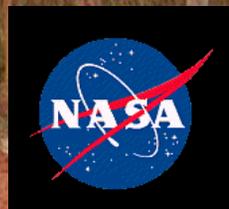


Contribution of Agricultural Expansion to Mato Grosso Deforestation 2001-2004



LC22: Douglas Morton, Yosio Shimabukuro, Ruth DeFries, Liana Anderson, Egidio Arai, Ramon Freitas, Fernando Espirito-Santo



What are the ecological implications of direct transitions from forest to cropland in Mato Grosso?

- **Carbon:** Changes in timing, spatial extent, and retained AGB are different between pasture and agriculture clearings.
- **Habitat:** Large clearings for cropland fragment the landscape and alter infrastructure needs.
- **Drivers and future trends:** Agricultural pressures are a part of any discussion on the future of Amazonia, but census data are an indirect measure of the contribution of cropland expansion to deforestation.

The fate of deforested lands can be assessed directly:

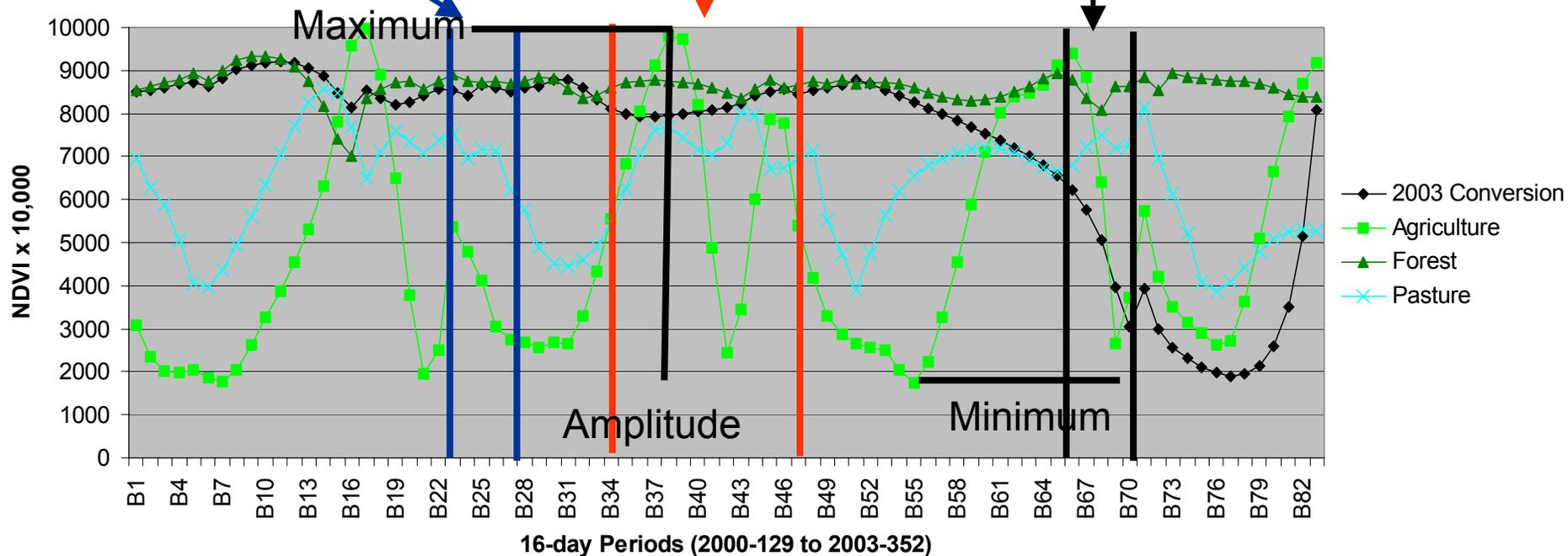
Combine high-resolution deforestation information (PRODES) and time series of MODIS imagery.

Using phenological curves from satellite data to classify land cover

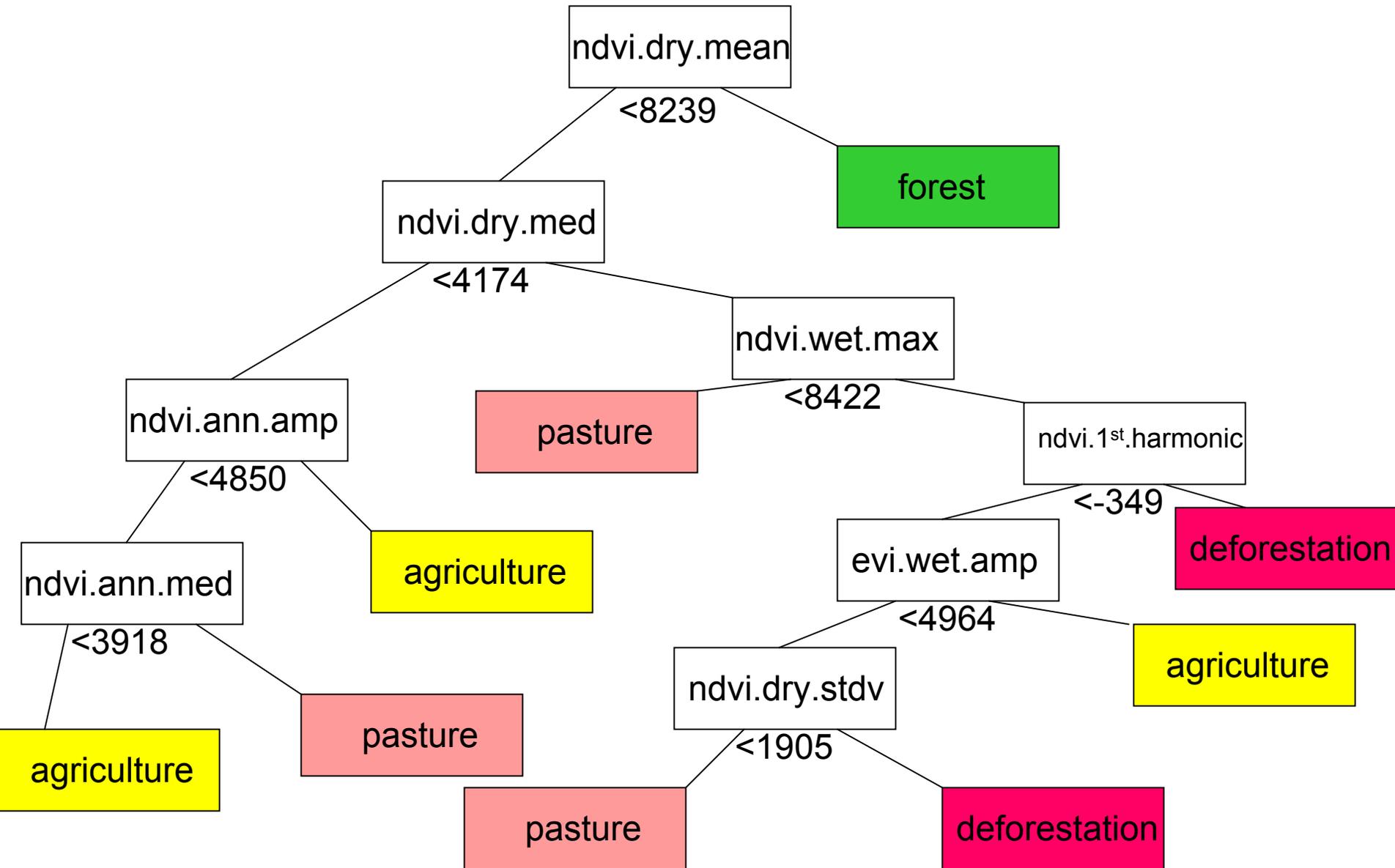
Classes separable with NDVI

Wet-season class confusion with NDVI

Dry season confusion between deforestation and cropland



Classification Tree From 2004 Field Data



Validation of Classification Accuracy Using 2005 Field Data

Pixel-Based Approach

	Agriculture	Deforestation	Forest	Pasture	Row total	User's
Agriculture	2007	163	0	428	2598	77.3%
Deforestation	171	1689	0	110	1970	85.7%
Forest	0	306	5547	0	5853	94.8%
Pasture	348	1232	0	4273	5853	73.0%
Column Total	2526	3390	5547	4811	16274	
Producer's	79.5%	49.8%	100.0%	88.8%		
Overall						83.1%

Polygon-Based Approach, Majority in Each Training Polygon

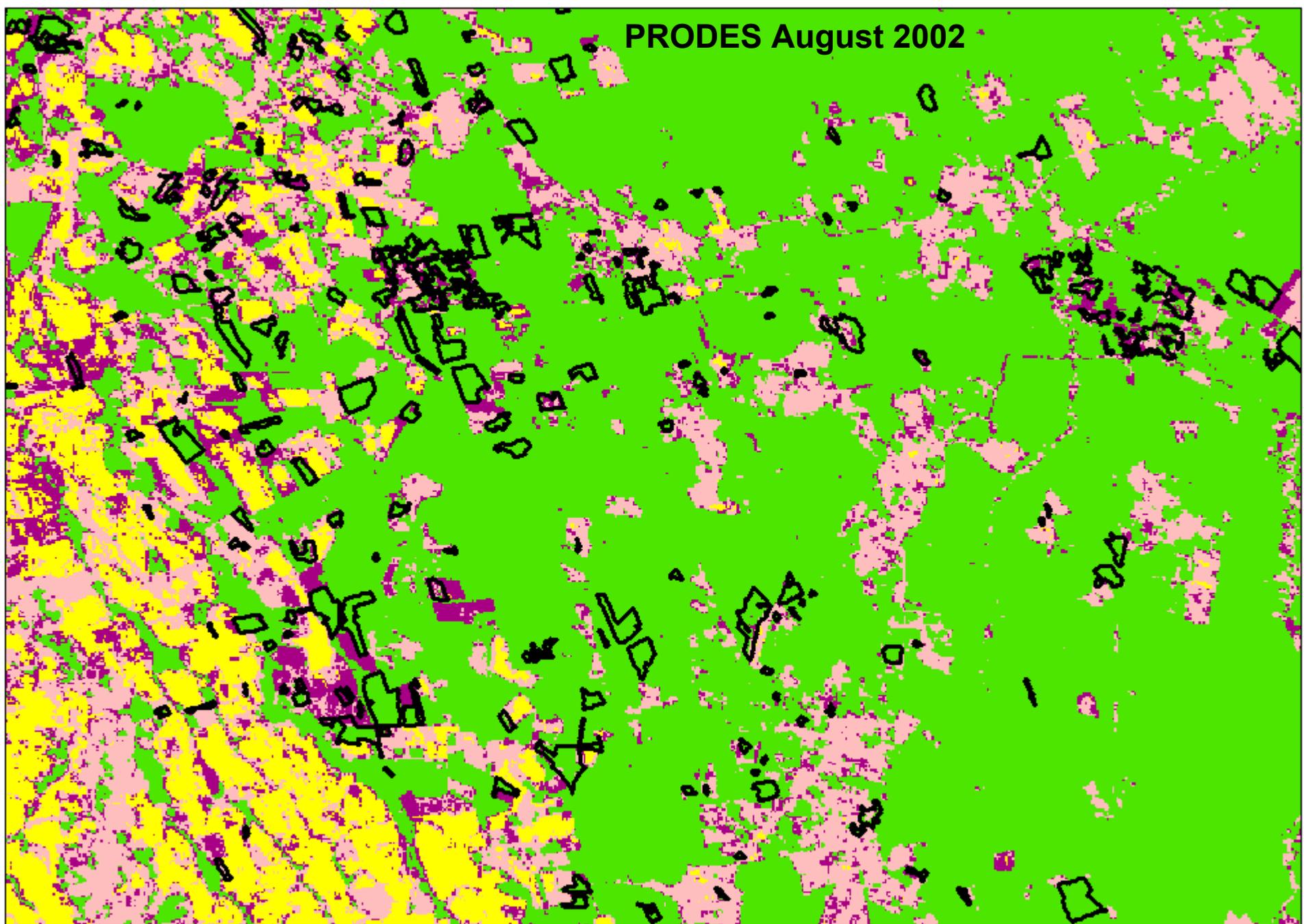
	Agriculture	Deforestation	Forest	Pasture	Row total	User's
Agriculture	95	3	0	6	104	91.3%
Deforestation	6	35	0	0	41	85.4%
Forest	0	3	5	0	8	62.5%
Pasture	8	37	0	65	110	59.1%
Column Total	109	78	5	71	263	
Producer's	87.2%	44.9%	100.0%	91.5%		
Overall						76.0%

Pasture and agriculture are highly separable based on time series metrics.

Answer—use PRODES polygons >25 hectares to identify deforestation (~Aug.), and the time series (Oct.-Oct.) to classify outcome with high confidence.

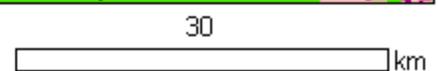
Method—Summarize the majority class within each PRODES polygon.

PRODES August 2002

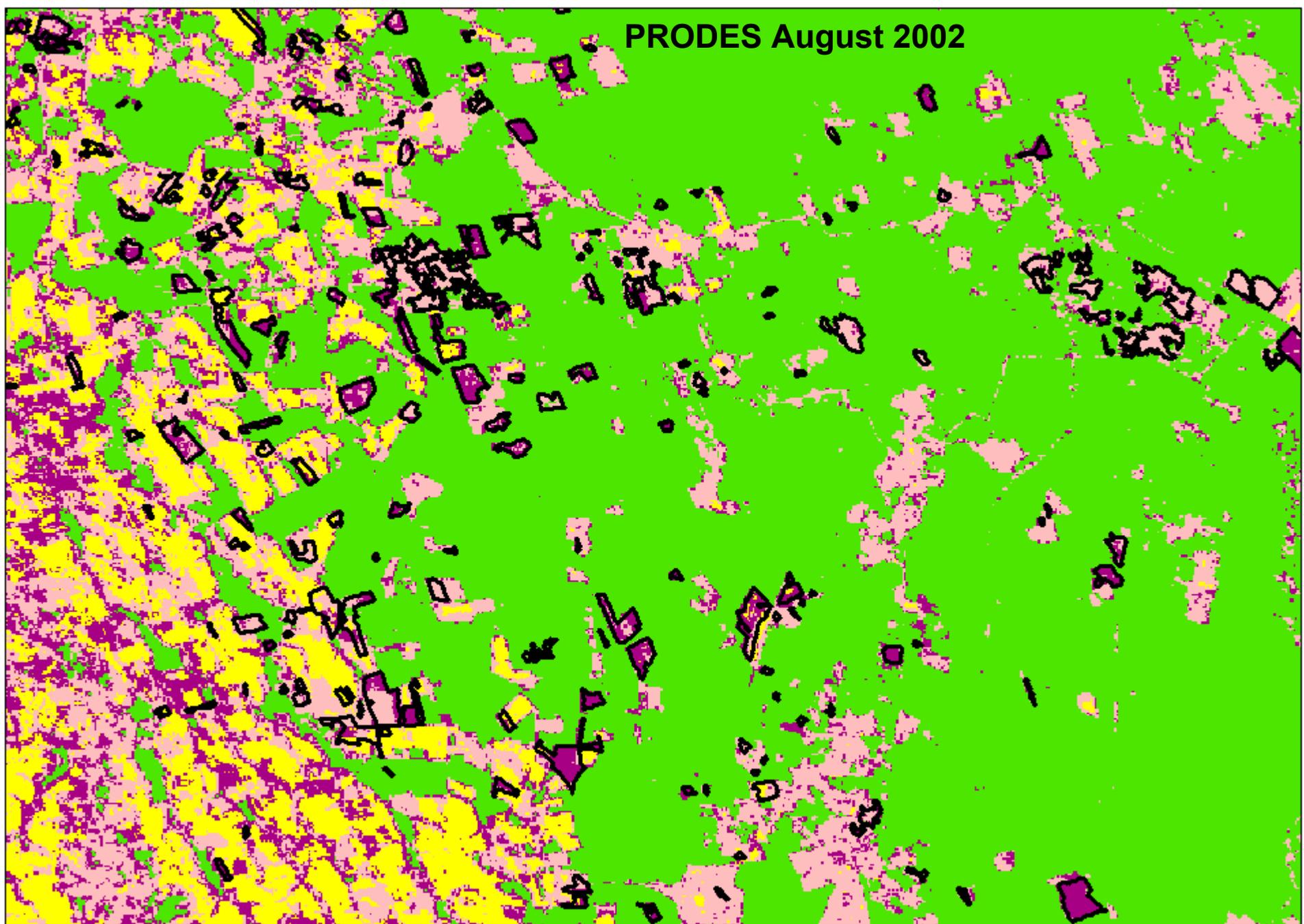


Pasture Agriculture Forest Deforestation/Edge

2000-2001



PRODES August 2002

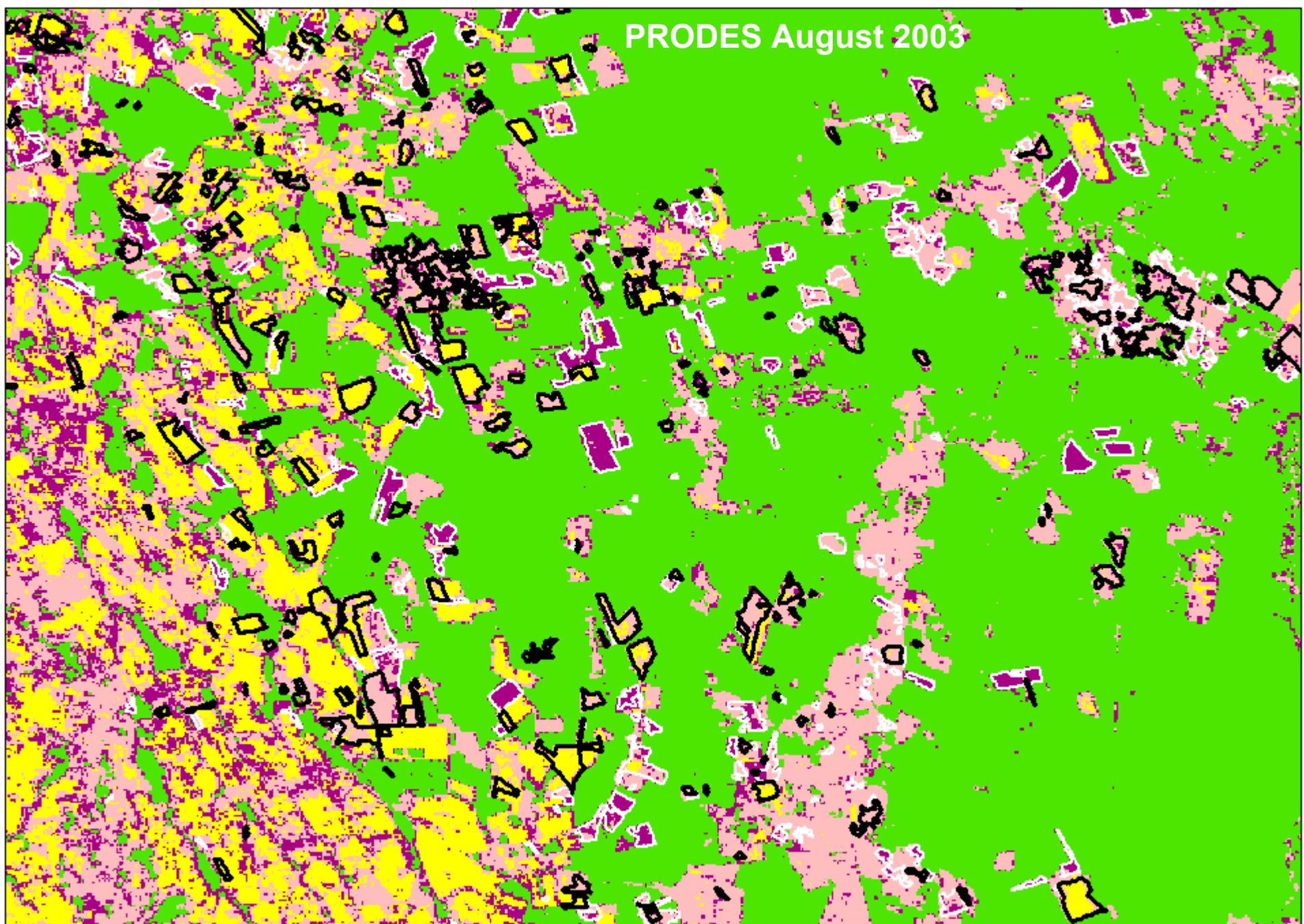


Pasture Agriculture Forest Deforestation/Edge

2001-2002

30 km

PRODES August 2003

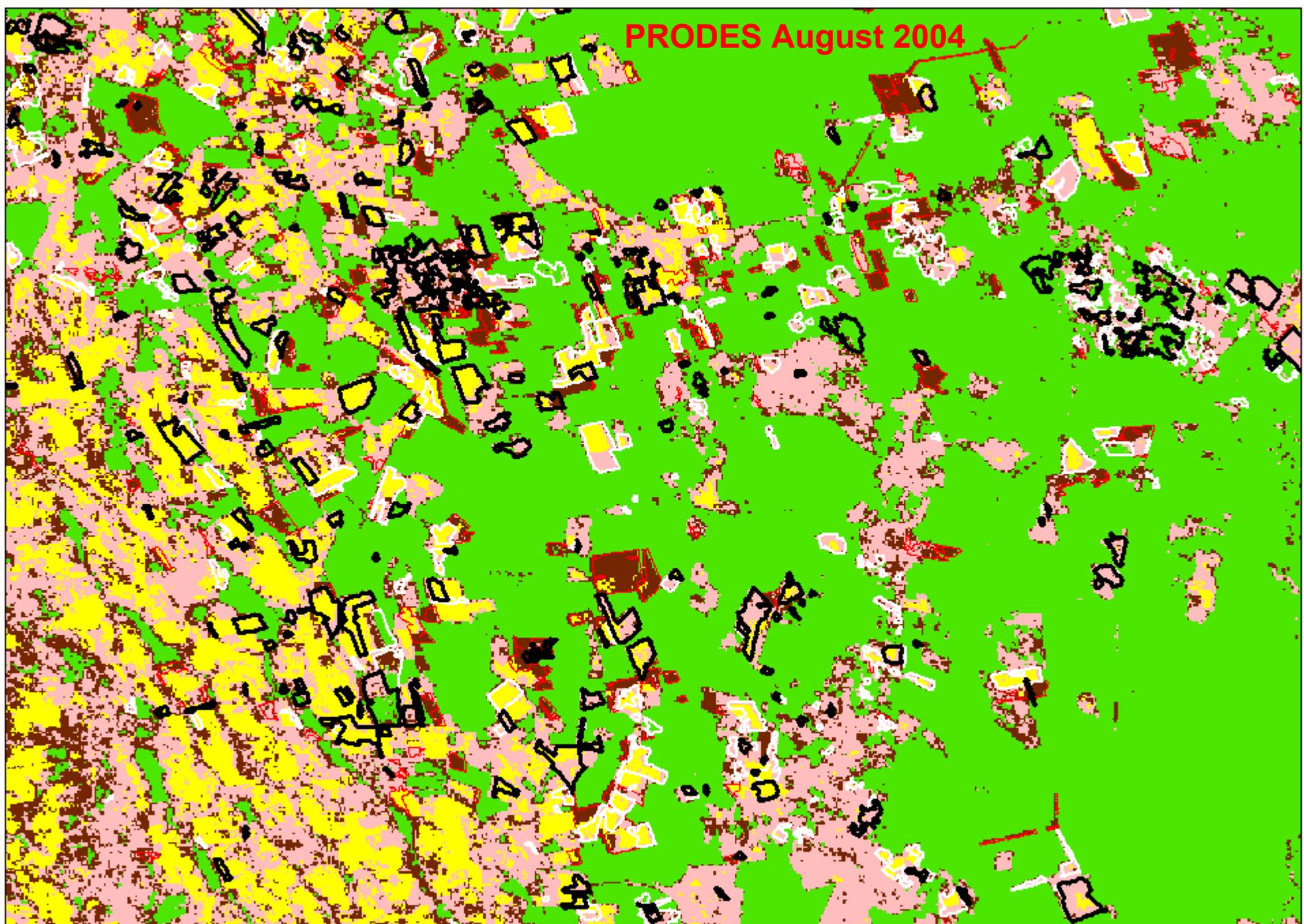


Pasture Agriculture Forest Deforestation/Edge

2002-2003

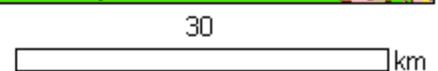
30 km

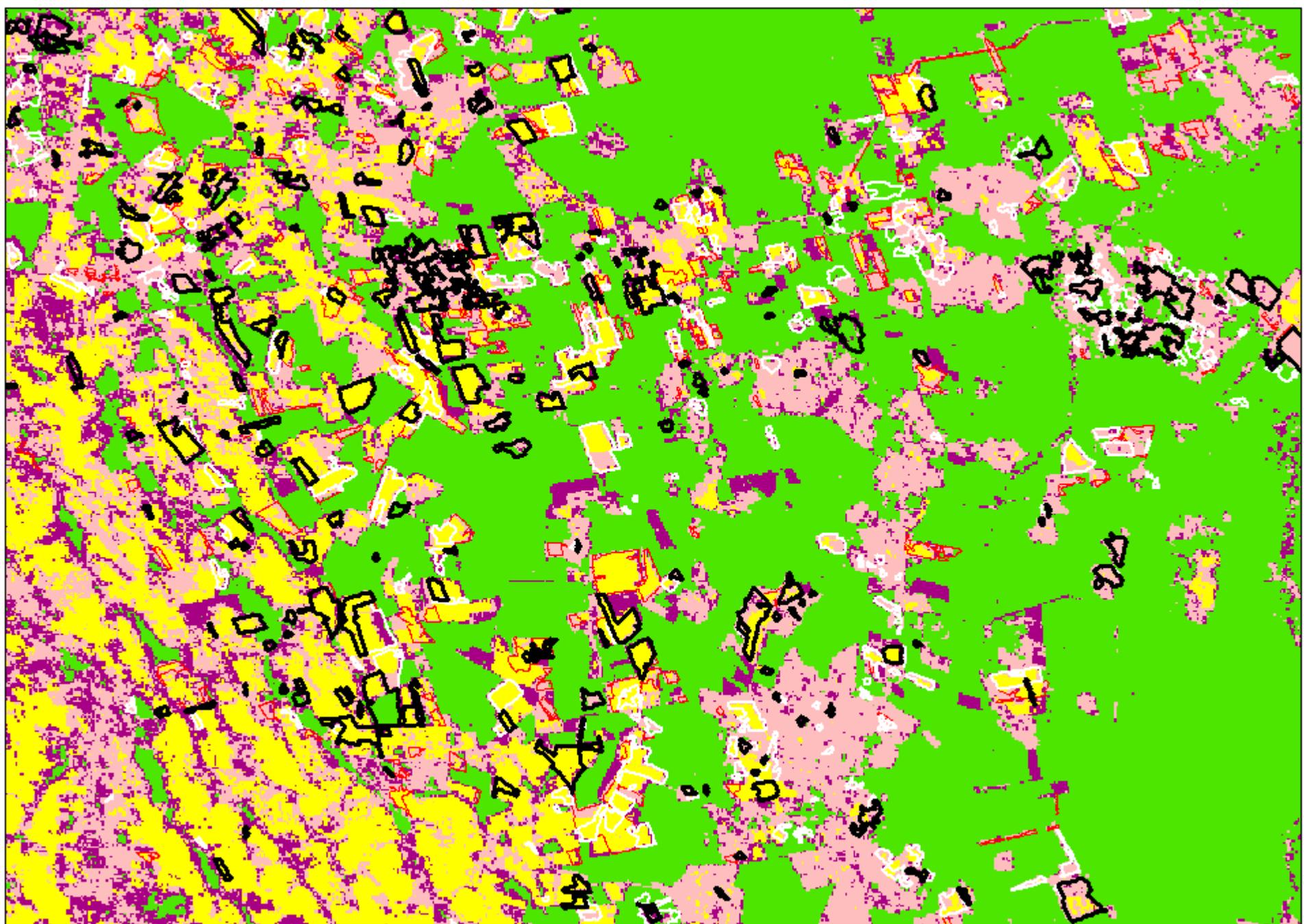
PRODES August 2004



Pasture Agriculture Forest Deforestation/Edge

2003-2004

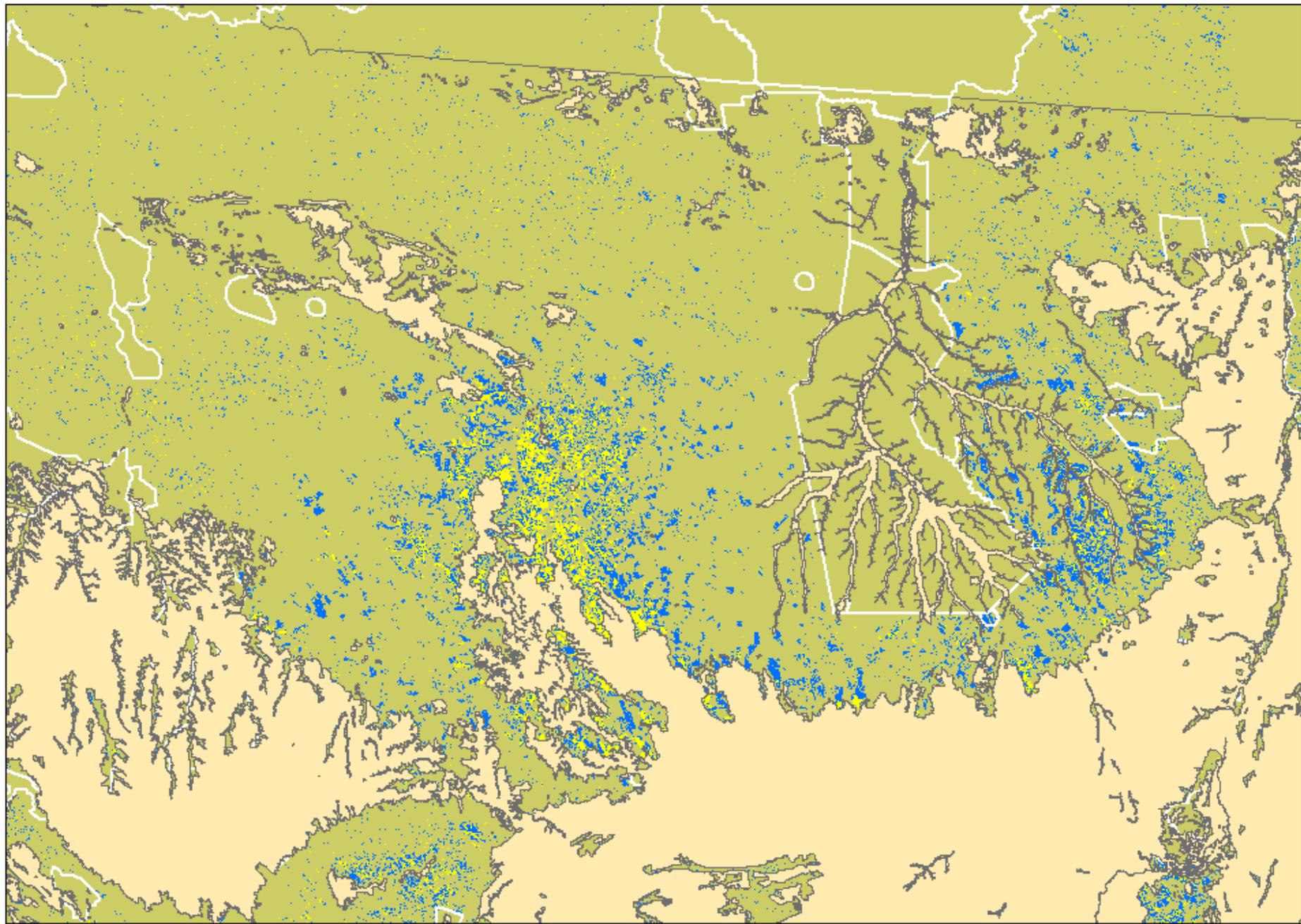




Pasture Agriculture Forest Deforestation/Edge

2004-2005

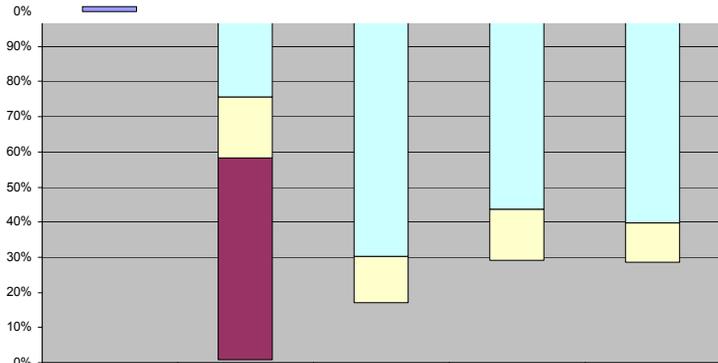
30 km



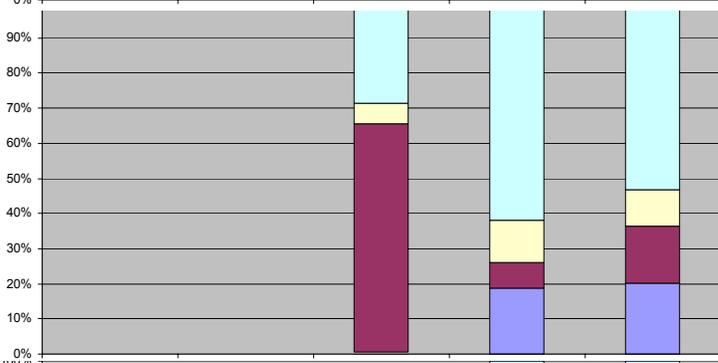
PRODES non-forest Agriculture in Forest 2000-2001 New Agriculture 2001-2005 Indigenous Reserve Boundaries

200 km

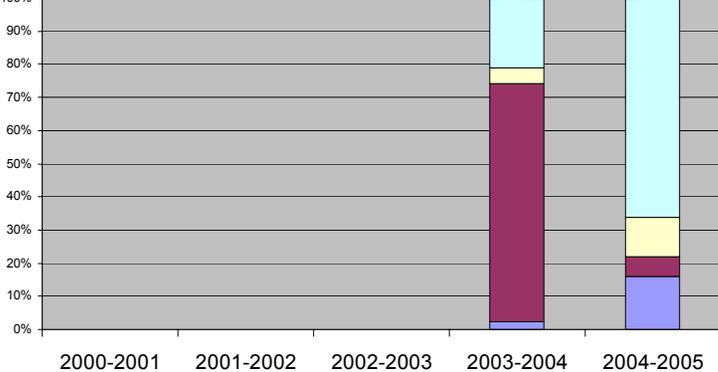
Percent PRODES area in MT by class for large (>25ha) events 2001-2004



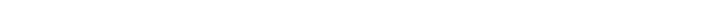
PRODES 2001 >25ha (Total = 5782 km²)



PRODES 2002 >25ha (Total = 8656 km²)



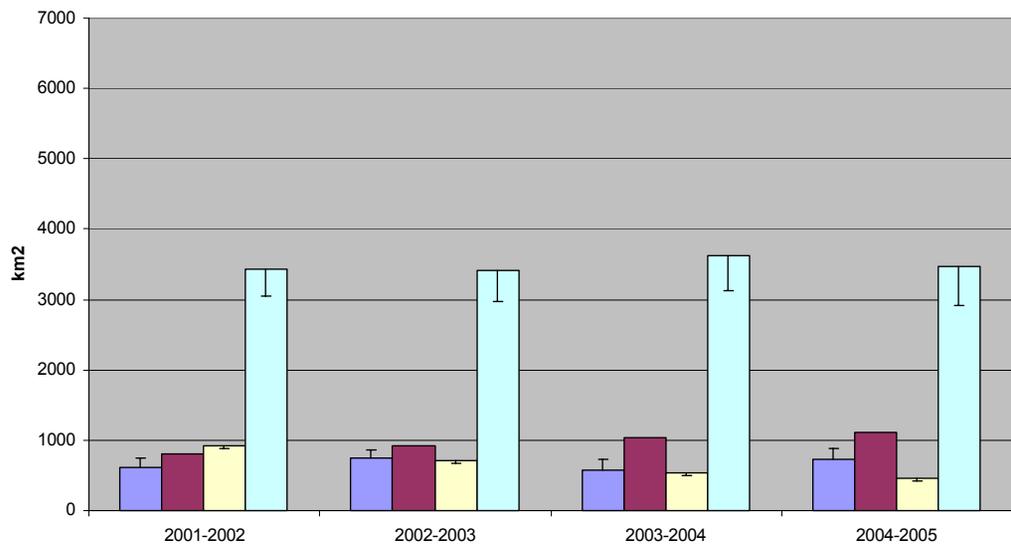
PRODES 2003 >25ha (Total = 9144 km²)



PRODES 2004 >25ha (Total = 8671 km²)

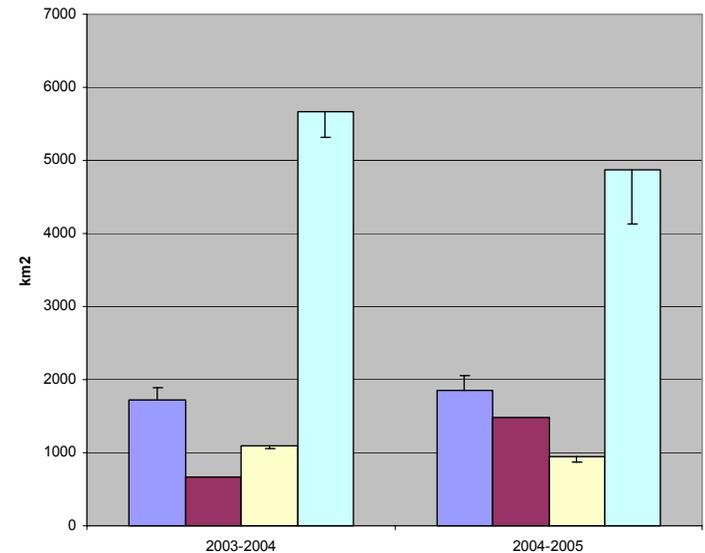
- Pasture
- Forest
- Deforestation
- Agriculture

PRODES 2001, area by class following deforestation



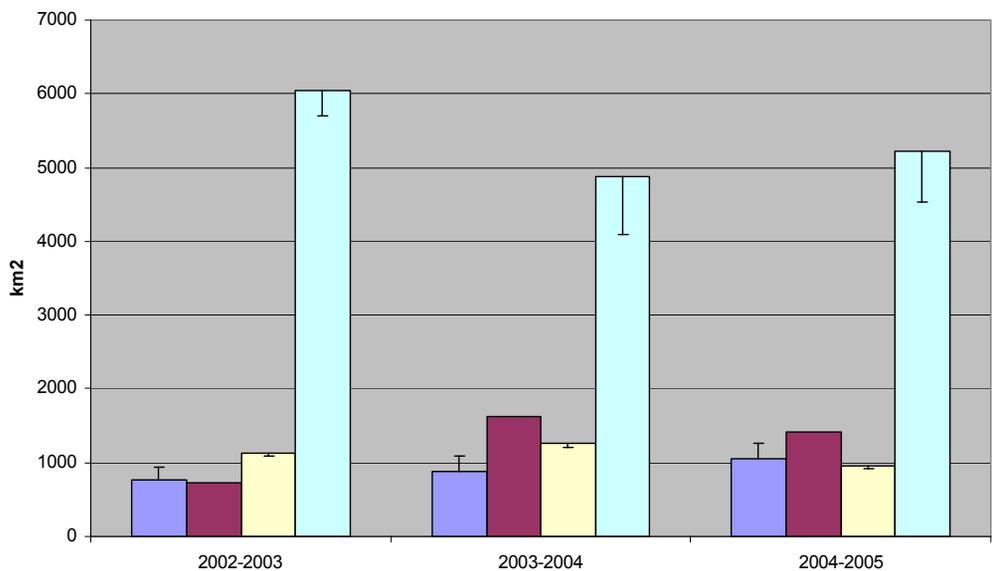
■ Agriculture ■ Deforestation

PRODES 2003, area by class

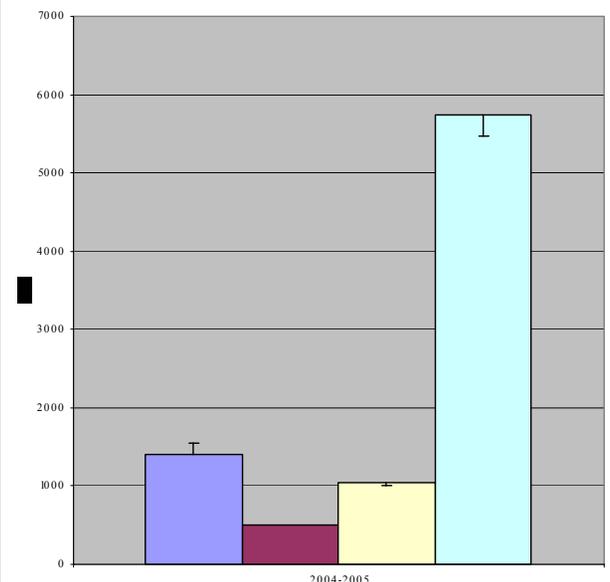


■ Forest ■ Pasture

PRODES 2002, area by class



PRODES 2004, area by class



Trajectory Corrections

- Time series provides valuable information about both land use practices and misclassification.

Examples:

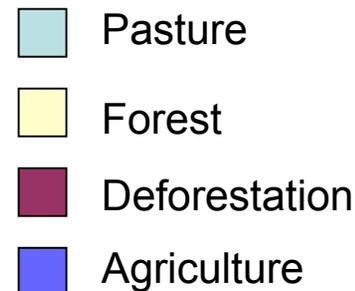
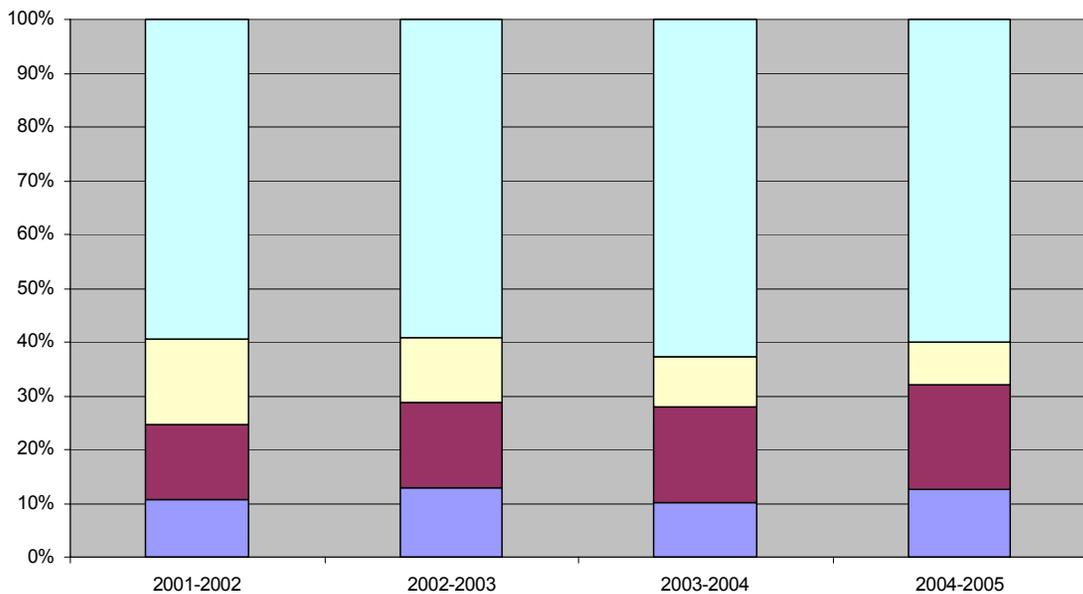
– A-A-P-A = A-A-A-A

– P-D-P-P = P-P-P-P

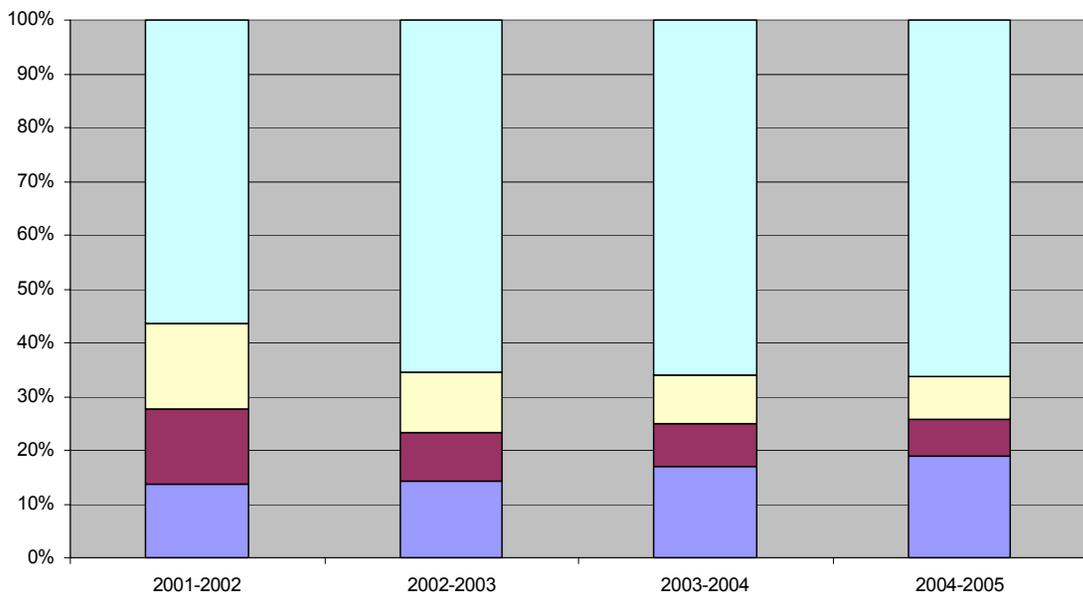
– P-A-A-A = A-A-A-A

- Fallow cycles, single crop rotation, pasture burning, variable view angle from MODIS (forest edge problems).
- These patterns can be interpreted to present information about land use and clarify the pasture/agriculture component of new clearing.

Majority classification of PRODES 2001, Unadjusted



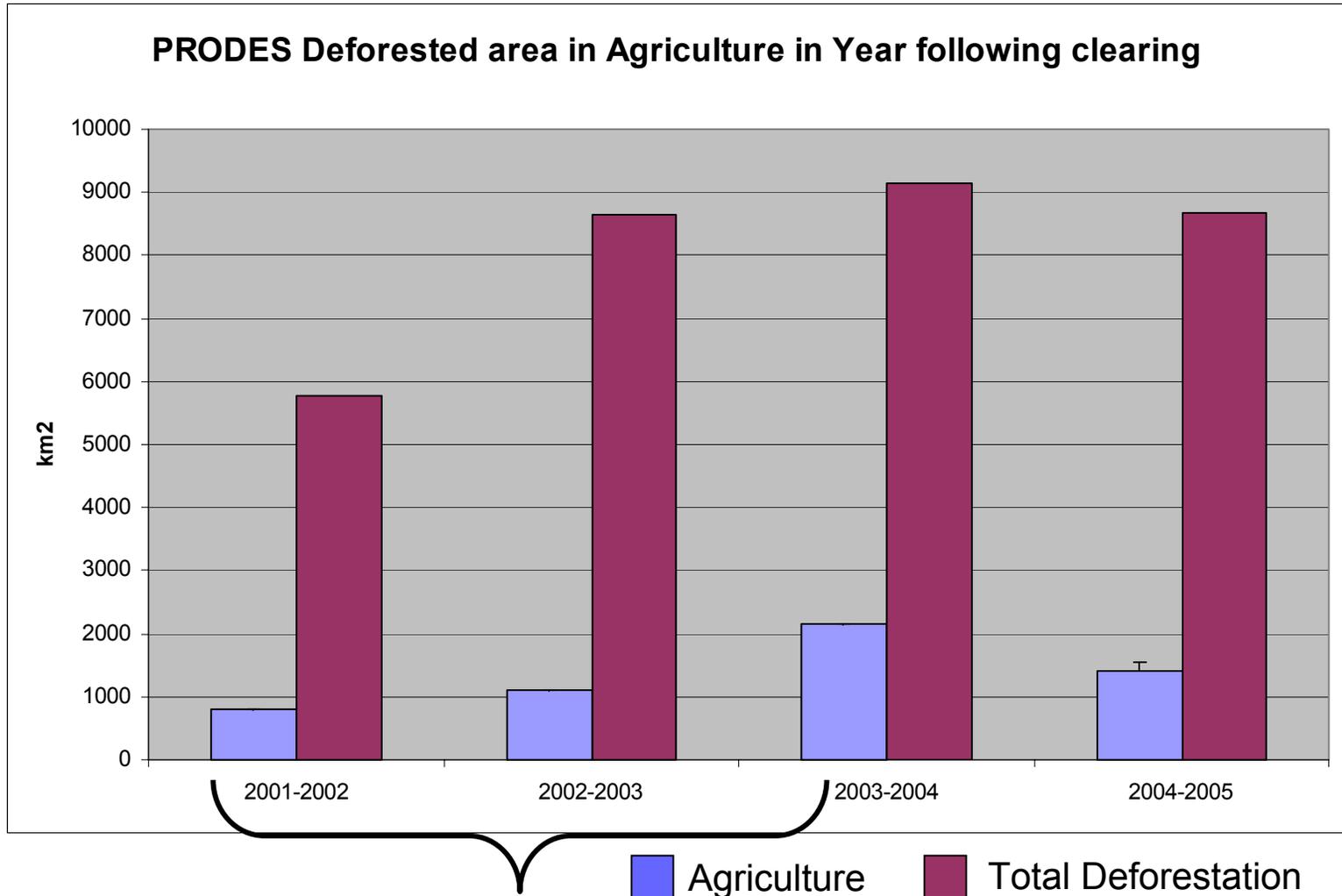
Trajectory classification of PRODES 2001



Trajectory-adjusted results show more consistent trends over time.

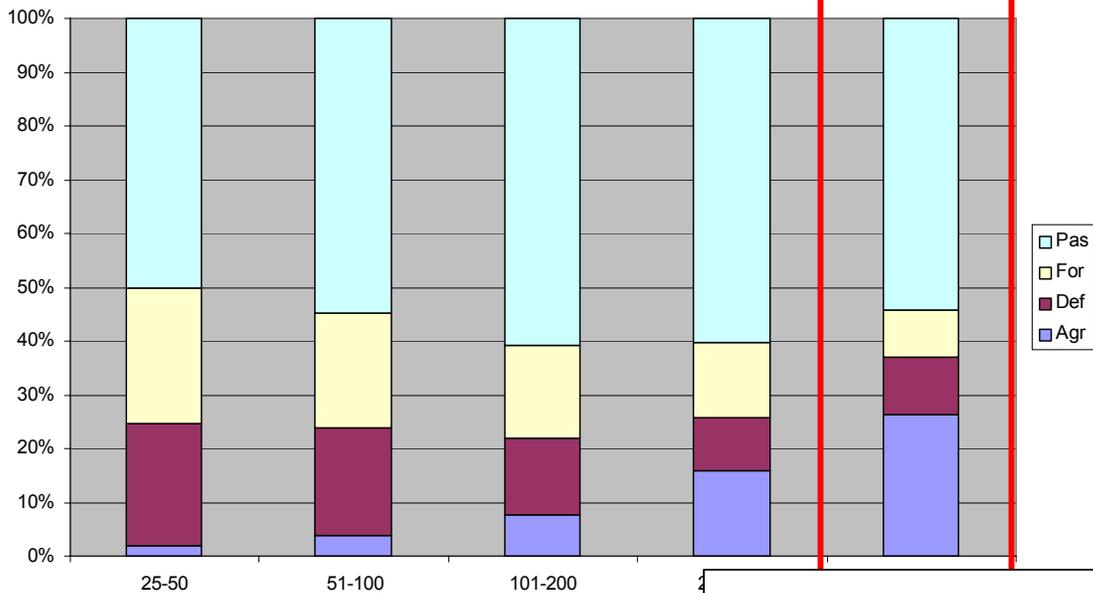
Fewer PRODES polygons remain in the deforestation/edge class, and forest edge/regrowth stabilizes around 7%.

Trajectory results



Forest conversion to agriculture between 2000 and 2004 constitutes **25%** of new agriculture in Mato Grosso during this period (Morton *et al.*, in press).

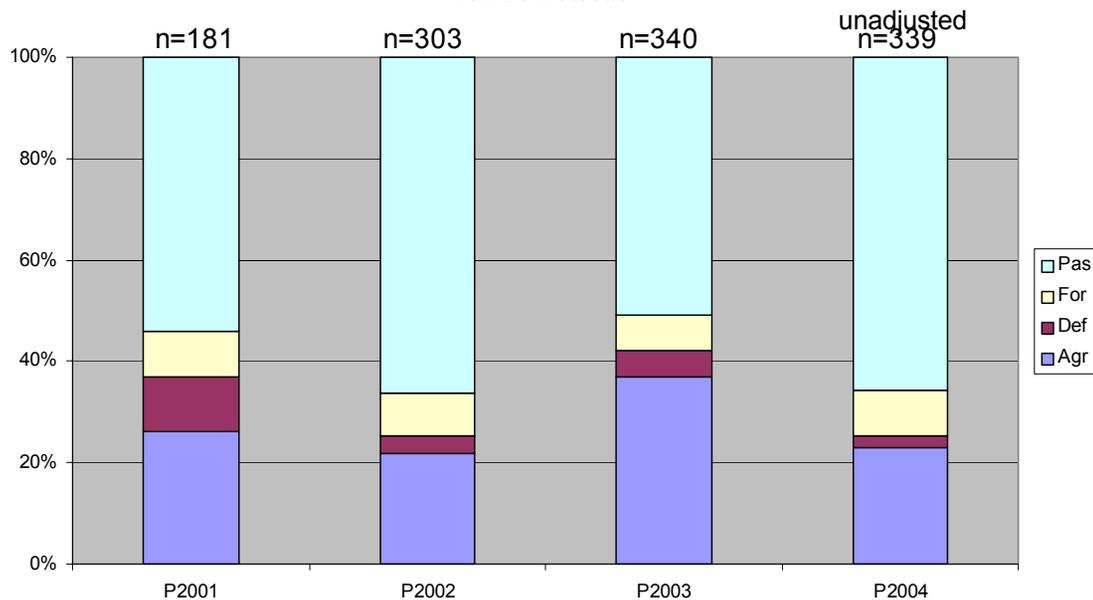
PRODES 2001 in 2001-2002 by Size Class



Direct conversion for agriculture is more common for the largest deforestation areas.

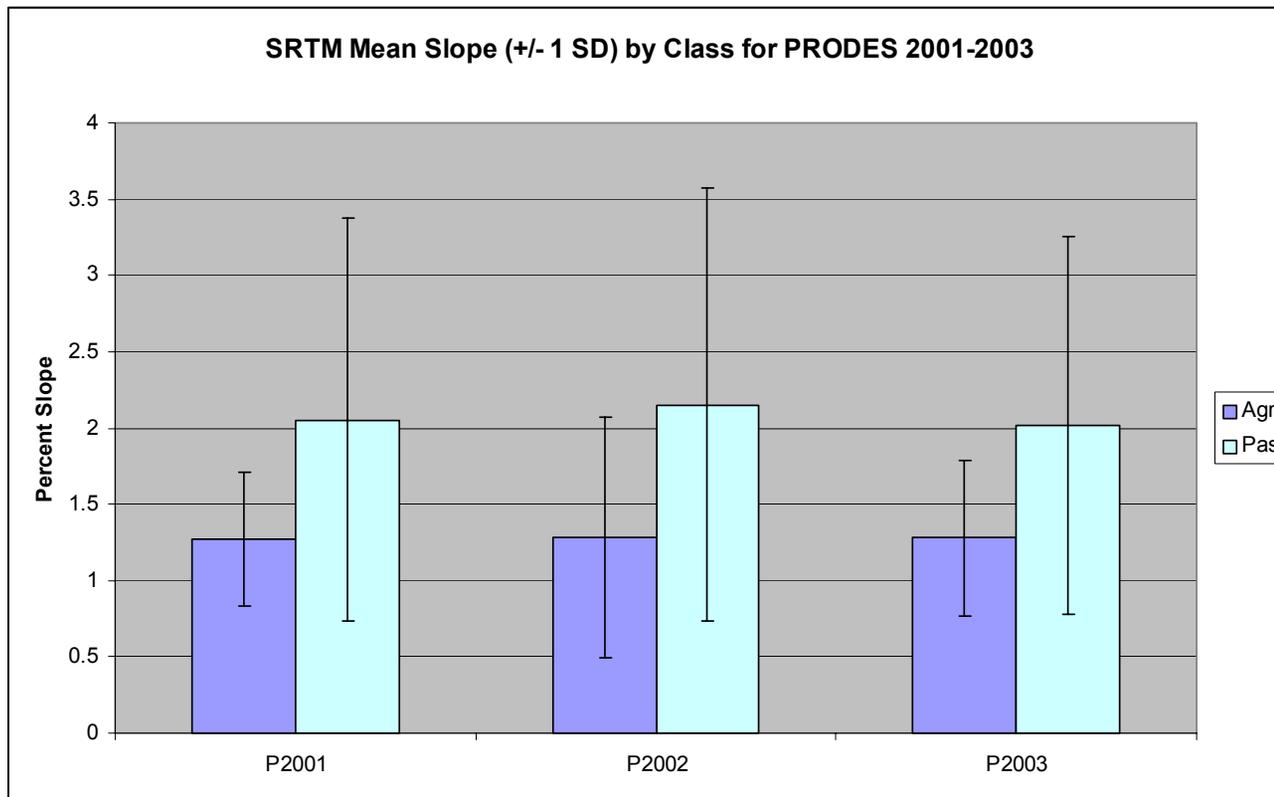
The percentage of the largest clearings that transition directly to agriculture increased for PRODES 2003. Unadjusted results for 2004 show the same number of large clearings, but a lower percentage in agriculture in 2004-2005.

Percent of Largest Deforestation Areas (>500ha) by Class in Year Following PRODES Detection



Slope as a predictor of Deforestation outcome

- Slope a defining characteristic of site suitability for mechanized agriculture (Jasinski et al., 2005 *Earth Interactions*)
- New agricultural areas follow similar trend.

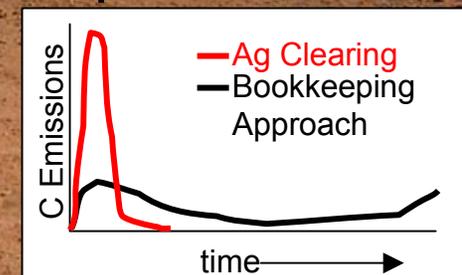


Conclusions

- Direct conversion of forest to agriculture is a large and growing percentage of deforestation in Mato Grosso between 2001-2005.

Carbon impacts:

Bookkeeping approach: ~20% of AGB lost to burning.
Field data suggest 100% combustion completeness is possible for conversion to agriculture.
No regrowth on this timeframe.



LC-39: Estimating the carbon loss from various types of land use fires in Amazonia.