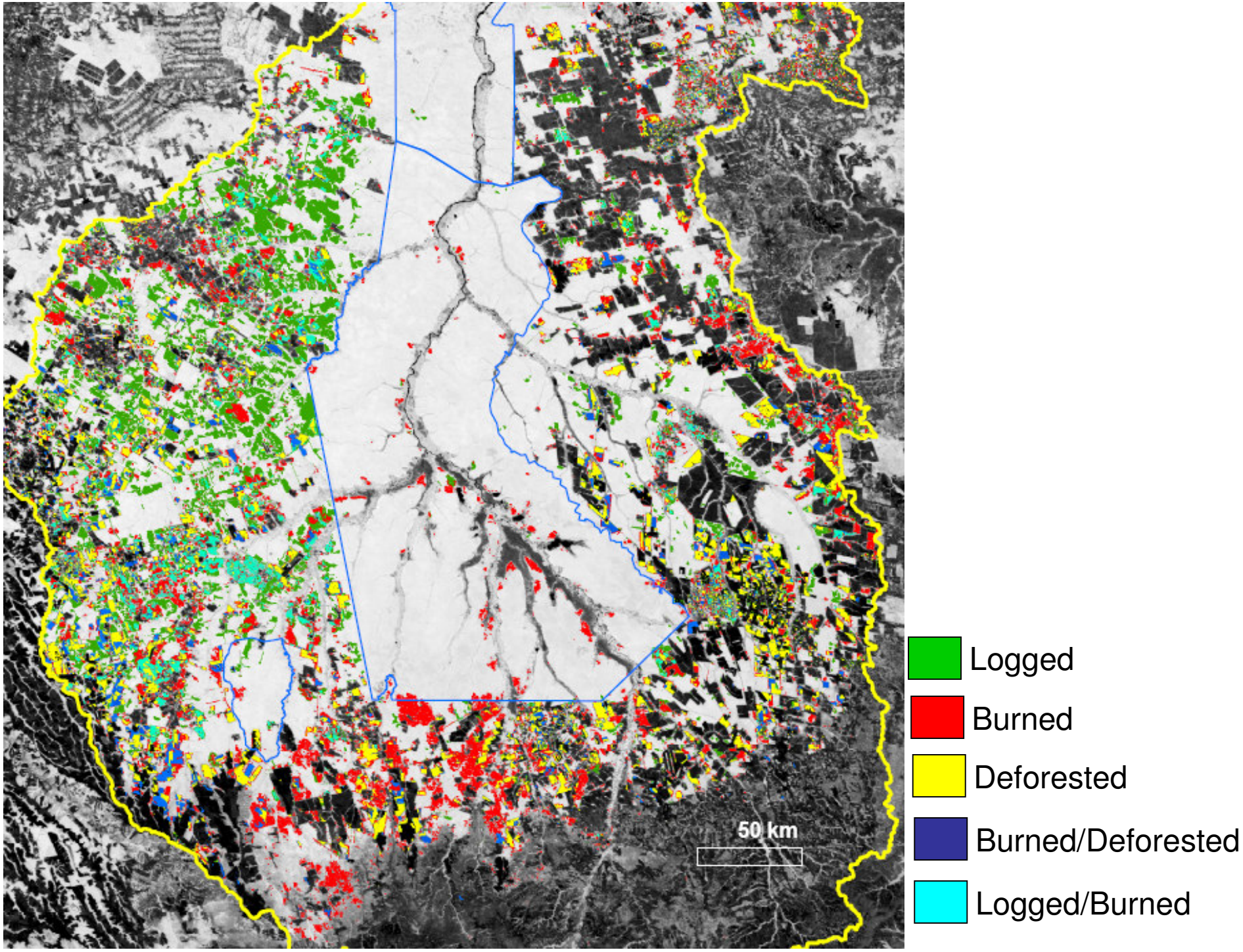
Total annual burned area and net new forest disturbance



Morton, *unpublished data*

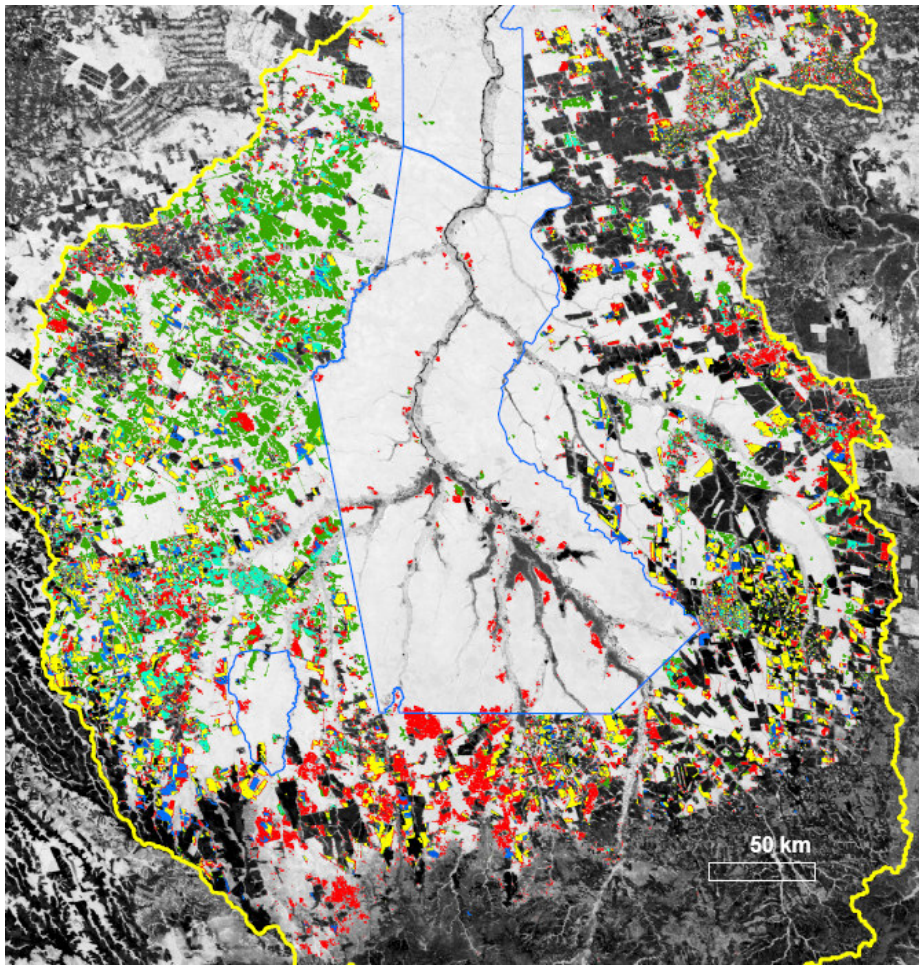

Burned Area (km2)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
High-3x
High-2x
High-1x
Pre-MODIS
2000
2001
2002
2003
2004
2005


Burned Area (km2)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Low-3x
Low-2x
Low-1x
Pre-MODIS
2000
2001
2002
2003
2004
2005


50 km
Logged
Burned
Deforested
Burned/Deforested
Logged/Burned

Burned Forest, Logging, and Deforestation

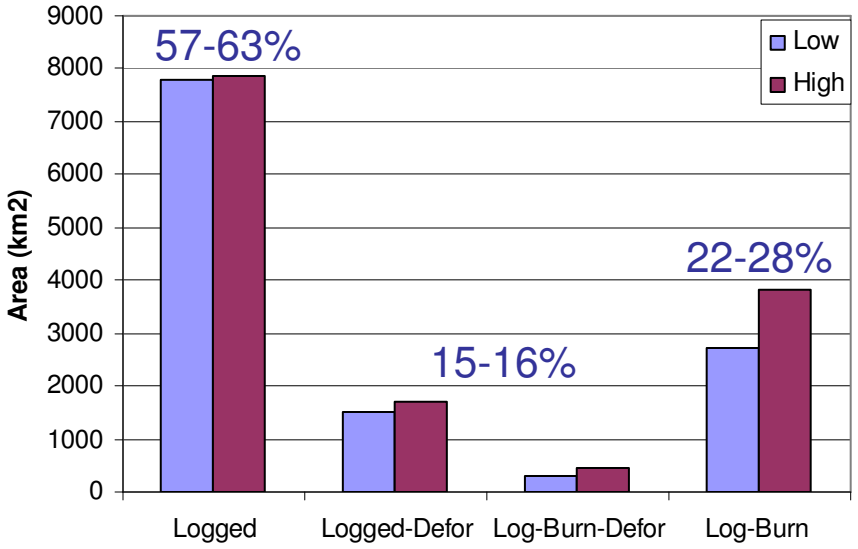
Low estimate, MODIS-based results:



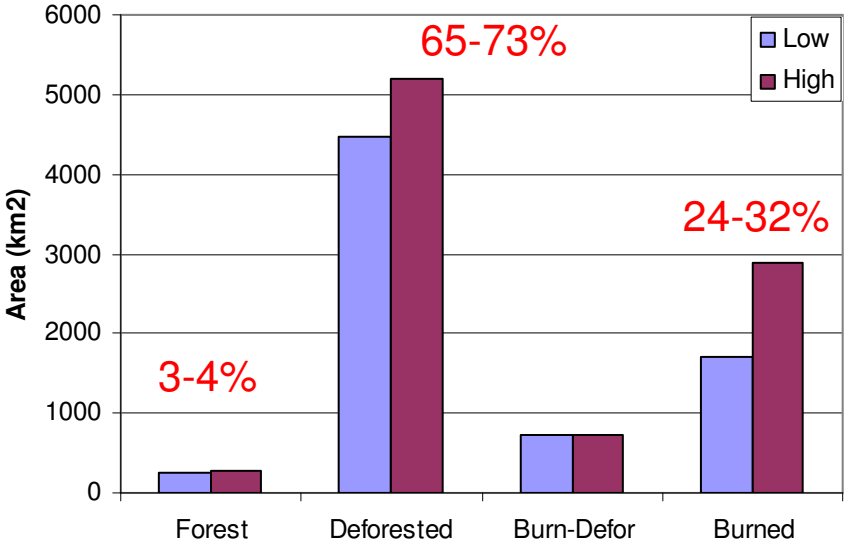
L B D B/D L/B

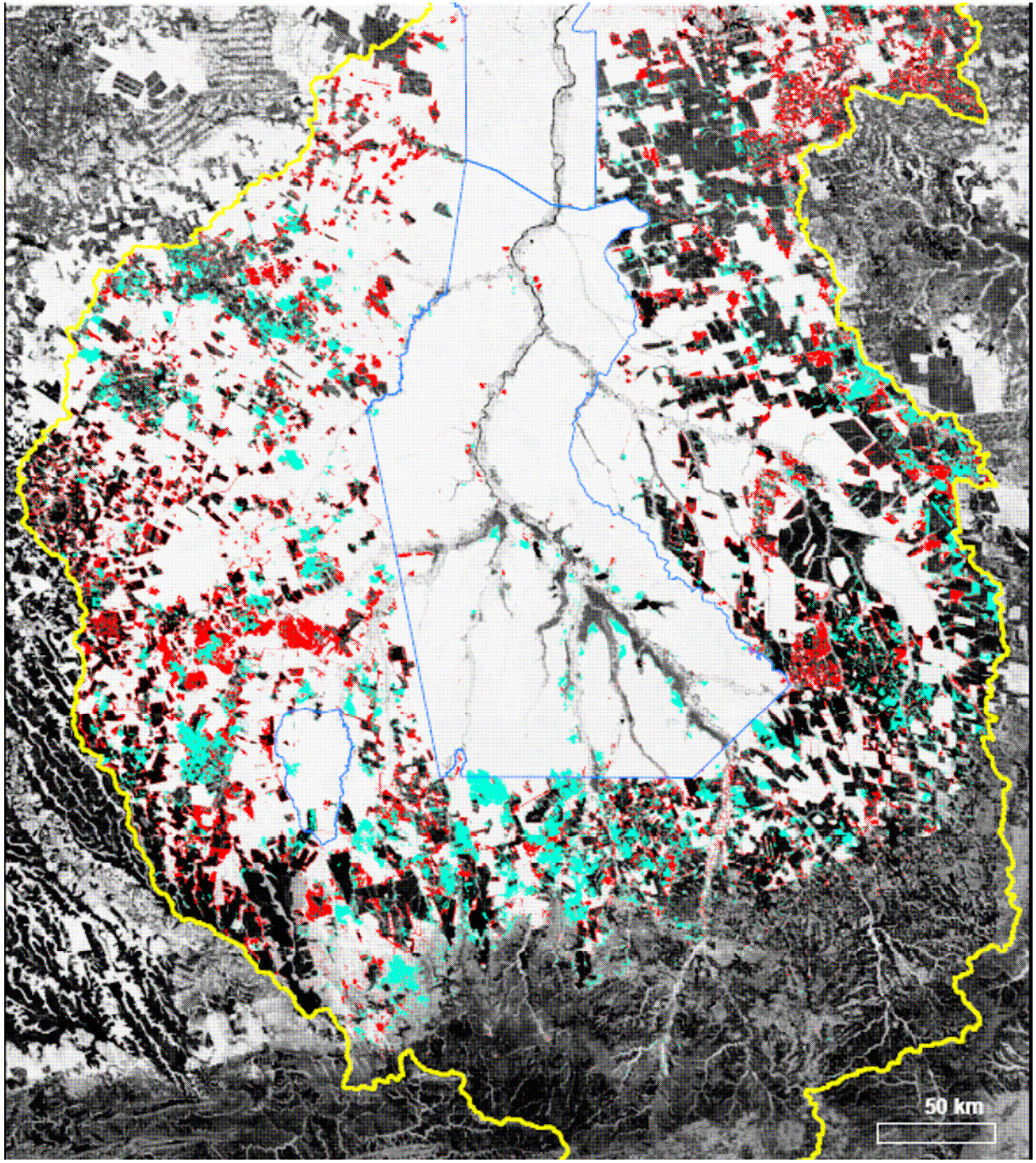
Morton, *unpublished data*

Logging 2000-2002 (Asner et al., 2005)



PRODES 2001-2005





First fire exposure visible in MODIS time series

~1999

43-48%

2000-2005

52-57%

Results Summary

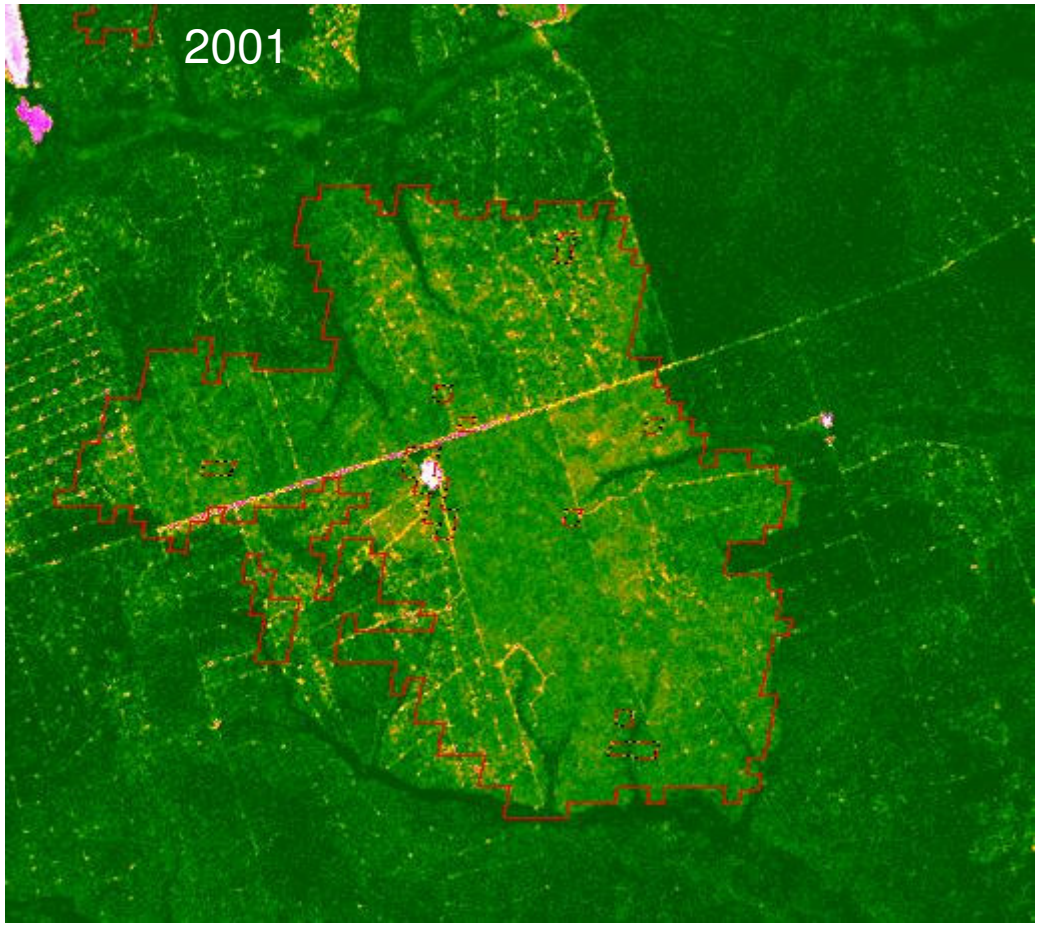
- Within the Xingu Basin in Mato Grosso,

  14.300 - 25.600 km^2 of forest burned during 1999-2005
- 50% burned only once
  50% burned 2x or 3x
- Following the first fire exposure, average fire frequency was every 3.1 years
- Of the total forest damages, 1/3 was logged (2000-2002), 1/3 deforested (2001-2006), and 1/3 burned (1999-2005)

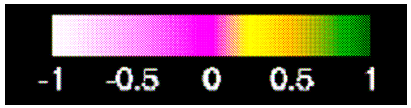
Next Steps

- Calibration between Landsat and MODIS
- When does the first fire exposure occur?
  - Historical perspective on the relationship between logging and fire: 21 year time series for Sinop (1984-2004).
  - Is logging a necessary precursor to fire?
  - How does climate mediate fire frequency?
    - Drought = Fuels
    - Nighttime Climate = fire spread potential
- How long does forest remain flammable following logging?
- How prevalent are fire-induced edge effects, only visible at Landsat resolution?
- Modeling impacts of frequent fire on forest succession.

Logged 1992-2001, burned in 1995 and 1999.



MODIS 1999 Burn Extent



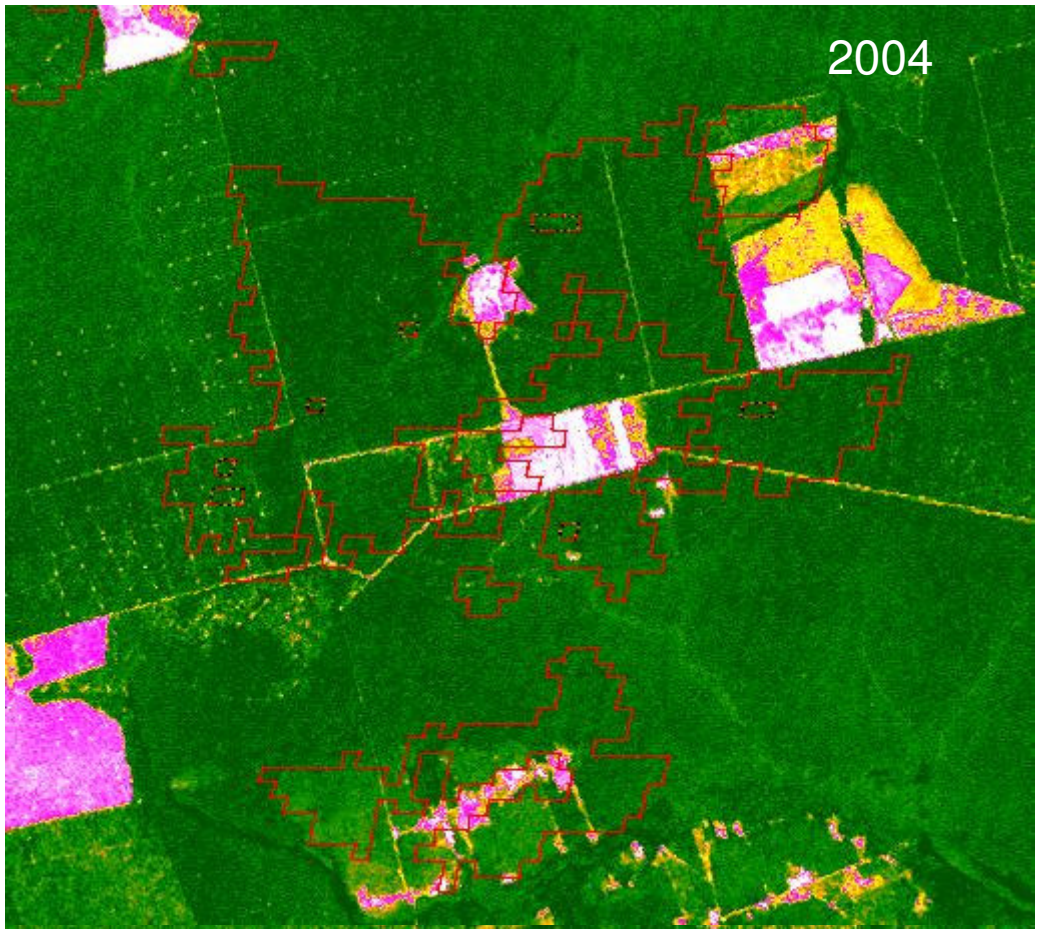
NDFI

$$NDFI = \frac{GV_{Shade} - (NPV + Soil)}{GV_{Shade} + (NPV + Soil)}$$

3 km

Following Souza *et al.*, 2005

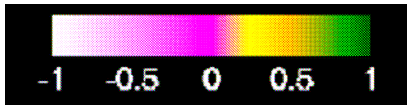
Logging Fire Relationship is Complex



3 km

Logged late 1980s - mid 1990s Burned in 1999

MODIS 1999 Burn Extent



NDFI

Not logged during 1984-2000 Burned 1999, 2002


Questions?