



# Big Science and the Development of a New Generation of Environmental Science Professionals in the Brazilian Amazon

Michael Keller

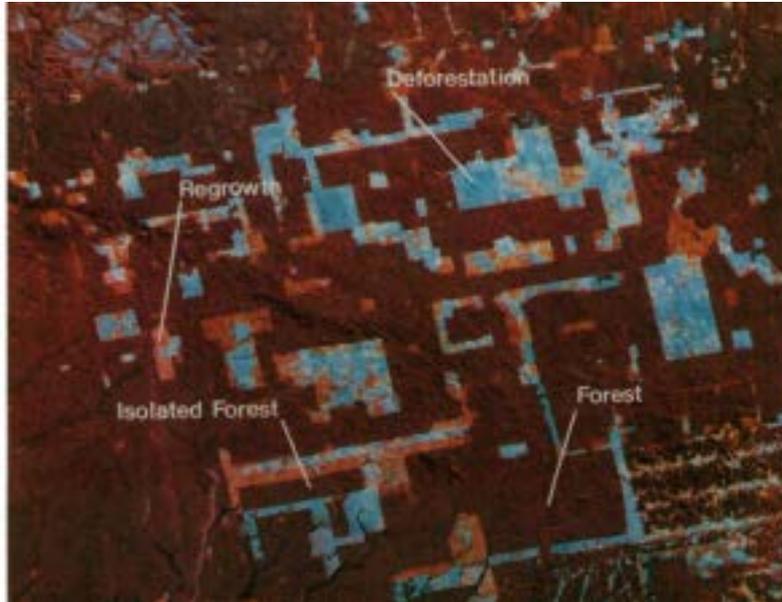
International Institute of Tropical Forestry

EMBRAPA Satellite Monitoring

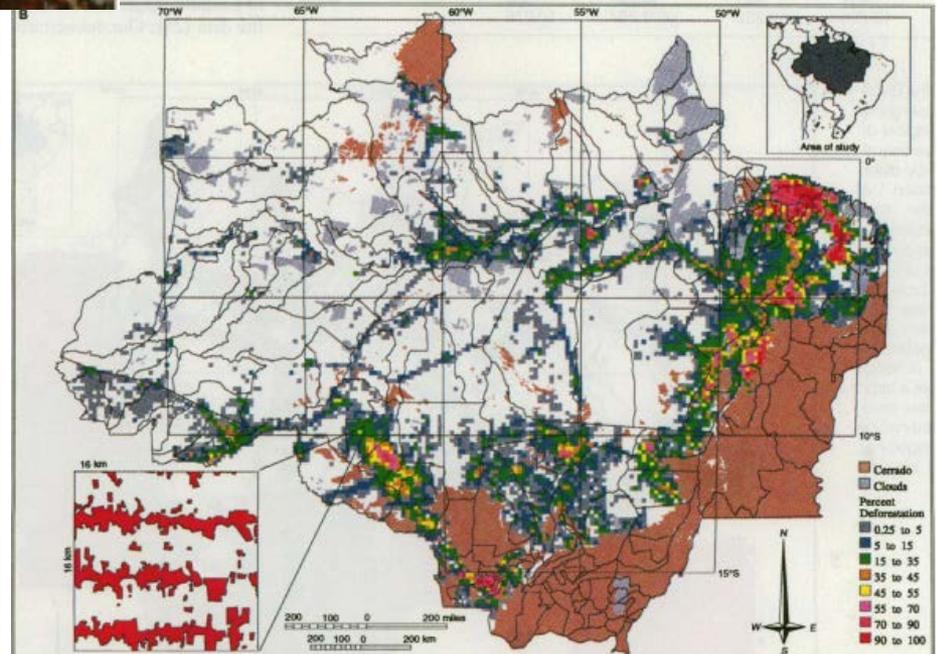
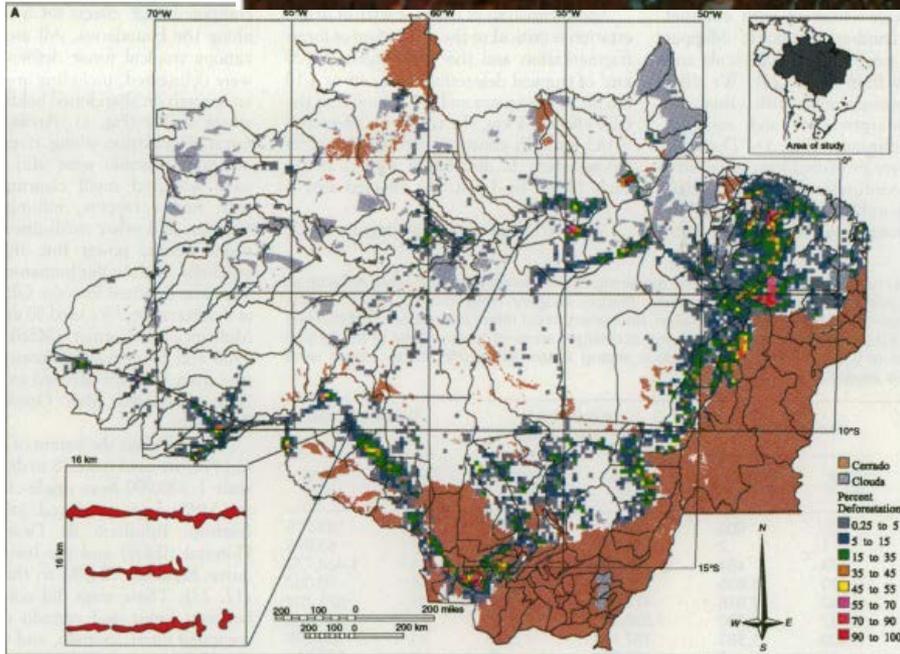
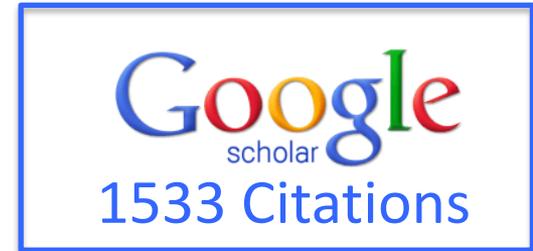
# What's this all about?

- Context: The Amazon deforestation crisis
- A brief history of IITF in the Brazilian Amazon
- A coordinated international scientific response to the deforestation crisis: Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA)
- IITF meets LBA in the Tapajos National Forest
- Examples of LBA research: Studies of selective logging in the Brazilian Amazon
- Capacity Building in LBA
- Concluding remarks

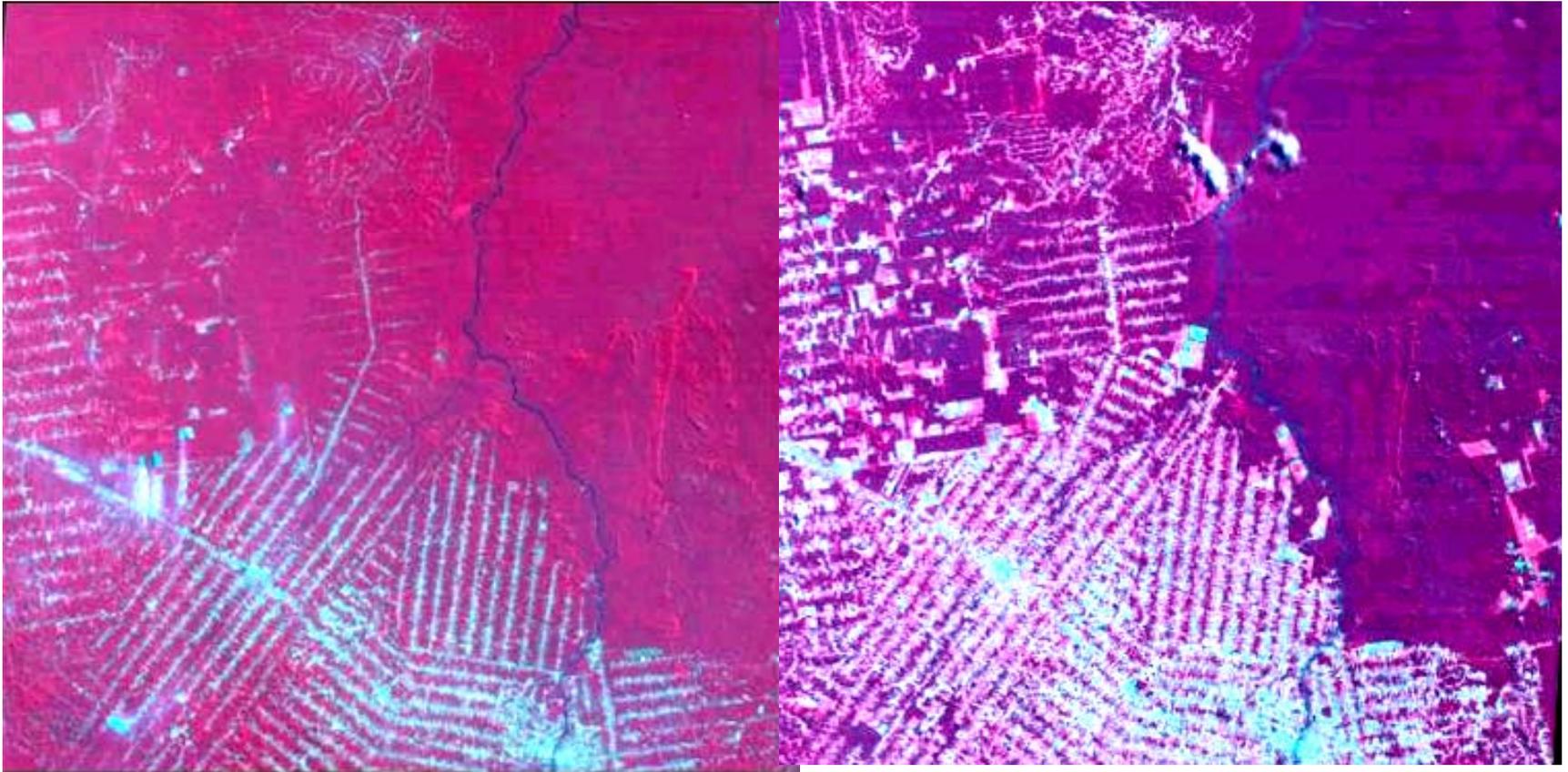
# Brazilian Amazon deforestation viewed from space



Skole & Tucker, *Science* 1993

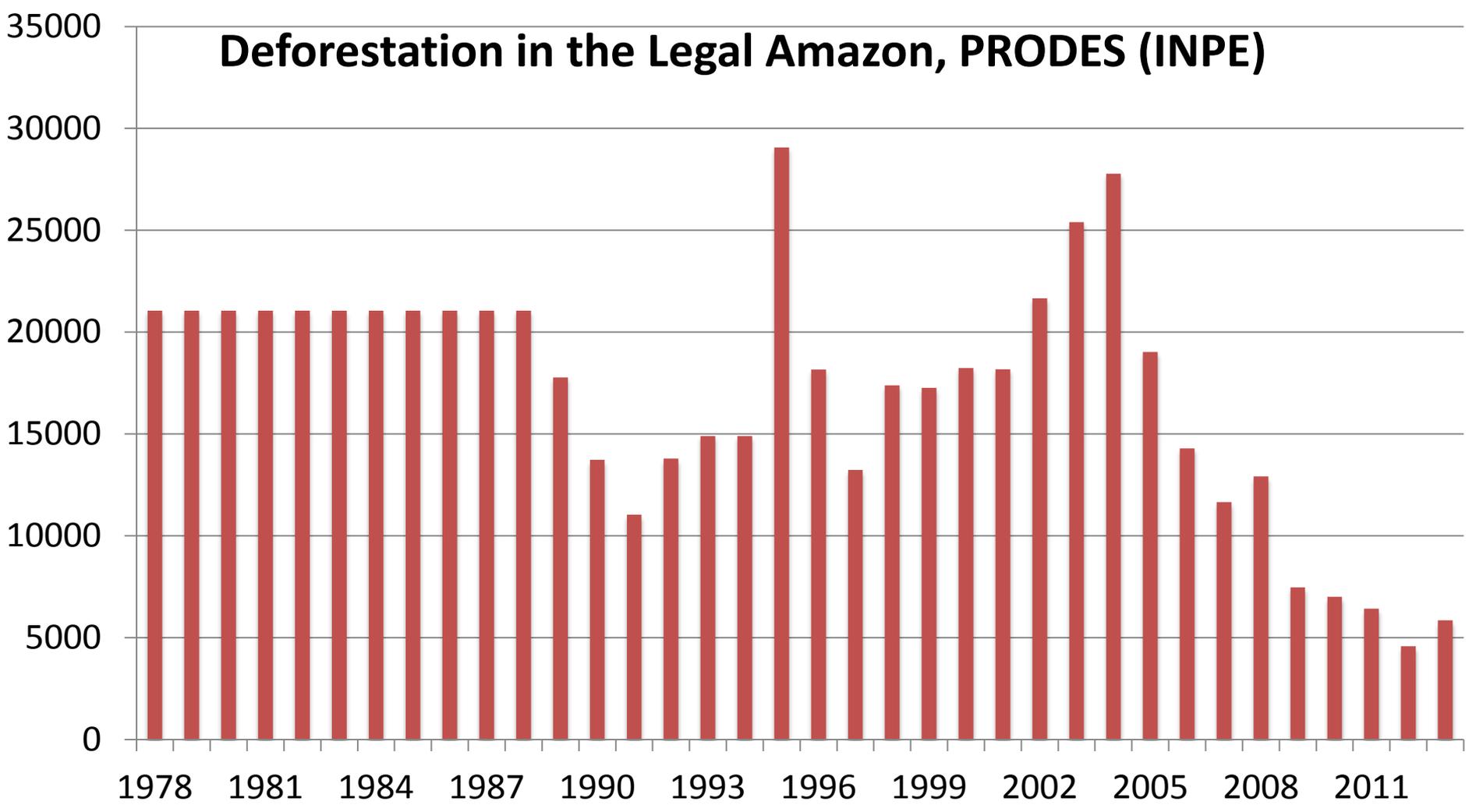


# Amazon deforestation continues 1986-1997



**Central Rondonia, Brazil: Forest clearing 1986-1997  
(Landsat imagery, forest=red) Courtesy TRFIC-MSU**

# Deforestation in the Legal Amazon, PRODES (INPE)



[http://www.obt.inpe.br/prodes/sisprodes2000\\_2013.htm](http://www.obt.inpe.br/prodes/sisprodes2000_2013.htm)

# IITF goes to the Amazon

- The Institute of Tropical Forestry (ITF) was international long before the word “international” was added to the title.
  - From 1943 to 1978 ITF scientists made 118 trips to Latin America including Brazil
  - Conducted 19 tropical forestry courses with 4 to 29 students each from across the region.

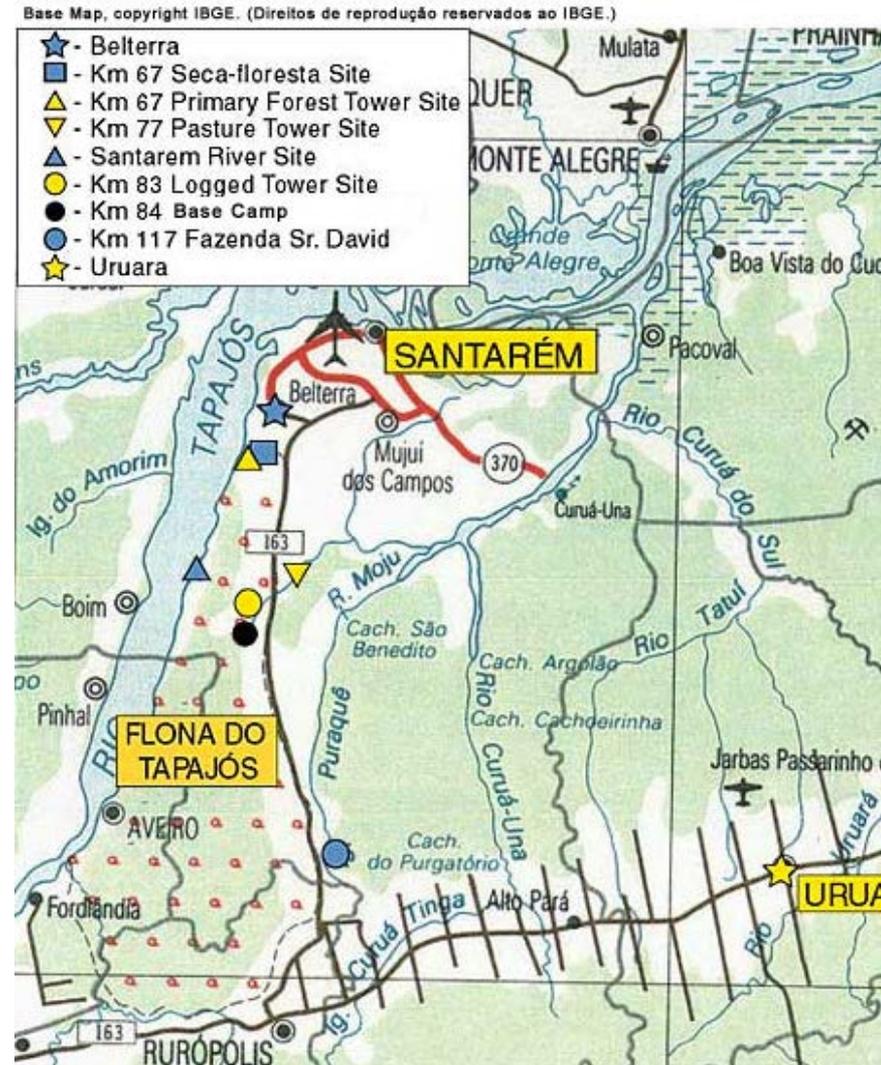
# IITF goes to the Amazon

*Dr. Ariel Lugo, IITF Director  
“took a trip to Brazil without  
a single appointment and  
simply visited Manaus and  
Belem knocking on doors.”*



Dr. Natalino Silva

## Tapajos National Forest



# IITF goes to the Amazon

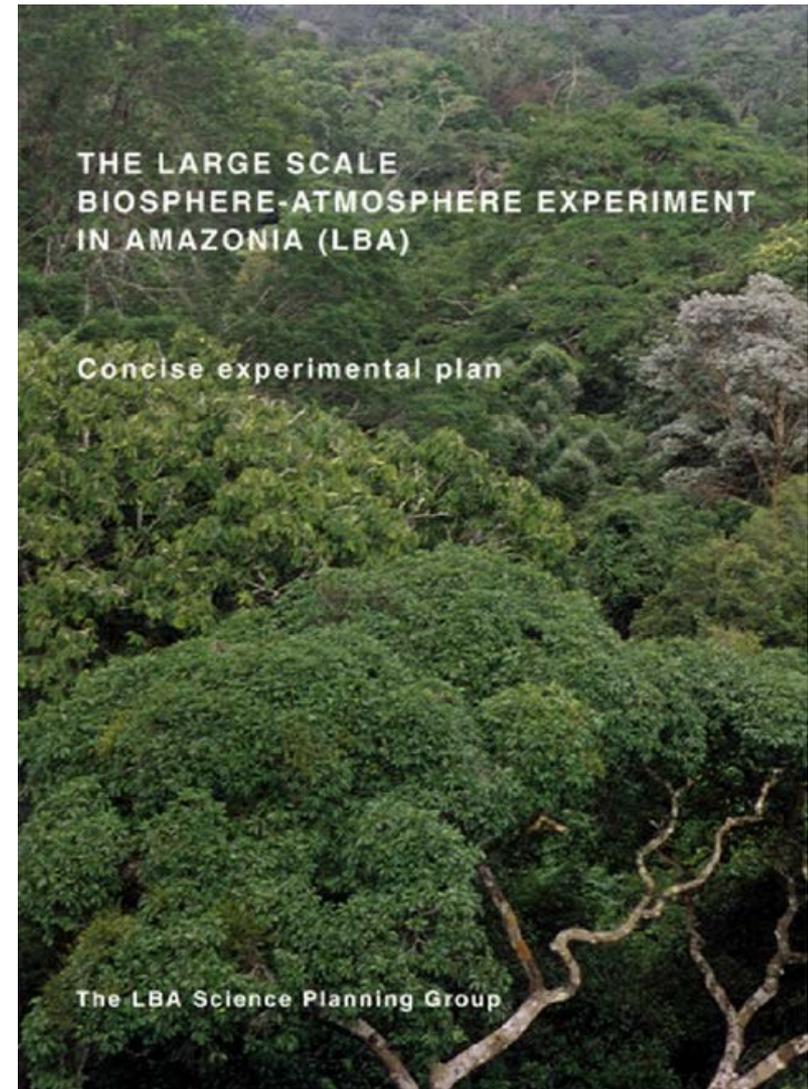


Photo J. Parrota

Dr. John Francis during the making of the *Trees of Tapajos*.

# Birth of the Large Scale Biosphere-Atmosphere Experiment in Amazonia

- An international scientific community organized in response to the Amazon deforestation crisis.
- LBA planning had many different roots all starting in the early 1990's.
- With Brazilian leadership, especially by Dr. Carlos Nobre, a concise experimental plan for LBA was published in 1996.
- NASA launched a first call for proposals to work on LBA in 1997.



# LBA: An Earth system science project

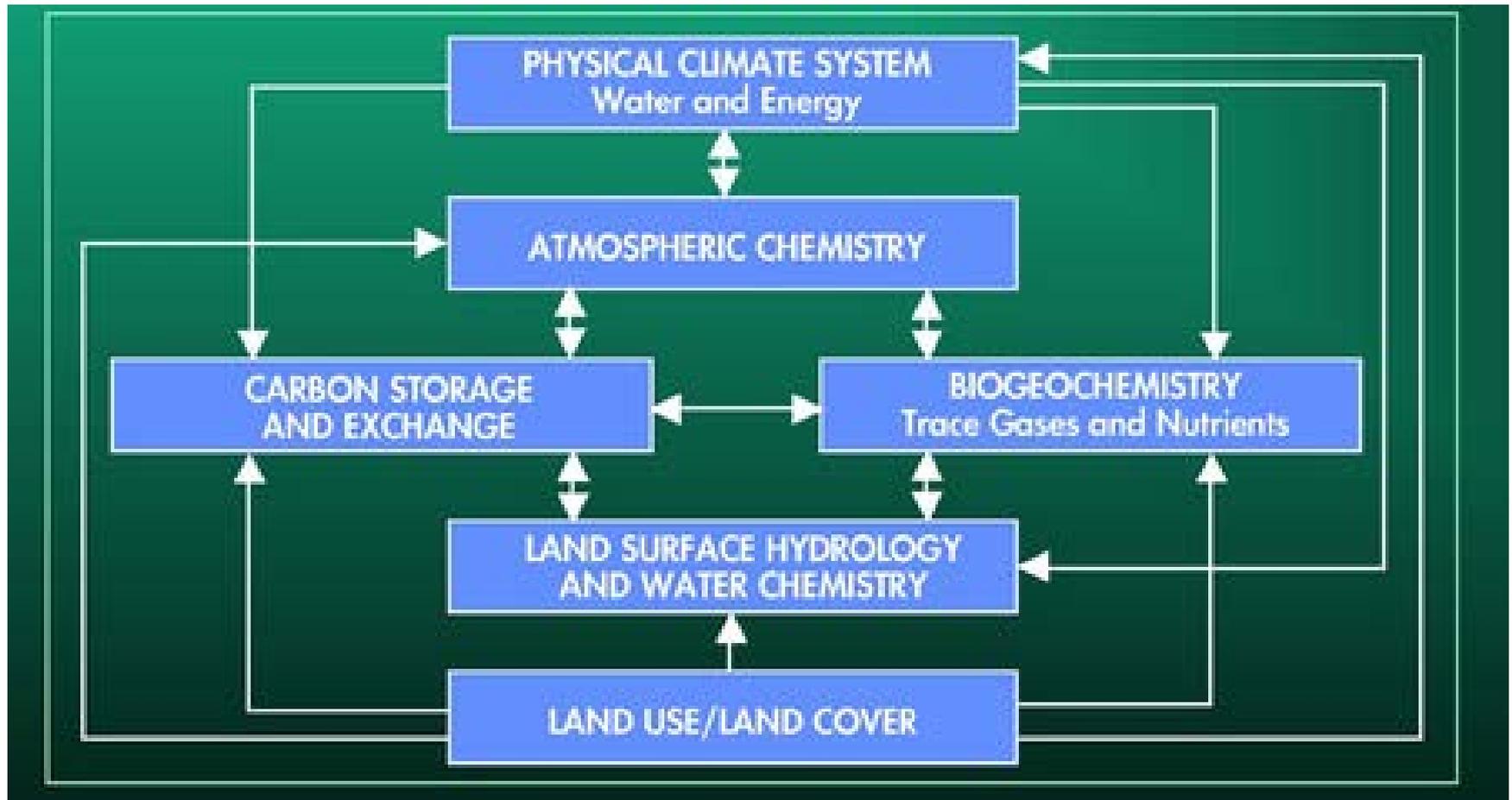
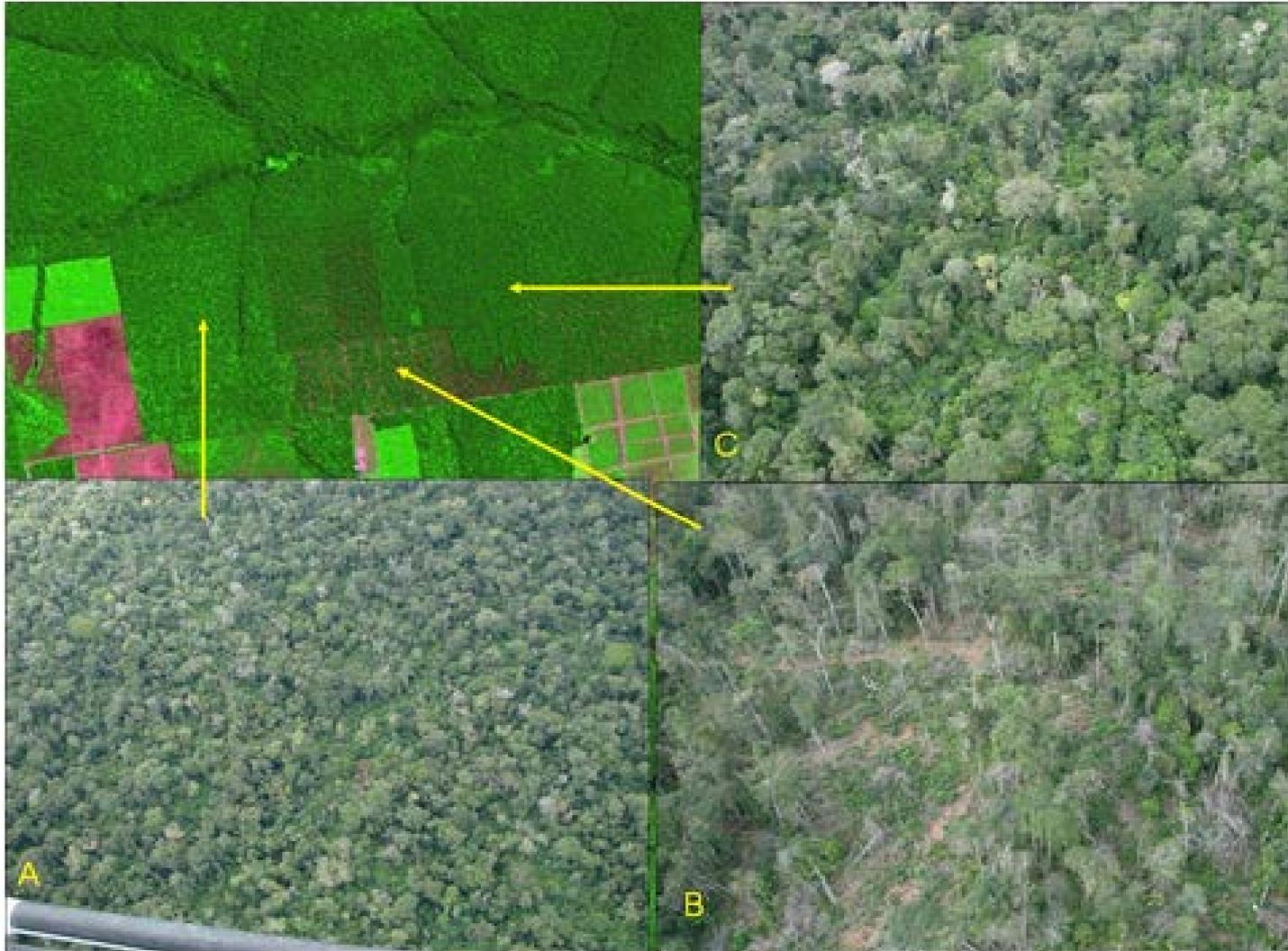


Figure from the *LBA Concise Plan* (1996)

# Selective logging in the Brazilian Amazon



# Selective logging done badly

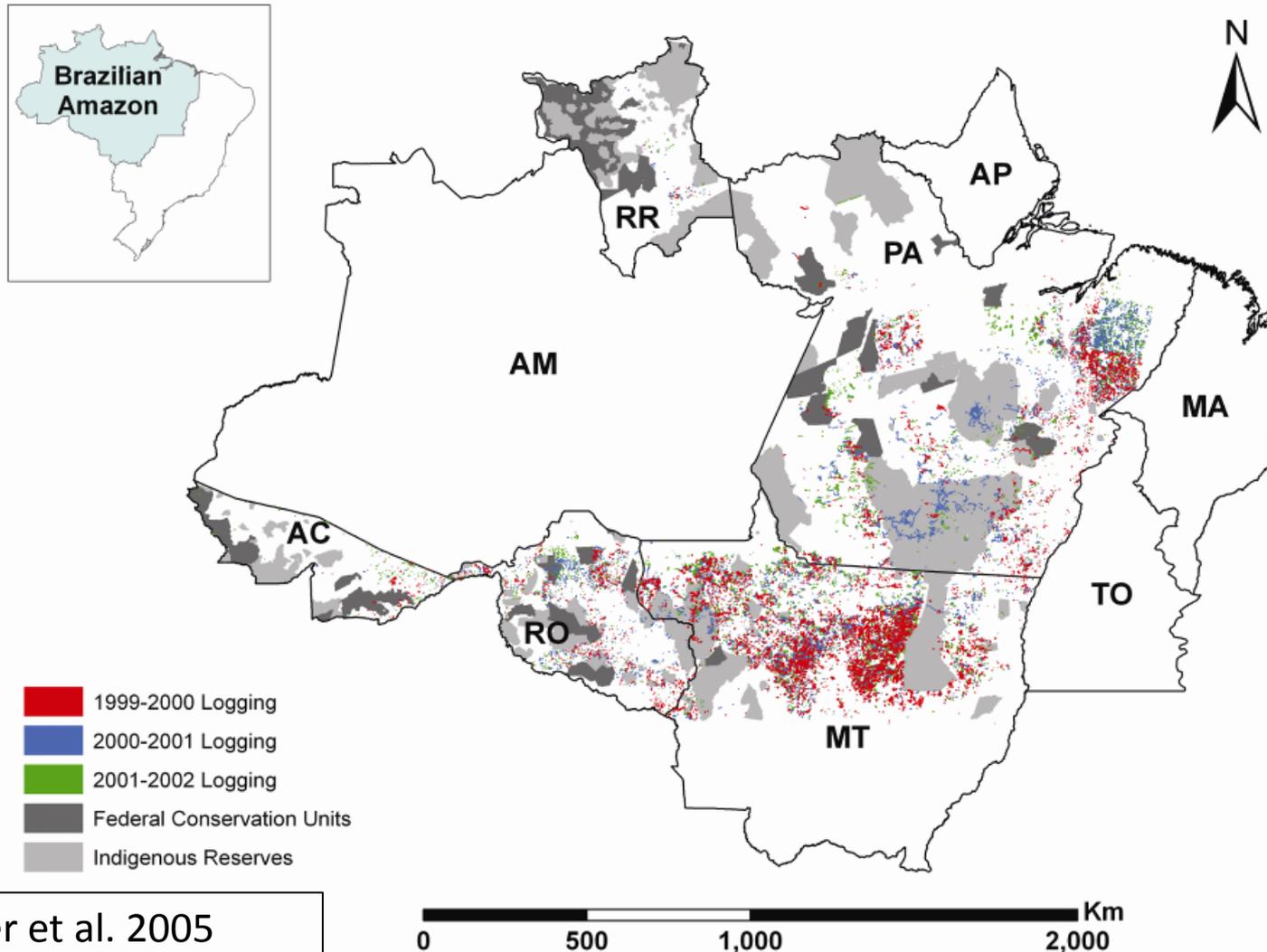


Source: INPE DEGRAD

# Selective logging done well



# Extent of logging 1999-2002 estimated using Landsat remote sensing

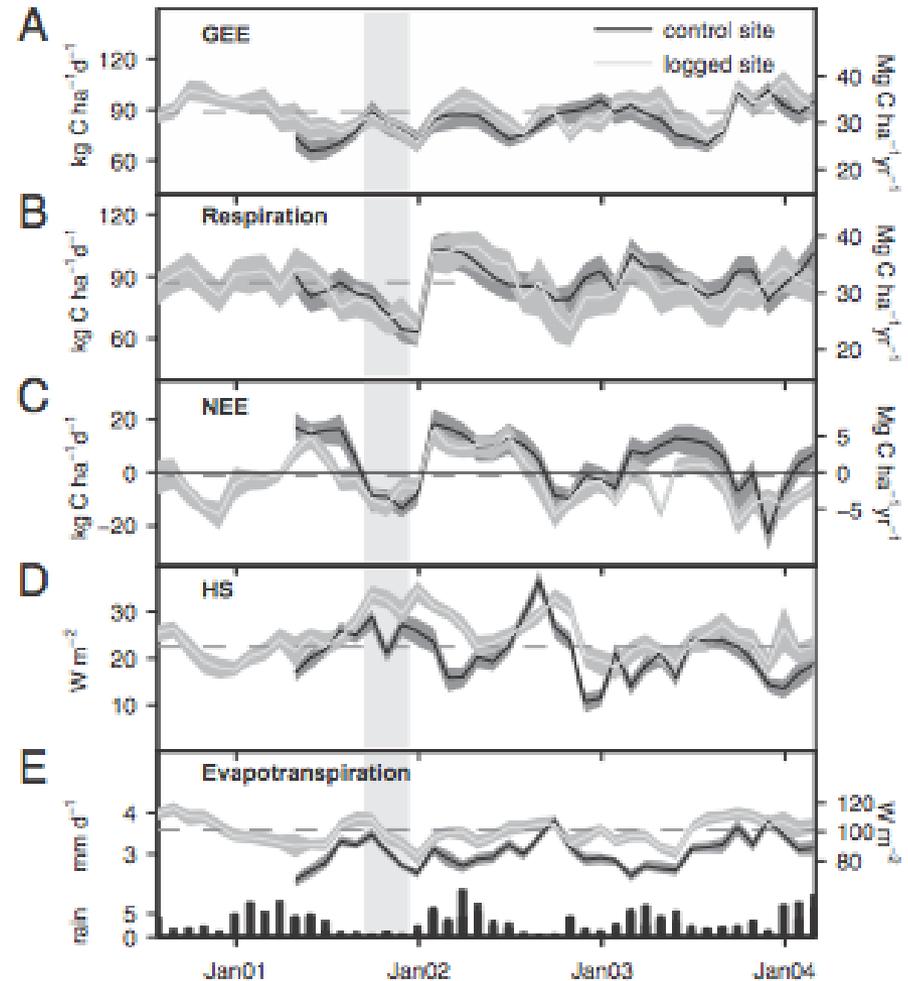


Asner et al. 2005

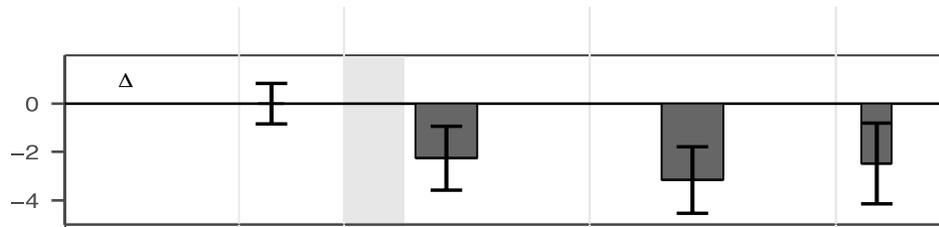
# Reduced impact logging minimally impacted forest carbon and energy exchange (paired tower measurements)



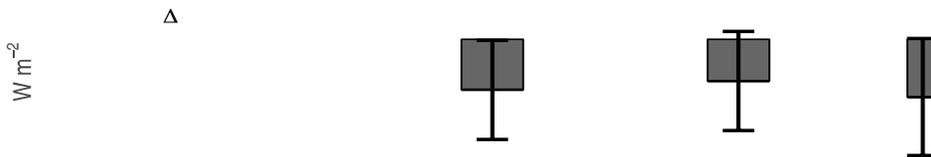
Miller et al. 2012; PNAS



# Reduced impact logging minimally impacts tropical forest carbon and energy exchange



The forest carbon and energy budgets were similar at the logged study site compared to an undisturbed control only 1 year after logging.

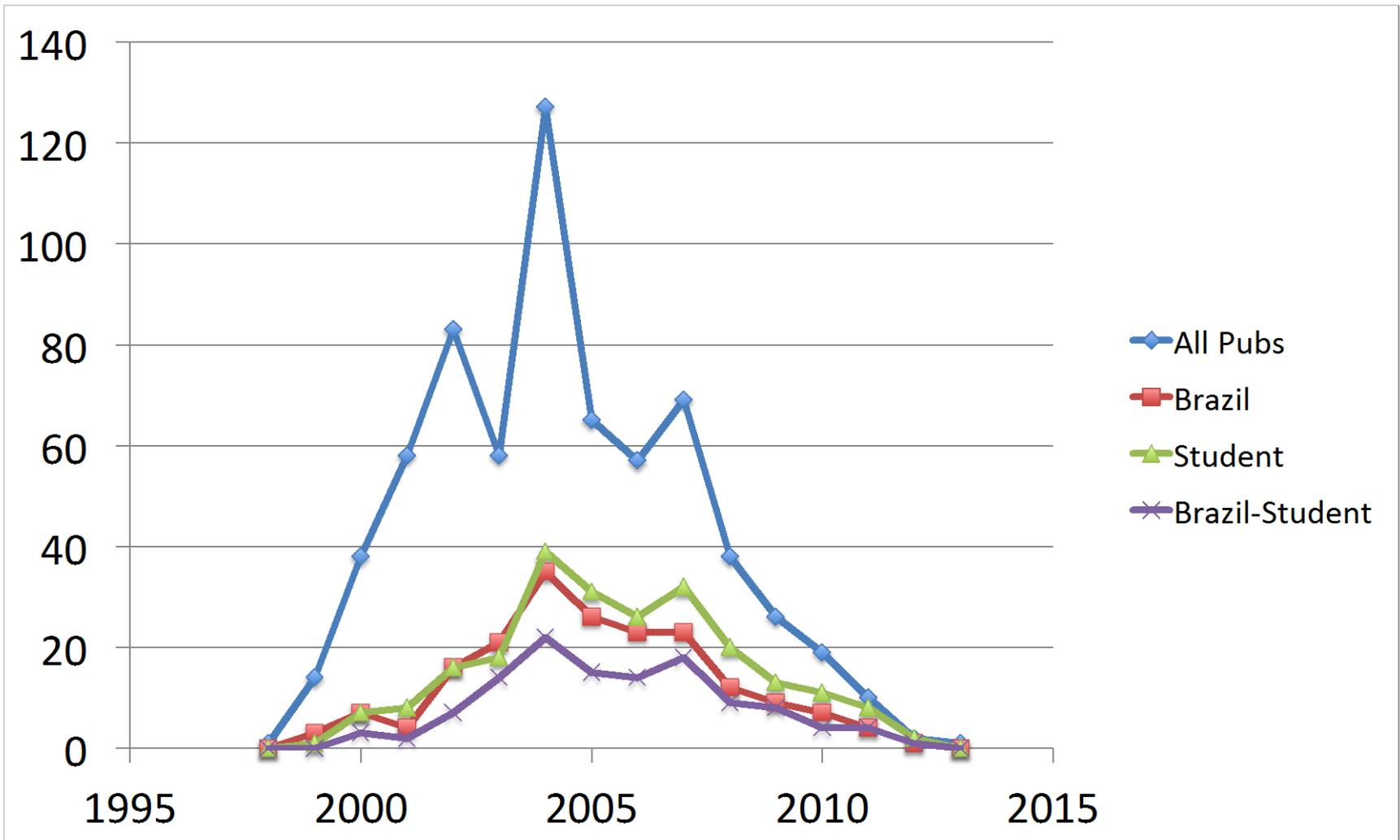


Miller et al. 2012; PNAS

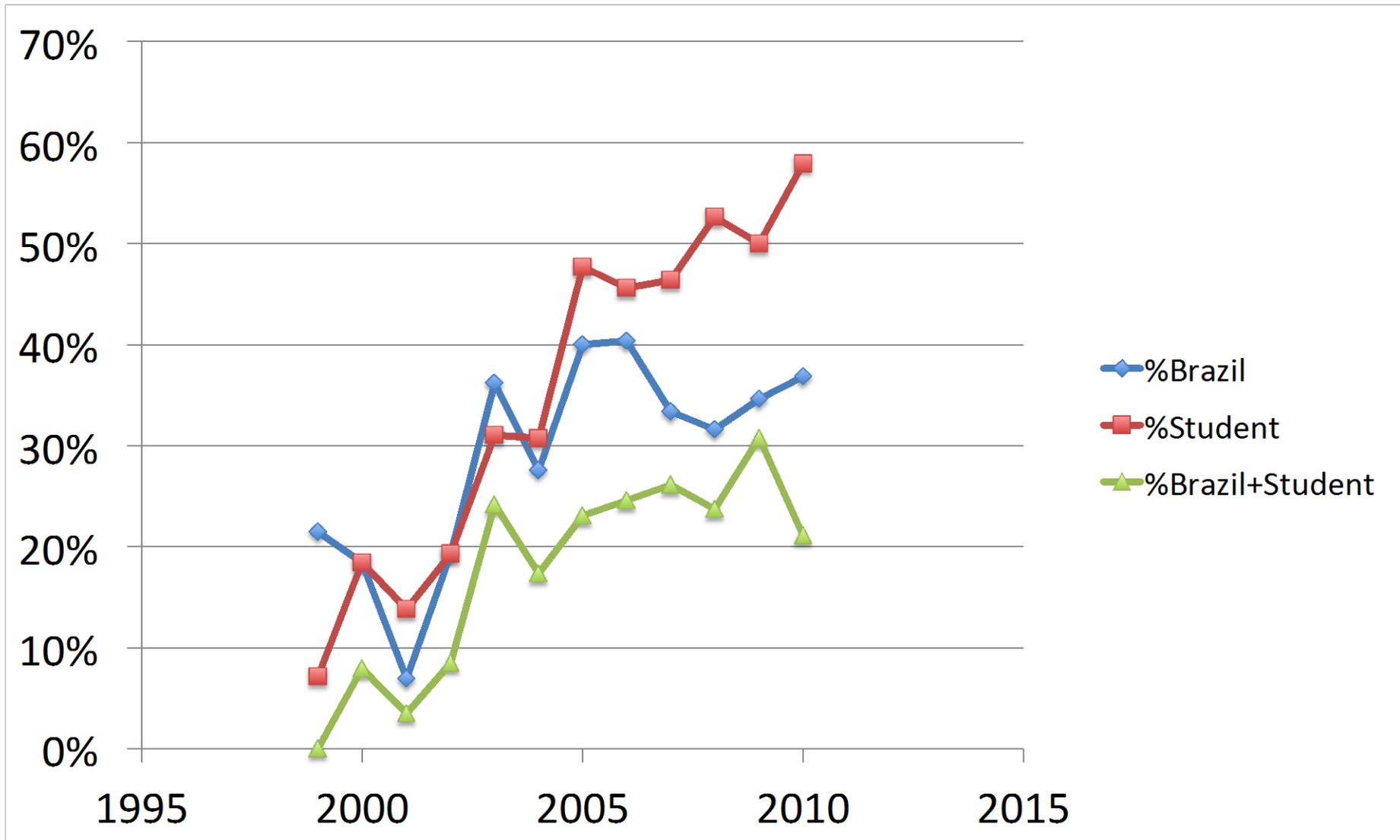
# LBA capacity building

- Education and training was built into LBA nearly at its origin.
- The first education and training committee meeting was held in 1997 just 3 months after the publication of the *Concise Plan* and before the first meeting of the international scientific steering committee.
- A training and education component was obligatory for all LBA science activities.
- Brazil dedicated millions of \$'s in scholarship support at undergraduate and graduate levels in LBA.

# LBA capacity building results from an analysis of publications (1/2)



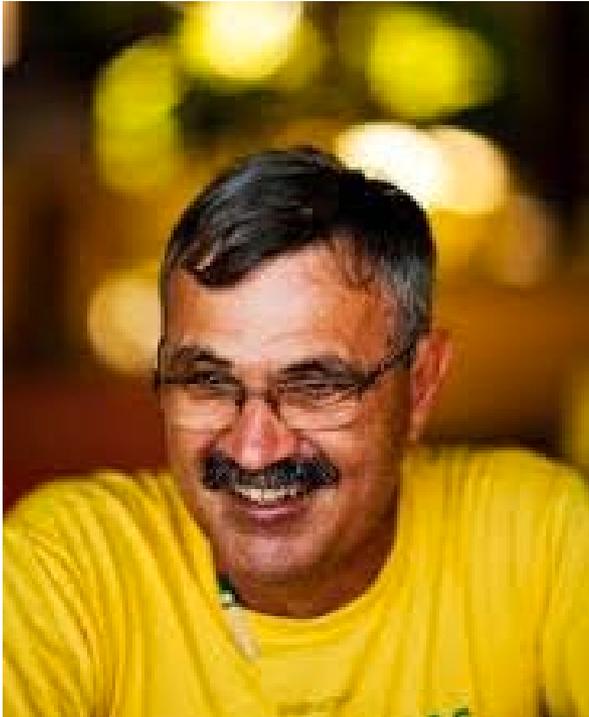
# LBA capacity building results from an analysis of publications (2/2)



# Reflections on Big Science and Capacity Building

- LBA was big science in at least one sense. It attracted a large amount of funding -- ultimately well more than \$100 million when considering the Brazilian *in-kind* contributions.
- *Was big science important for capacity building?* Without question, the concentration of resources helped.
- *Would an equivalent amount spent on small science have been more effective?* Not necessarily.

# Reflections on Big Science and Capacity Building



- “The tower was not the most *important* part of my research and training program but it was the most *imposing*.”
- Could he have recruited the equivalent number and quality of students with shovels and diameter tapes?

Dr. Nicolau Priante Filho  
Retired Professor,  
University of Mato Grosso

# Happy Anniversary IITF!



INTERNATIONAL INSTITUTE OF TROPICAL FORESTRY