PRESENTATION GIVEN AT LTC SPRING FORUM ENTITLED:

""INTEGRATING GEOSPATIAL AND FIELD-BASED SCIENCE TO ASSESS BIODIVERSITY CONSERVATION: A SPECIAL FORUM OF WOMEN RESEARCH LEADERS"

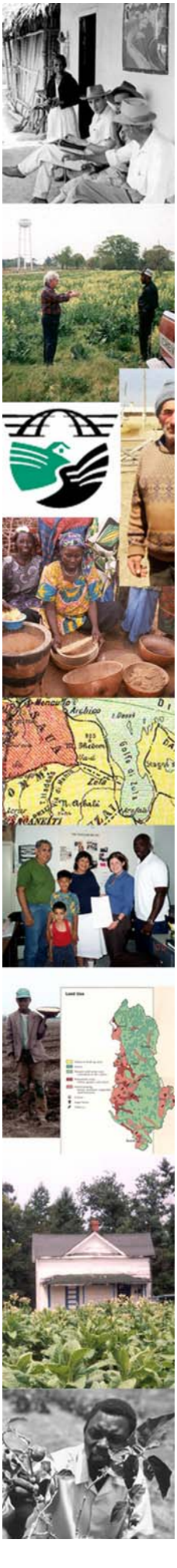
APRIL 2-3 & 15, 2009

UNIVERSITY OF WISCONSIN, MADISON, WI, USA

HOSTED BY

LAND TENURE SOCIETY

This workshop was generously supported by the American people through the United States Agency for International Development (USAID) under the terms of the TransLinks Cooperative Agreement No.EPP-A-00-06-00014-00 to the Wildlife Conservation Society (WCS). TransLinks is a partnership of WCS, The Earth Institute, Enterprise Works/VITA, Forest Trends and the Land Tenure Center. The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States government.



This work was funded with the generous support of the American people through the Leader with Associates Cooperative Agreement No.EPP-A-00-06-00014-00 for implementation of the TransLinks project. The contents of this report are the responsibility of the author and do not necessarily reflect the views of the United States government.

Land Tenure Center

LAND USE TRANSITIONS AND ECOSYSTEM SERVICES IN TROPICAL FORESTS

Ruth DeFries

LTC Spring Forum, Integrating geospatial and field-based science to assess biodiversity conservation. Keynote address and Yi-Fu Tuan Lecture Series

♦♦♦♦♦♦♦♦♦

Provided by the **Land Tenure Center.** Comments encouraged:
Land Tenure Center, Nelson Institute of Environmental Studies,
University of Wisconsin, Madison, WI 53706 USA
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http://www.ies.wisc.edu/ltc

Land Use Transitions and ~~Conservation~~ Ecosystem Services in Tropical Forests

R. DeFries, Columbia University

Seminar University of Wisconsin Madison, April 2009

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J. Dempewolf, University of Maryland
M. Hansen, South Dakota State University
F. Achard, Joint Research Center
N. Ramankutty, McGill University
J. Foley, Univ of Minnesota
R. Houghton, Woods Hole Research Institute
T. Rudel, Rutgers University
M. Uriarte, Columbia University

With funding from NASA LCLUC, LBA, and TE programs

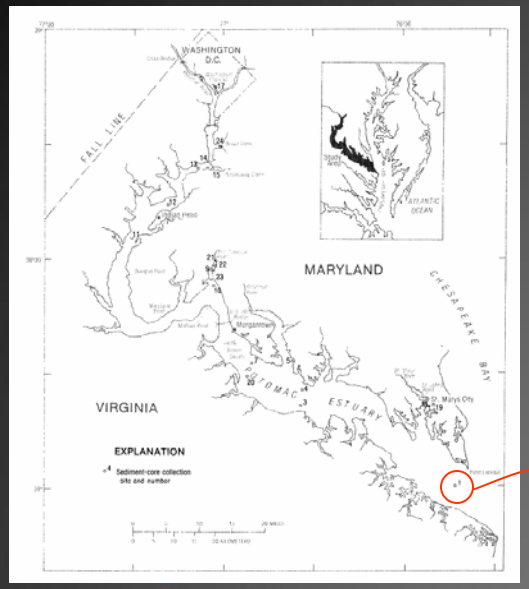
FOREST REGROWTH IN CENTRAL NEW ENGLAND

Height of forest clearing circa 1830 in central New England

Regrowing hardwood forest circa 1930

Photos from Fisher Museum Harvard Forest, Harvard University

LAND USE TRANSITIONS IN THE CHESAPEAKE BAY WATERSHED: THE POLLEN RECORD



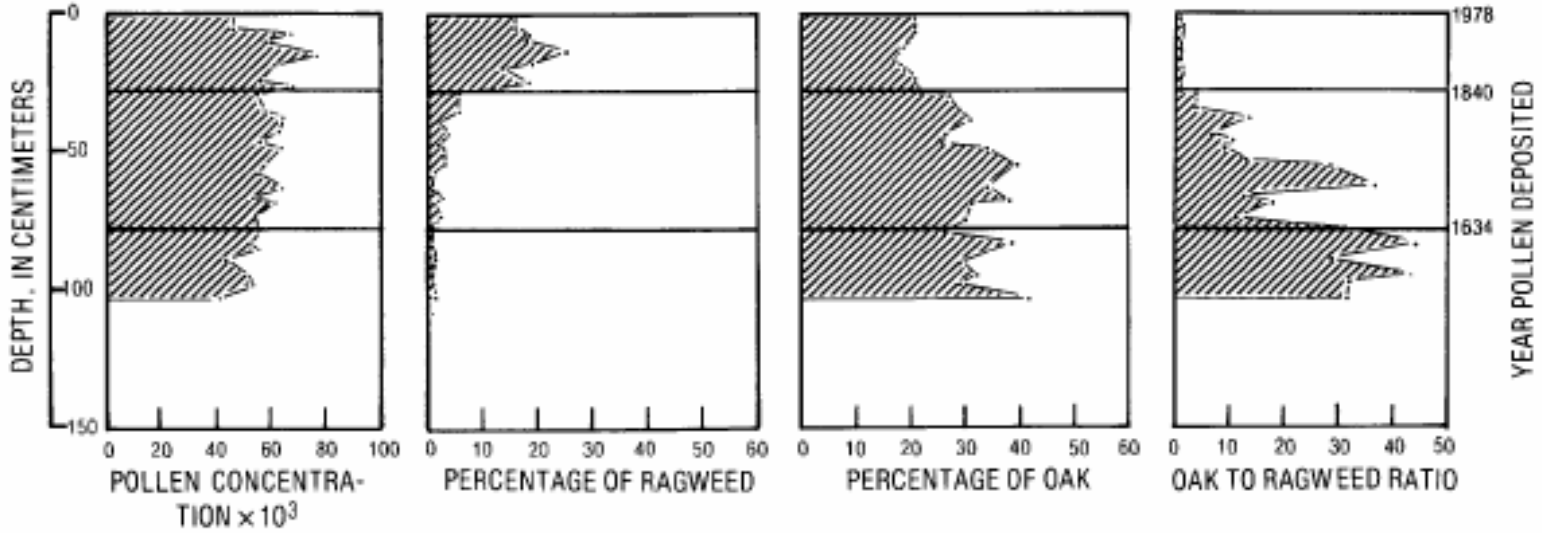
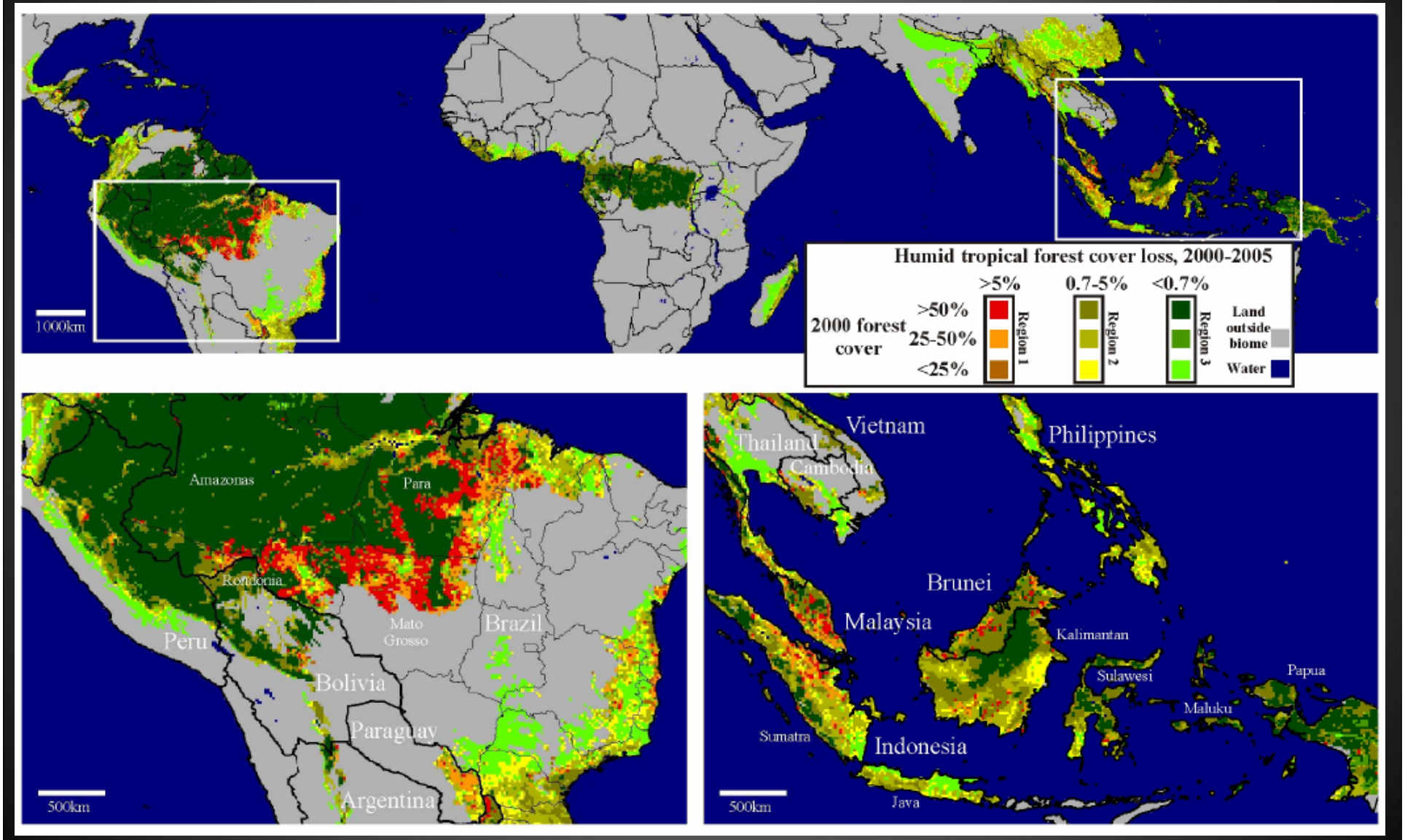


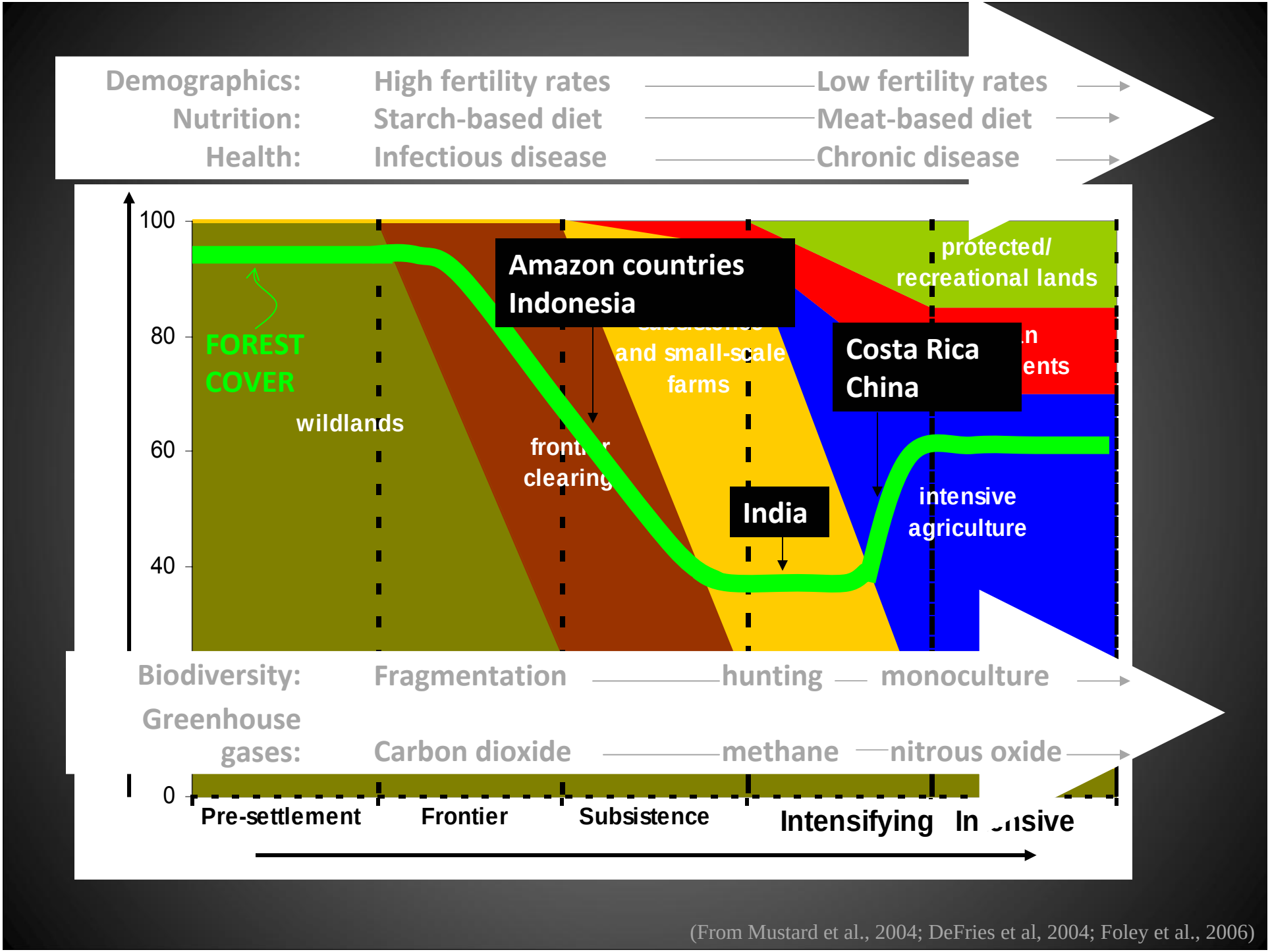
Figure 5. Pollen profile in core 1. Pollen concentration is the total number of pollen grains per gram of dry sediment.

(DeFries, 1987)

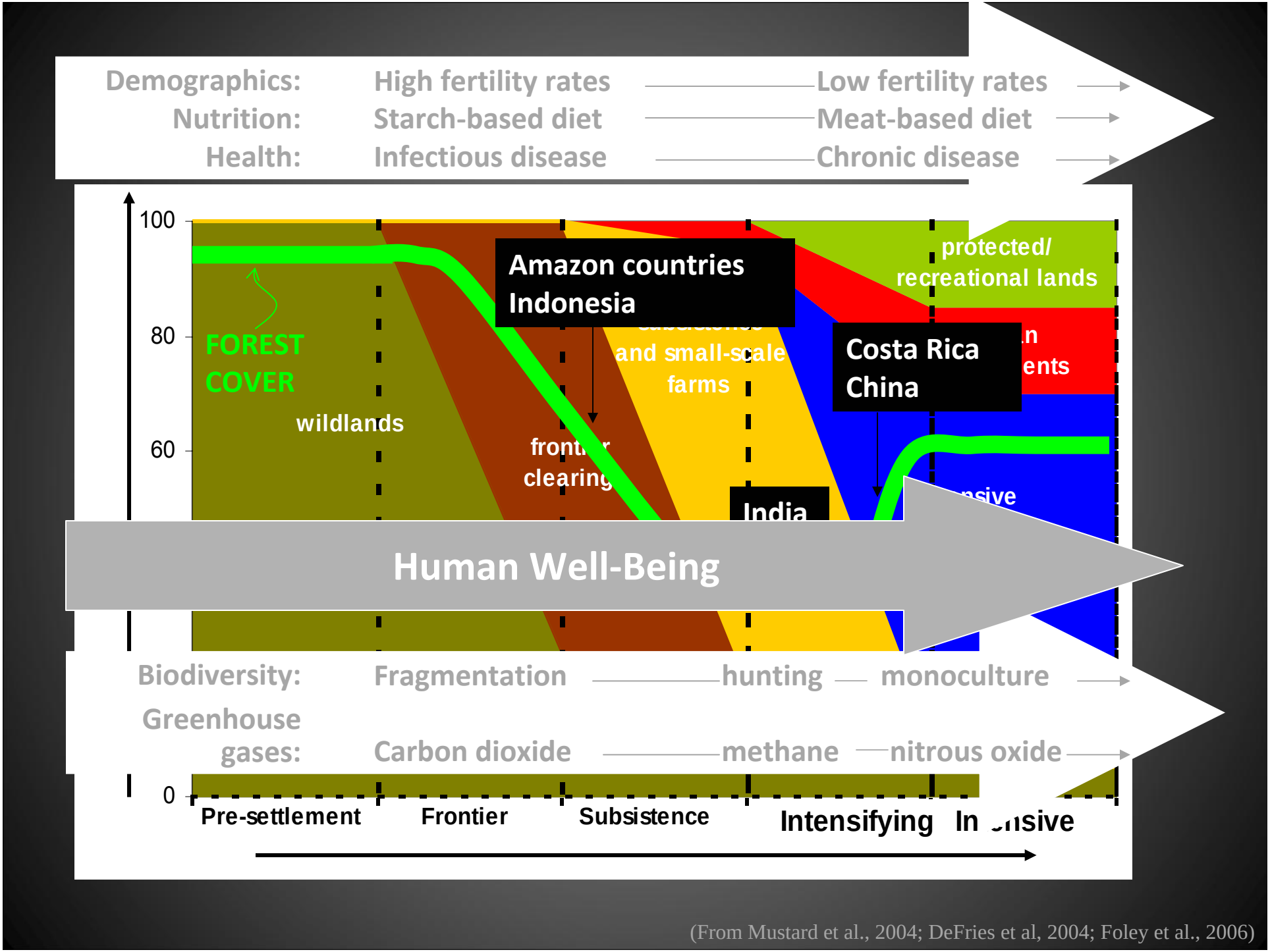
SATELLITE DATA: FOREST LOSS IN 2000-05



(Hansen et al., 2008, PNAS)

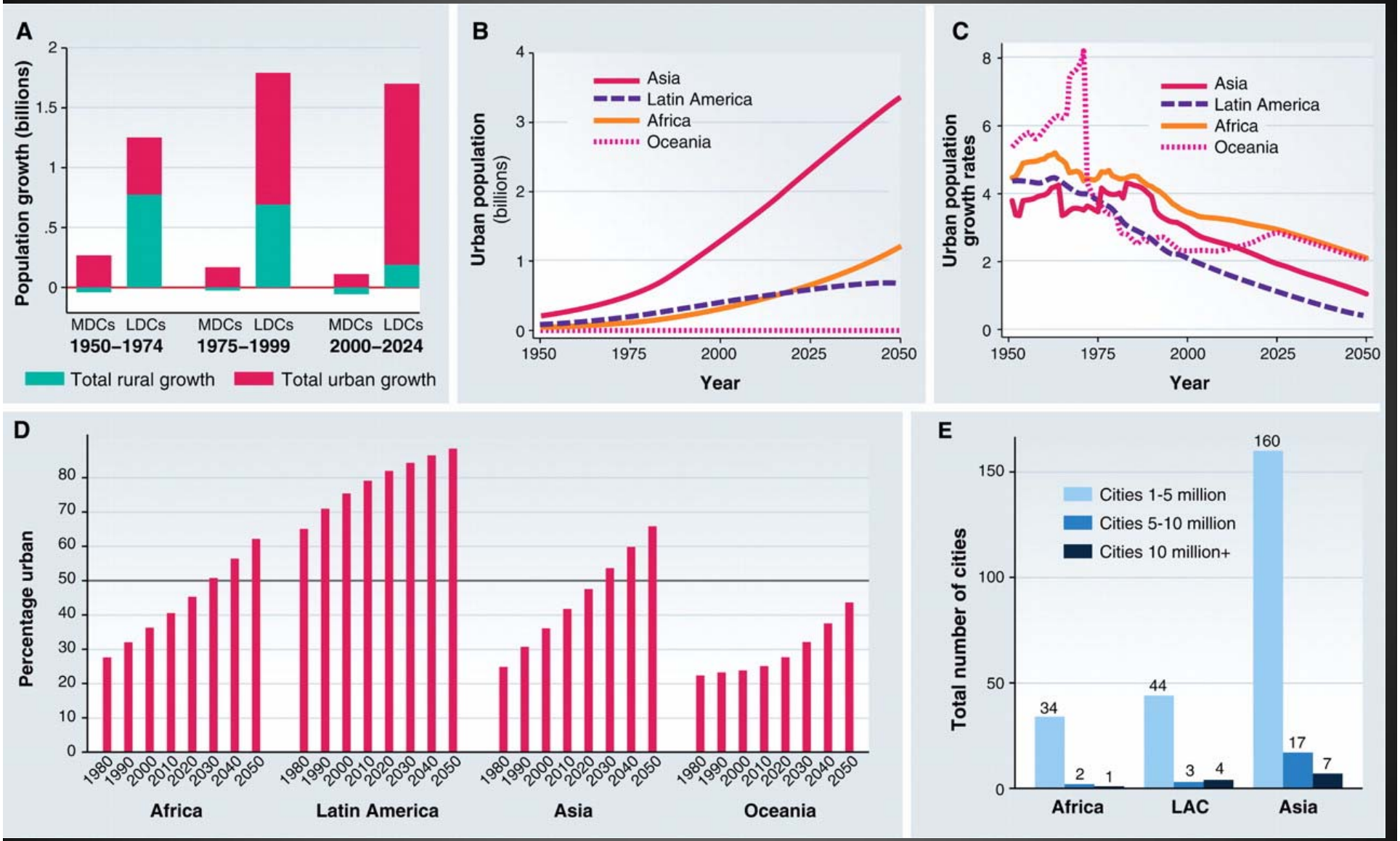


(From Mustard et al., 2004; DeFries et al, 2004; Foley et al., 2006)



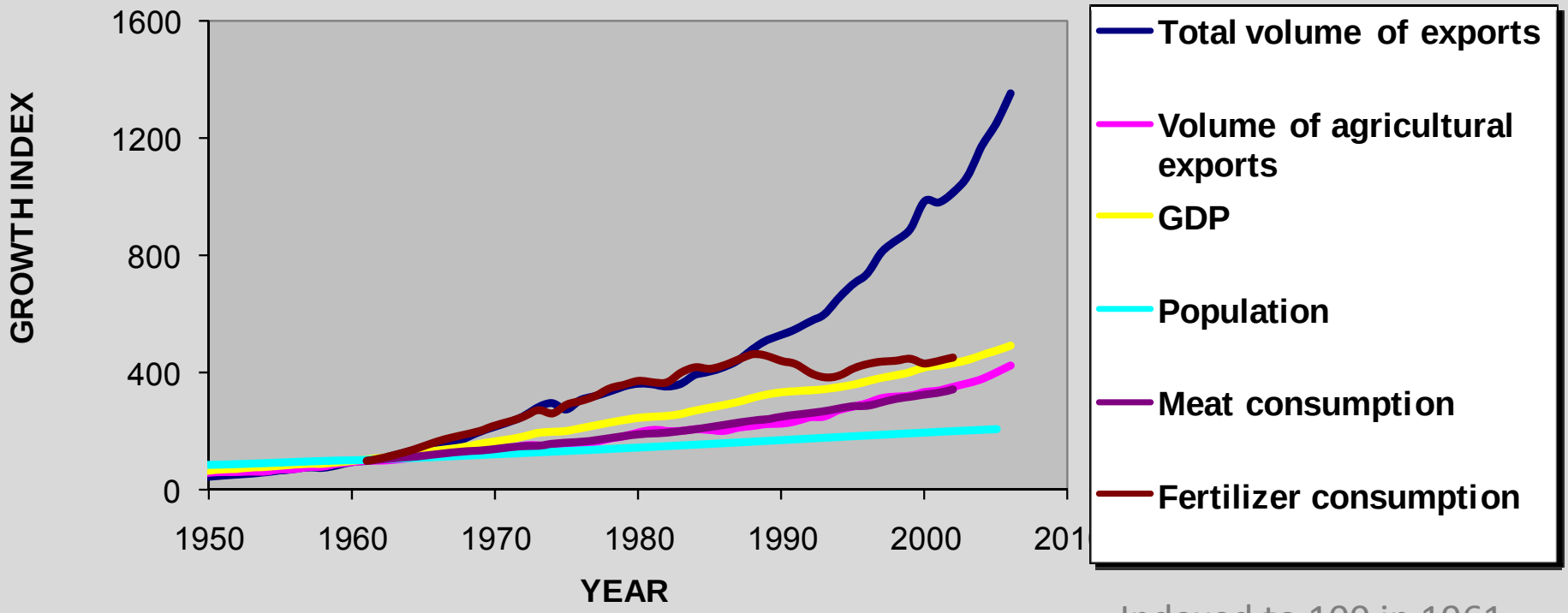
(From Mustard et al., 2004; DeFries et al, 2004; Foley et al., 2006)

WHAT ARE LIKELY FUTURE PRESSURES ON TROPICAL FORESTS IN AN URBANIZING WORLD?



The Urban Transformation of the Developing World
Montgomery (2008)

…AND A WORLD WITH INCREASING TRADE AND CONSUMPTION



Indexed to 100 in 1961

Data from:
Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision
World Trade Organization, 2007, International Trade Statistics 2007
World Resources Institute. 2007. *EarthTrends: Environmental Information.*
Food and Agriculture Organization, FAOSTAT

WHICH DEMOGRAPHIC AND ECONOMIC FACTORS ARE ASSOCIATED WITH GROSS DEFORESTATION IN 2000-05 ACROSS 40 TROPICAL HUMID FOREST COUNTIES?

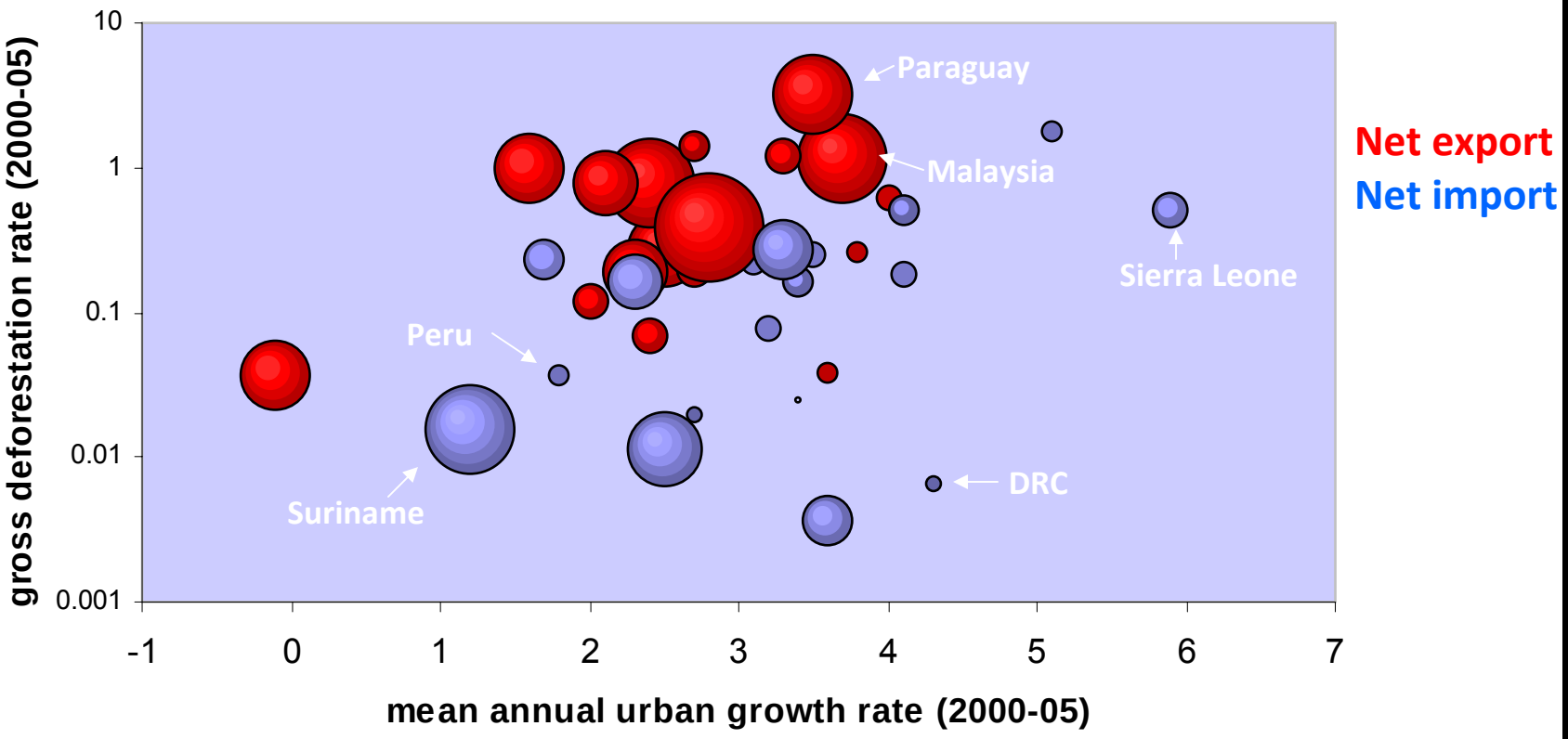
VARIABLE	Model 1	Model 2	Model 3
Intercept	0.30 (0.03)****	0.30 (0.03)****	0.30 (0.03)****
DEMOGRAPHIC:			
annual urban growth rate (2000-05)	0.07 (0.04)*		0.07 (0.03)**
annual rural growth rate (2000-05)	-0.03 (0.04)		
ECONOMIC:			
net agricultural trade per capita (2003-04)		0.11 (0.03)****	0.11 (0.03)****
GDP per capita (mean 2000-05)		0.03 (0.03)	
annual GDP growth rate (mean 2000-05)		0.05 (0.03)*	
% change in net agricultural trade (1999-2001 to 2003-04)		0.05 (0.03)*	
R^2	.10	.40	.36
Adjusted R^2	.05	.33	.33

****p<.001, ***p<.01, p<.05**, *p<.10

Deforestation data from Hansen et al. (2008); other data from UN, FAO, and World Bank sources

(DeFries et al, submitted)

URBAN GROWTH AND AGRICULTURAL TRADE SIGNIFICANT



ln(Y) = -3.22* + .43 (urban growth rate)* + 9.10 (net agricultural trade per capita)****

Y = gross deforestation rate 2000-05 (from Hansen et al., 2008)
R^2 = .31, adjusted R^2 = .27, F=.001
*** *p*<.05, ***p*<.001**

(unpub.)

META-ANALYSIS OF CASE STUDIES INDICATES LESSER IMPORTANCE OF SMALL FARMERS AND COLONIZATION, WITH GROWING IMPORTANCE OF INTERNATIONAL MARKETS AND PLANTATIONS FROM 1980s TO 1990s

Regions (No.of studies)	Drivers, 1980s (% of studies)	Drivers, 1990s (% of studies)	Change from 80s to 90s (Chi square, *p* value)
Amazon (60)	Ranching (52%) Soybean Farms (0%) Internat. Mkts. (13%) Colonization (74%) Small Farmers (87%) Road Building (71%)	Ranching (76%) Soybean Farms (10%) Internat. Mkts. (31%) Colonization (38%) Small Farmers (69%) Road Building (83%)	3.7, *p*=.05 3.4, *p*=.07 2.9, *p*=.09 8.0, *p*=.01 2.9, *p*=.09 not signif.
Southeast Asia (44)	Plantation Ag. (21%) Insecure Tenure (3%) Small Farmers (90%) Colonization (45%) Logging (52%) Pop. Growth (52%)	Plantation Ag. (60%) Insecure Tenure (53%) Small Farmers (67%) Colonization (20%) Logging (67%) Pop. Growth (53%)	6.8, *p*=.01 15.1, *p*=.00 3.5, *p*=.06 2.6, *p*=.105 not signif. not signif.

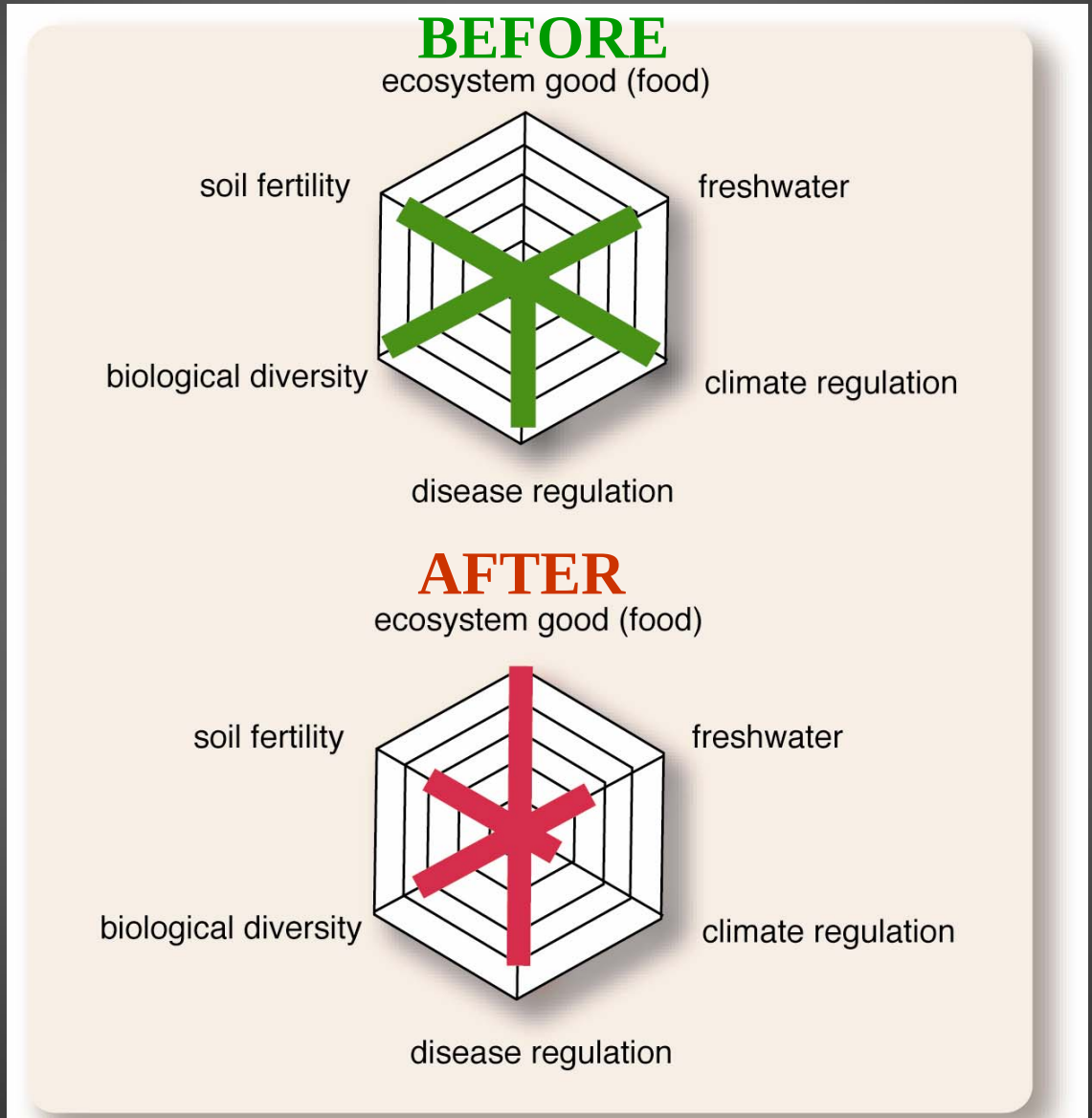
(Rudel et al., in press)

The New York Times

New Jungles Prompt a Debate on Rain Forests

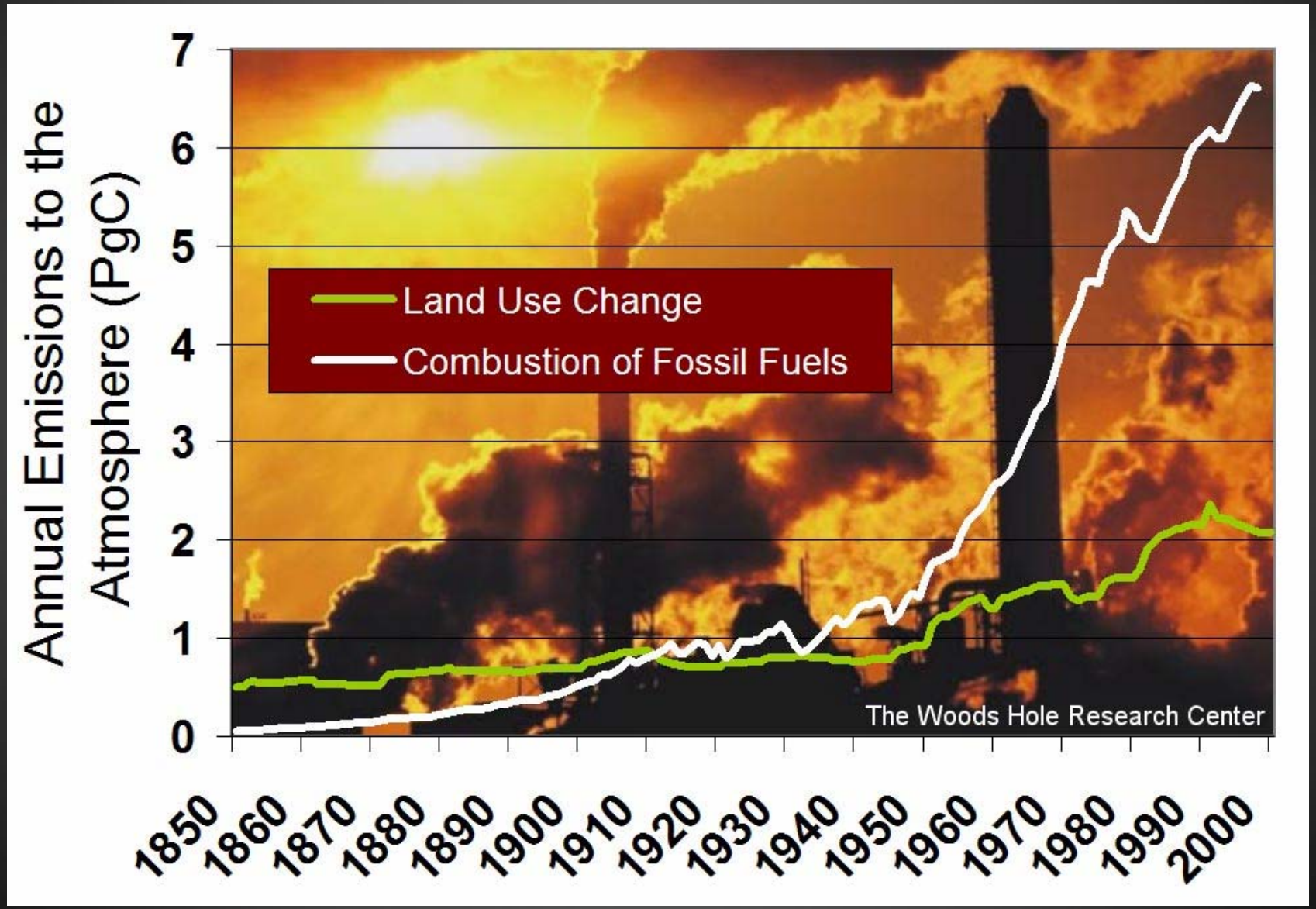
By ELISABETH ROSENTHAL
Published: January 29, 2009

Land Use: A trade-off between meeting demands for basic human needs and unintended ecosystem consequences



(DeFries, Asner, and Foley, 2004, *Frontiers in Ecology and Environment*)

Historical Estimates of Carbon Emissions (1850-2000)



SEVERAL POLICY EFFORTS ARE UNDERWAY AIMING TO REDUCE EMISSIONS FROM DEFORESTATION

UN FRAMEWORK CONVENTION ON CLIMATE CHANGE INCLUDED REDUCING EMISSIONS FROM DEFORESTATION AND DEGRADATION (REDD) IN BALI ROADMAP

Decision -/CP.13

Reducing emissions from deforestation in developing countries: approaches to stimulate action

FT.com FINANCIAL TIMES

UK

FT Home > UK

Brazil pledges to make big cut in Amazon deforestation

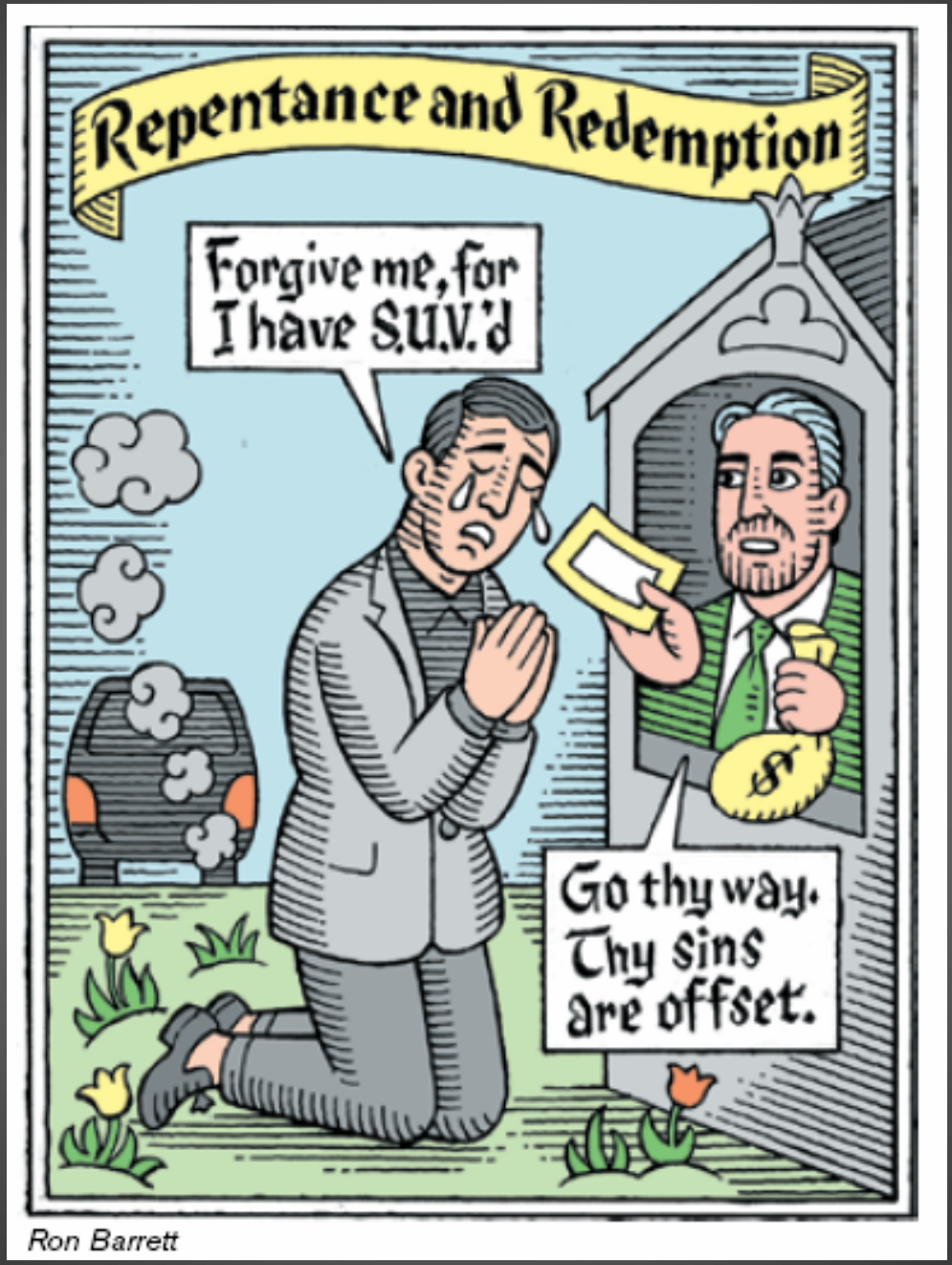
By Jonathan Wheatley in São Paulo
Published: December 2 2008 02:00 | Last updated: December 2 2008 02:00

Brazil vowed yesterday to cut the amount of deforestation in the Amazon over the next decade to less than half the current rate.

The pledge followed an announcement last week that 12,000 sq km of forest had been destroyed in the 12 months to the end of July - an increase of nearly 4 per cent over the previous year, but down from a record high of more than 27,000 sq km in the same period in 2003-04.

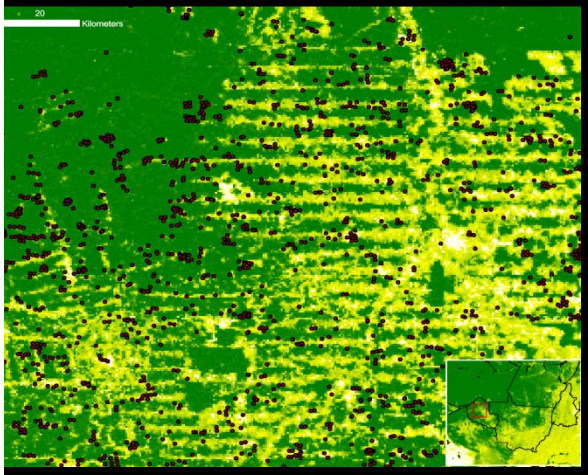
Carlos Minc, environment minister, said deforestation in the Amazon would fall to 5,000 sq km a year by 2017, beginning with a 40 per cent reduction during the period of 2008 to 2010.

Tropical forest carbon under discussion for US Climate legislation


Repentance and Redemption
Forgive me, for I have S.U.V.'d
Go thy way. Thy sins are offset.
$

Ron Barrett

SPATIAL PATTERNS OF CHANGING PRESSURES ON TROPICAL FORESTS

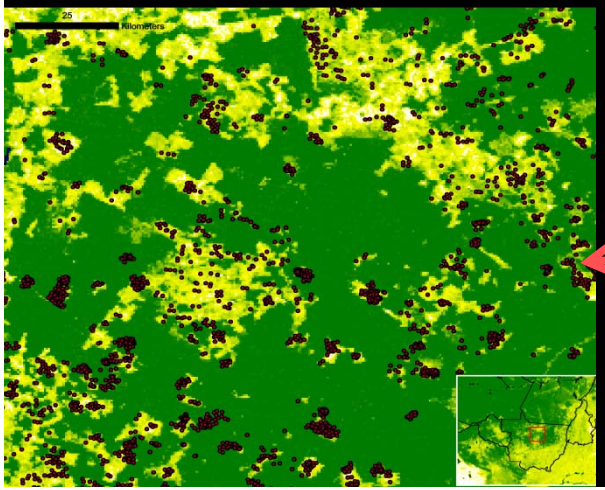


2001 Tree cover

0%

100%

2001-03 active fire

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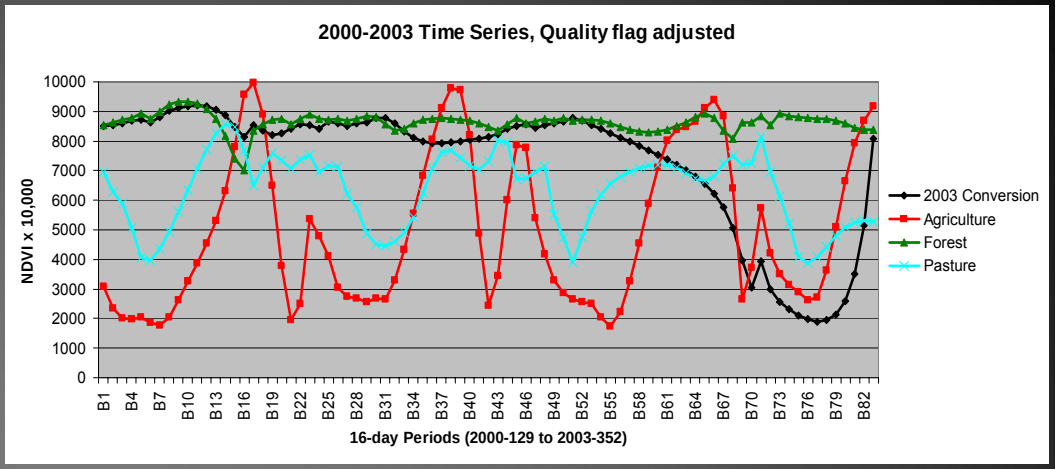
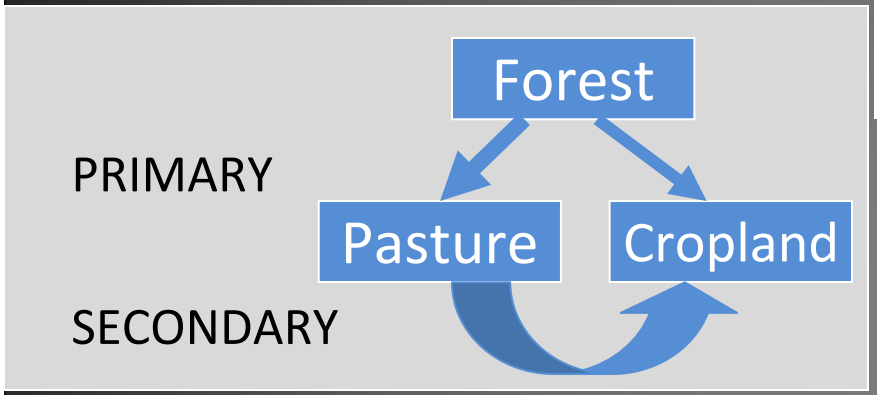
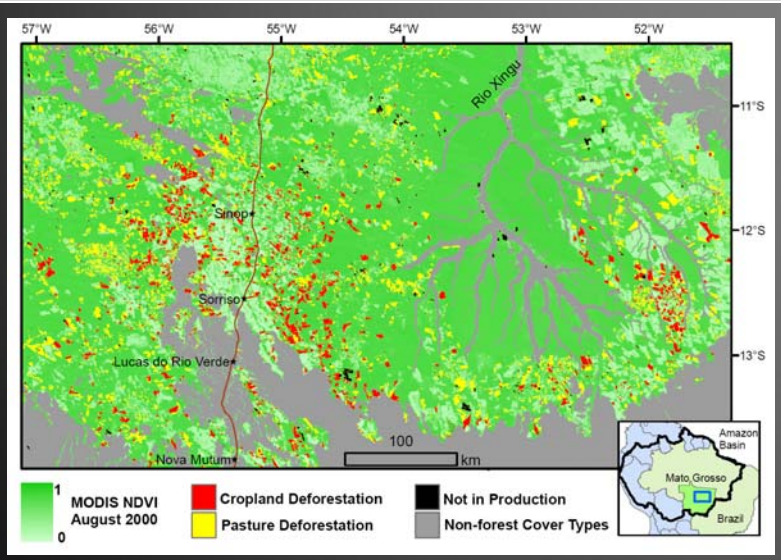
PALETA


BUNGE

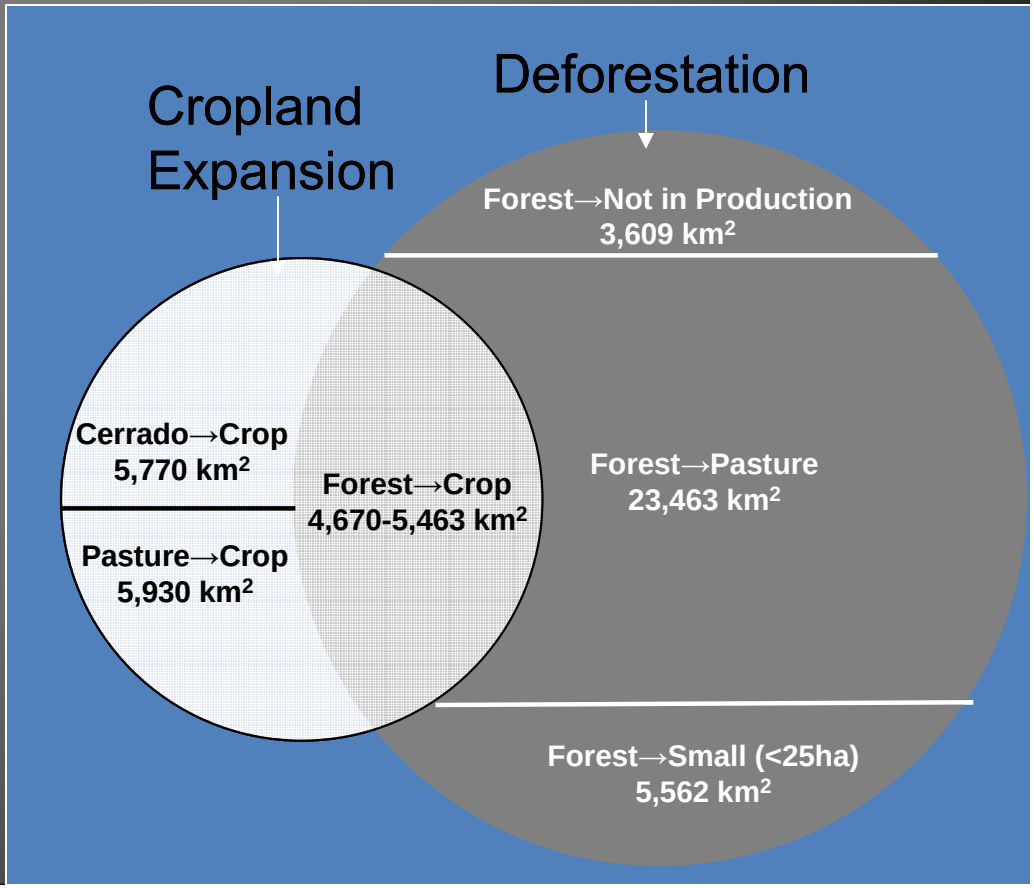
CHANGING LAND USE DYNAMICS IN 2000-05 IN MATO GROSSO: TRACKING WITH MODIS 250m DATA



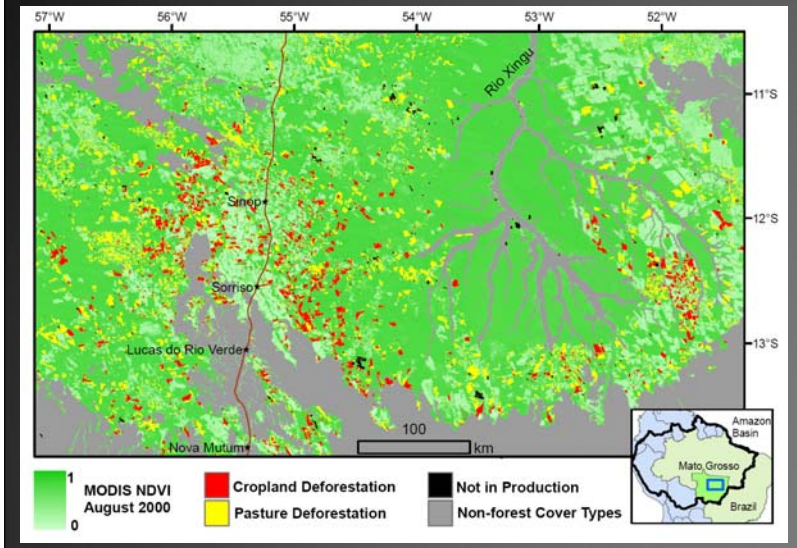




(Morton et al., PNAS, 2006)



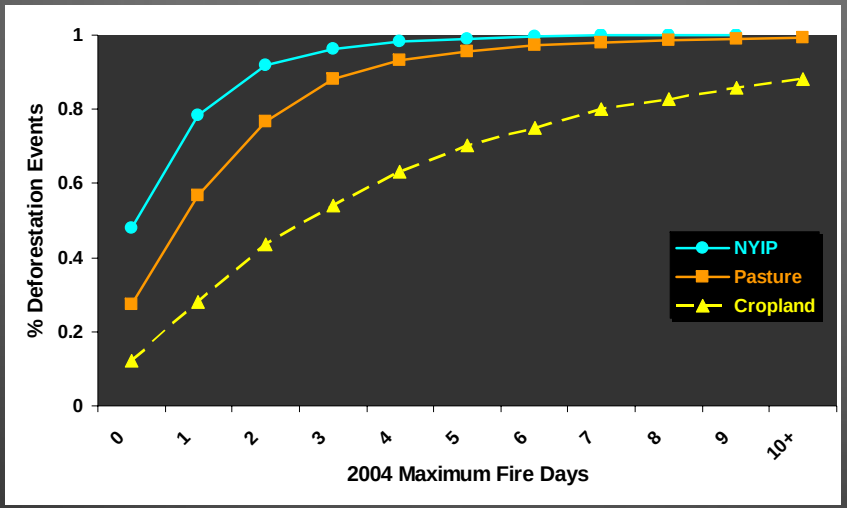
SOUTHERN AMAZON: CONSEQUENCES OF CHANGING PRESSURES FOR CARBON EMISSIONS



Forest to pasture

Forest to crop

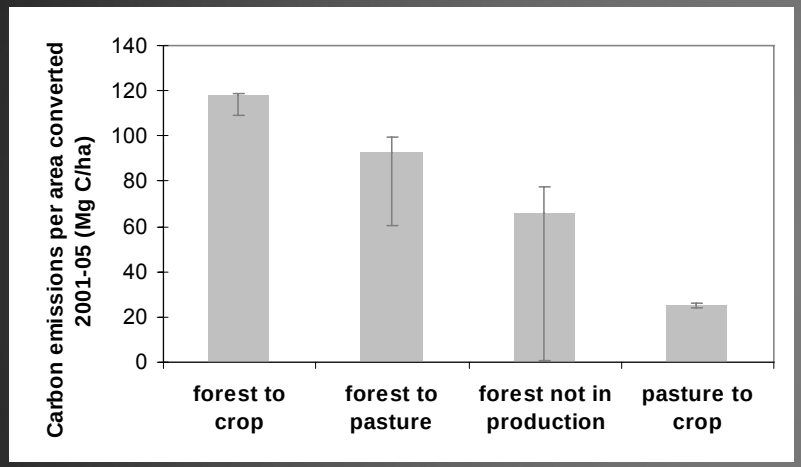
Conversions of forest to cropland exhibit higher-frequency and longer duration of MODIS-detected fires than pasture conversions in 2000-05



Not in production (NYIP)

(Morton et al, 2008)

FOREST TO CROP CONVERSIONS HAVE HIGHER PER AREA EMISSIONS THAN PASTURE CONVERSIONS AND LARGER FRACTION OF BIOMASS BURNED



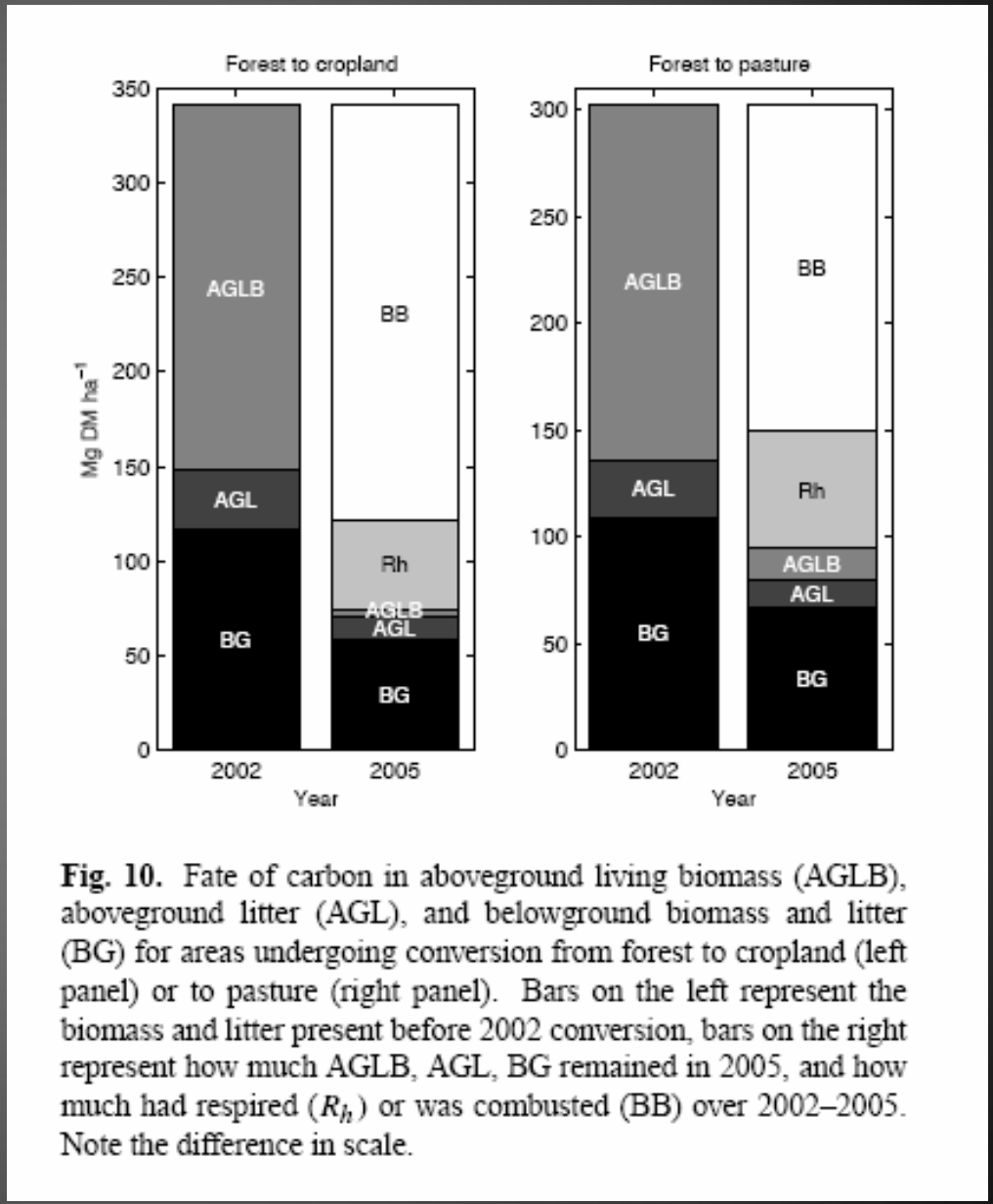


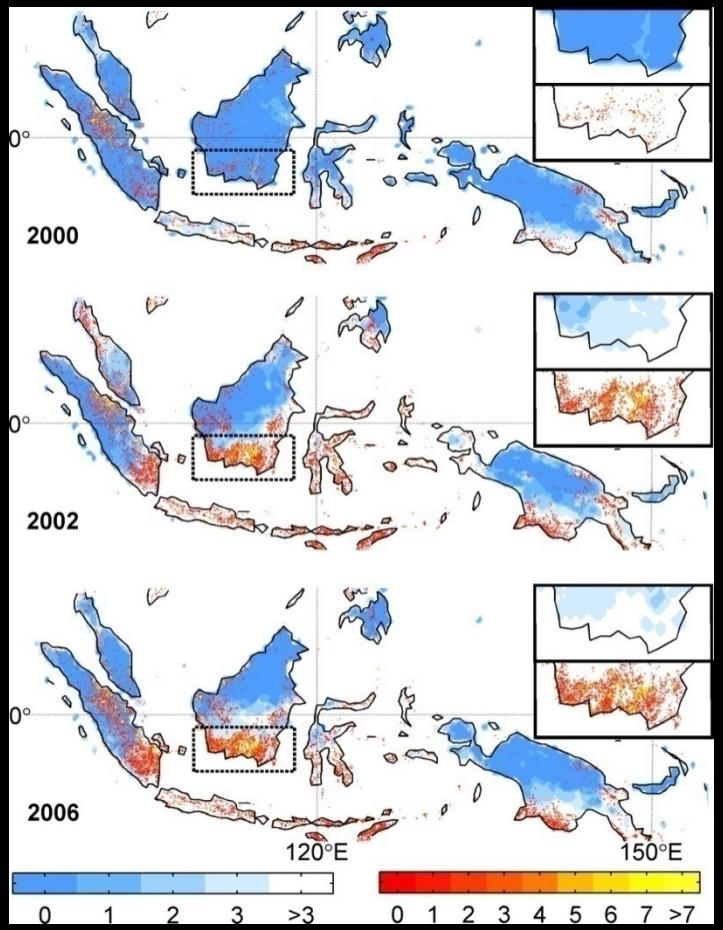
Fig. 10. Fate of carbon in aboveground living biomass (AGLB), aboveground litter (AGL), and belowground biomass and litter (BG) for areas undergoing conversion from forest to cropland (left panel) or to pasture (right panel). Bars on the left represent the biomass and litter present before 2002 conversion, bars on the right represent how much AGLB, AGL, BG remained in 2005, and how much had respired (R_h) or was combusted (BB) over 2002–2005. Note the difference in scale.

Results from DECAF model

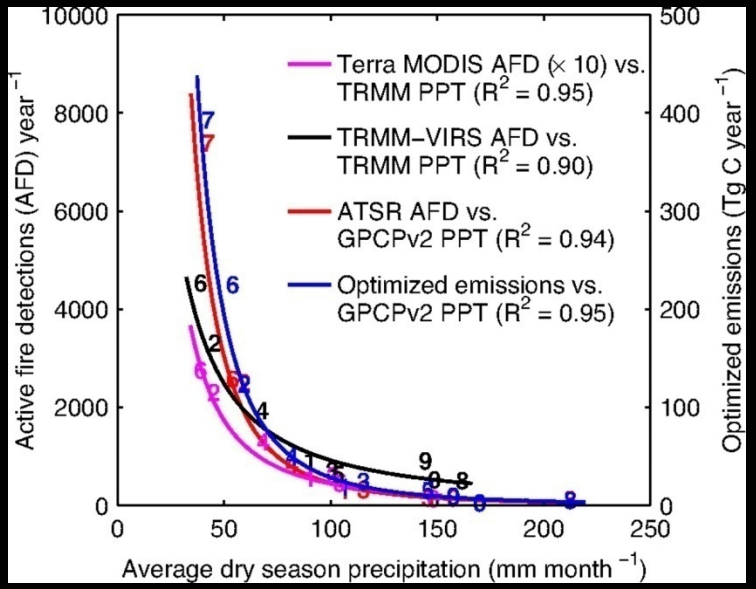
(DeFries et al, 2008; van der Werf et al., 2009)

SOUTHEAST ASIA: FEEDBACKS BETWEEN CLIMATE AND PRESSURES ON FORESTS

Dry season length (blue) and fire detections (red) for the strong 2000 La Niña and 2002 and 2006 moderate El Niño years



Relation between average precipitation rates during peak fire season and satellite-derived active fire detections (AFD)



van der Werf G. R. et.al. PNAS 2008;105:20350-20355

DRY YEARS ASSOCIATED WITH LOSS OF FOREST COVER

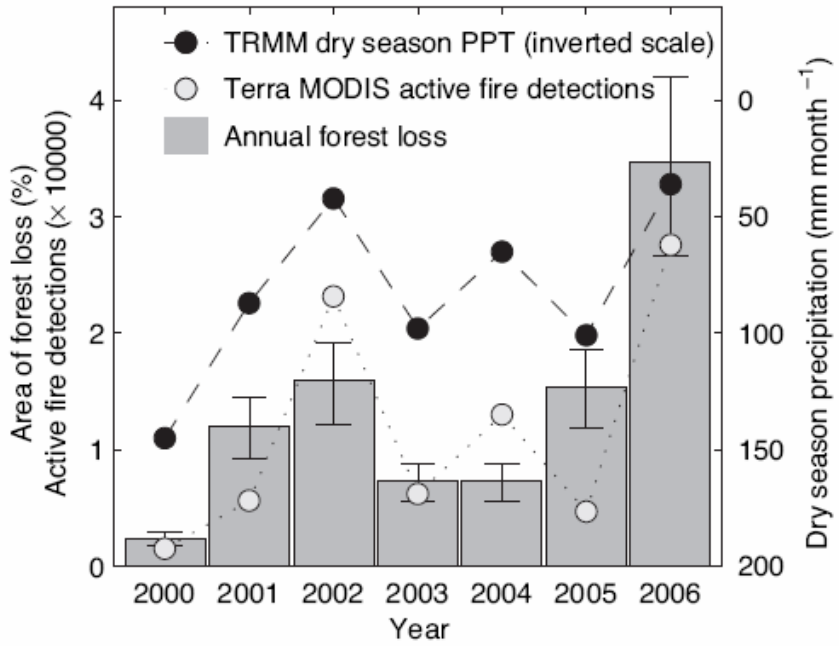
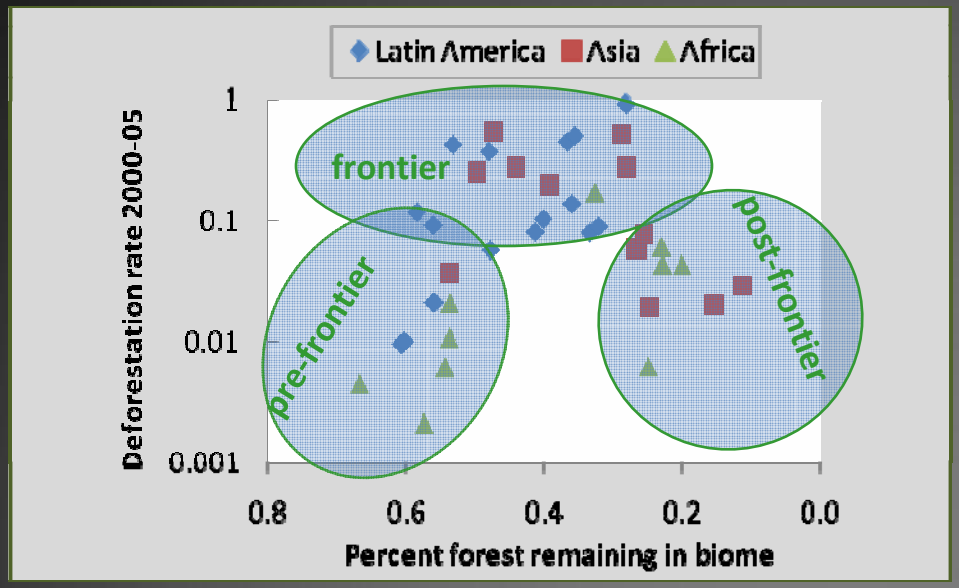


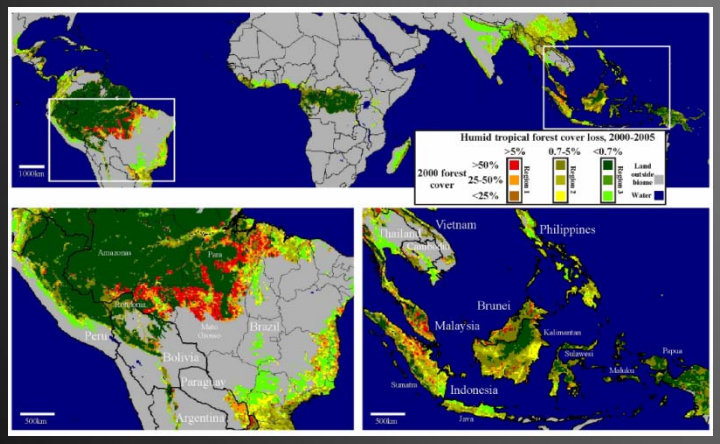
Fig. 4. Interannual rate of forest loss in southern Borneo (south of 1°S) shown as percentage of area with >50% woody cover in 2000 (33), average dry season precipitation based on TRMM precipitation (14), and Terra-MODIS active fire detections (20). Error bars on forest loss rates indicate the omission errors (positive) and commission errors (negative).

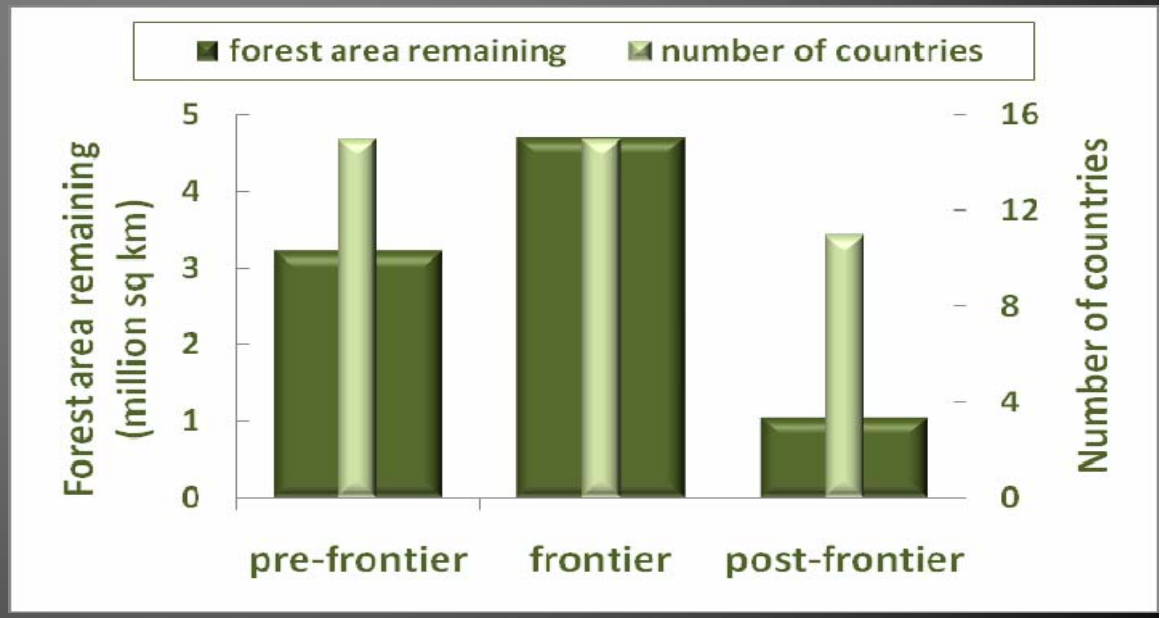
Burned peat in central Kalimantan

van der Werf G. R. et.al. PNAS 2008;105:20350-20355

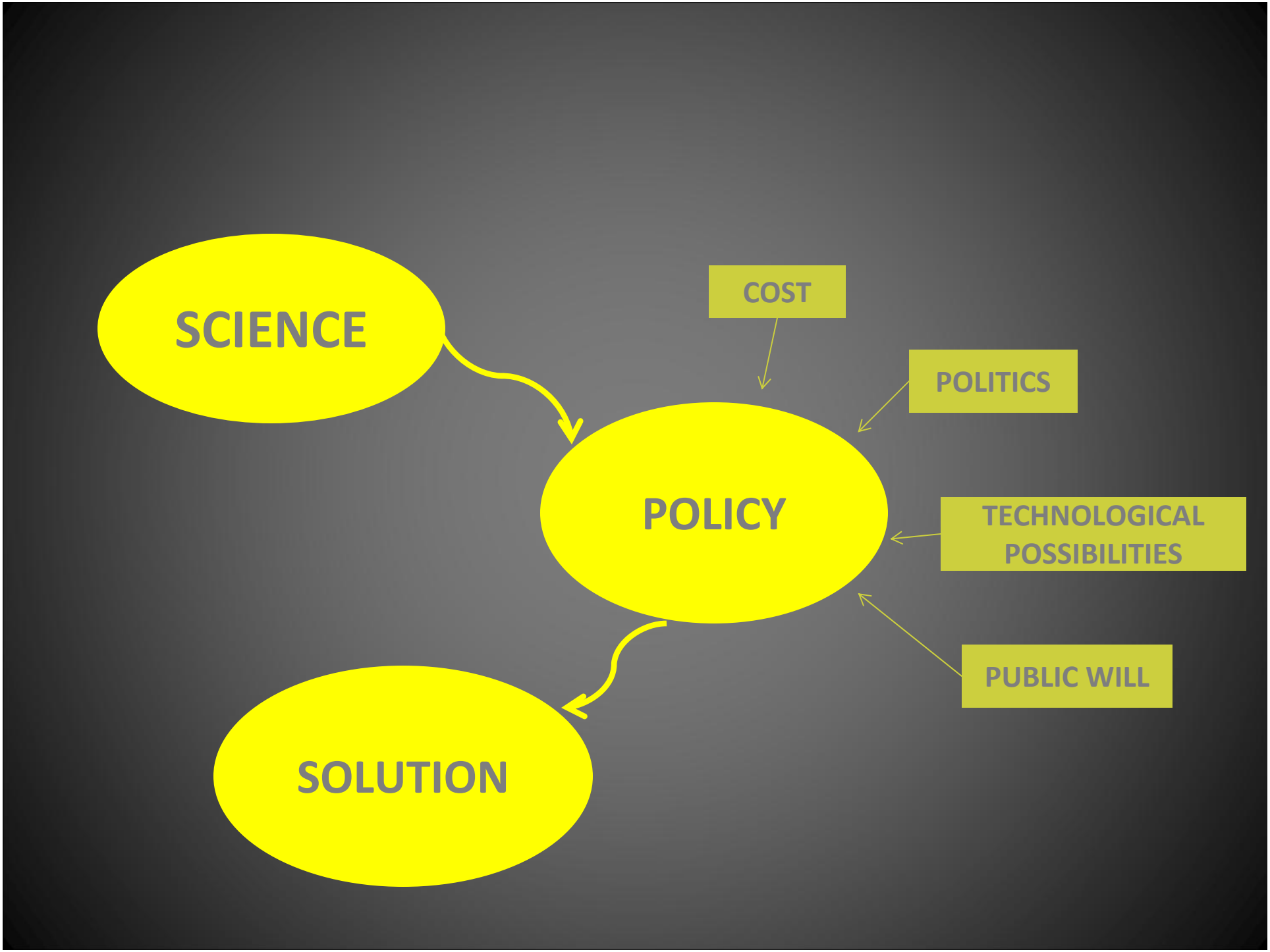


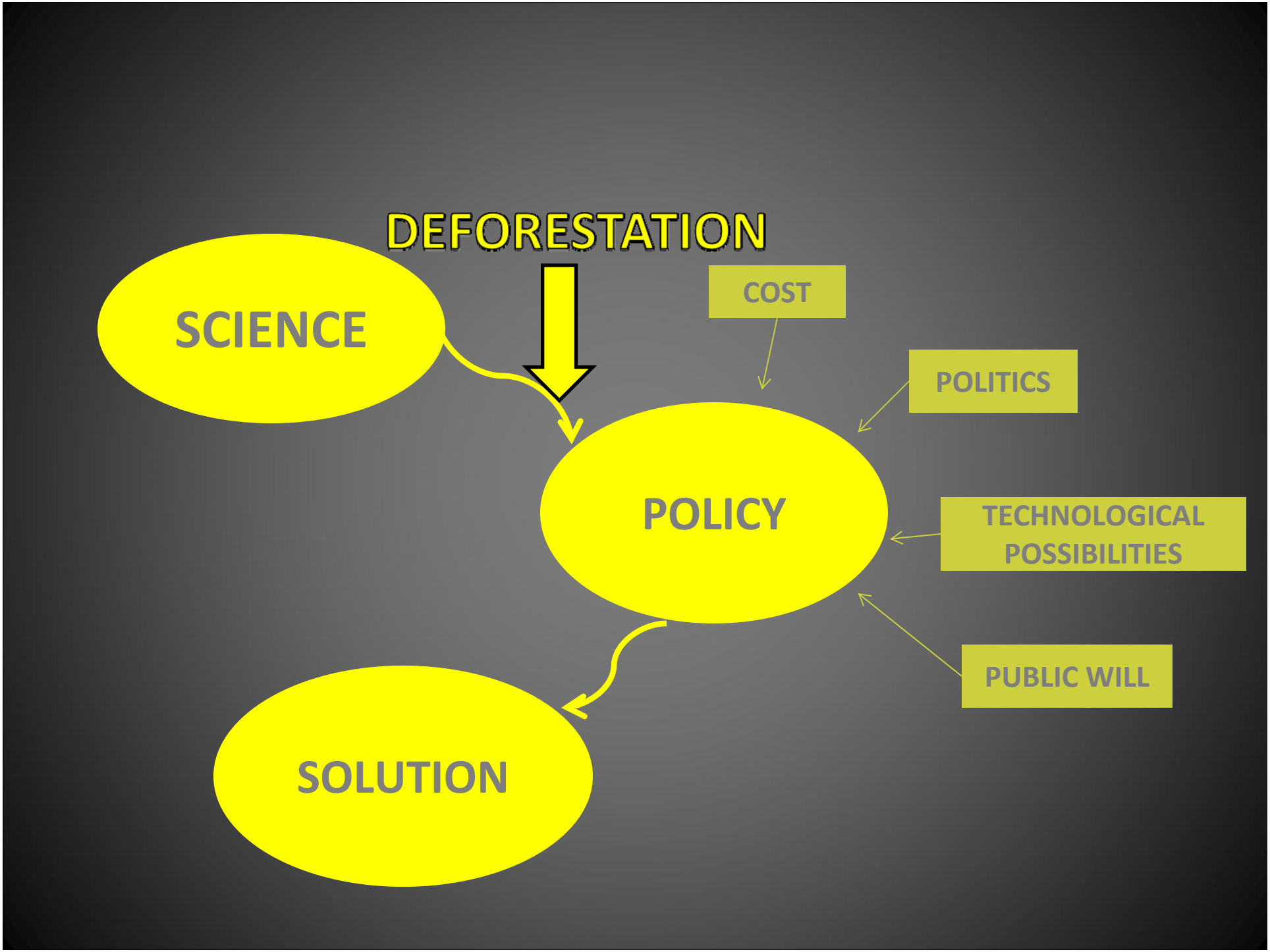
~1/3 of remaining humid tropical forest resides in pre-frontier countries yet to face deforestation pressures



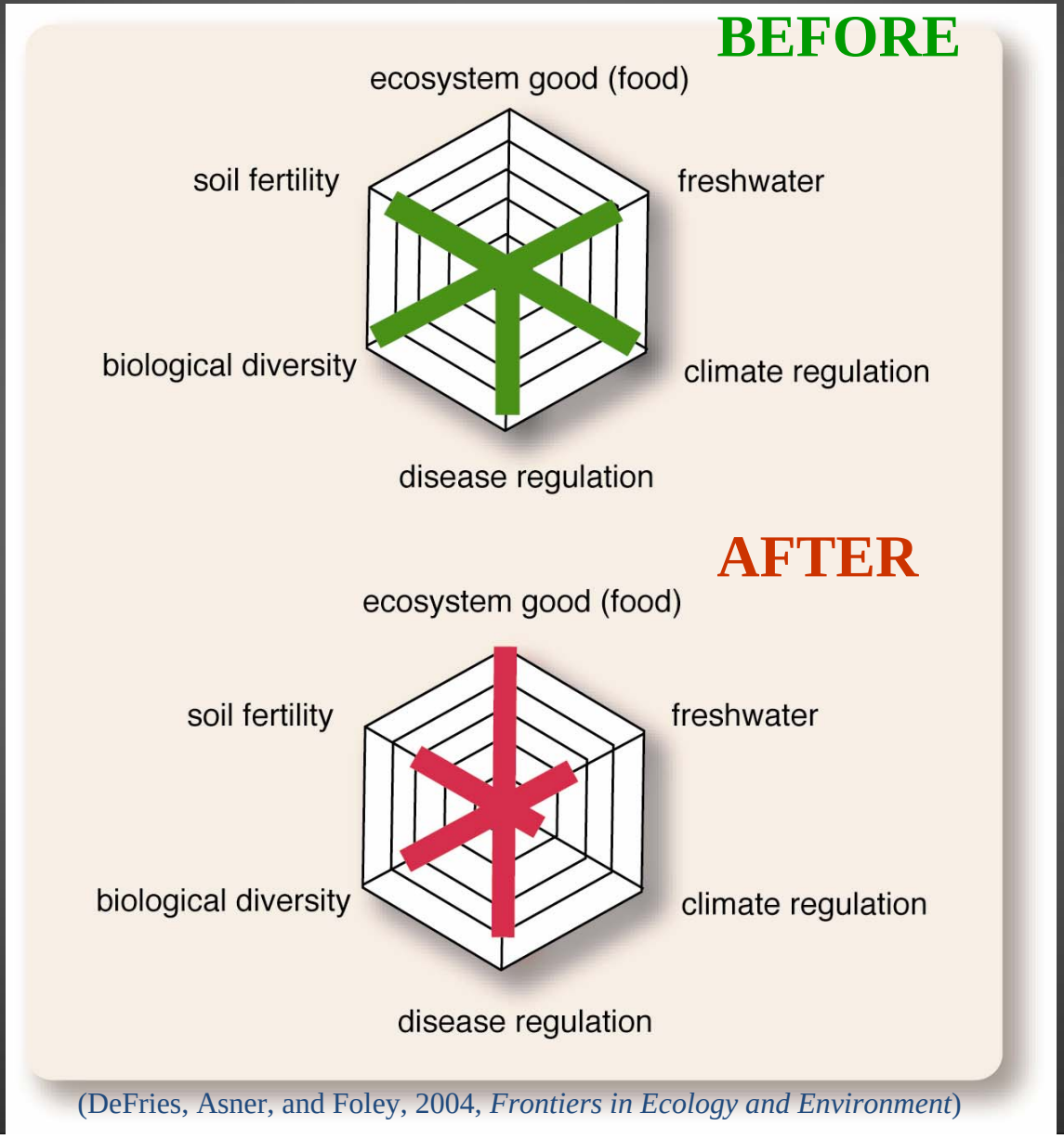


(DeFries et al., submitted)

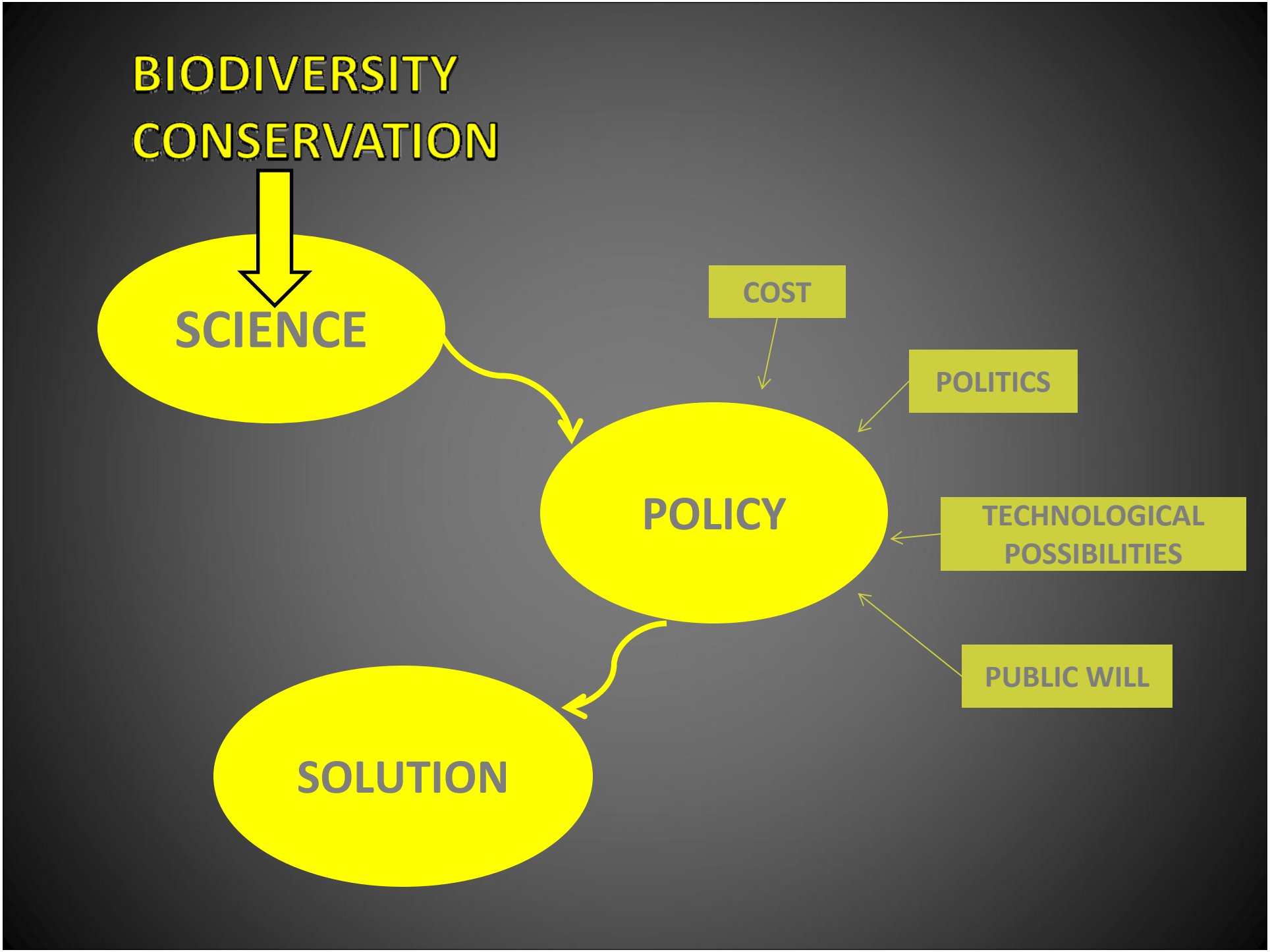

SCIENCE
COST
POLITICS
POLICY
TECHNOLOGICAL POSSIBILITIES
PUBLIC WILL
SOLUTION

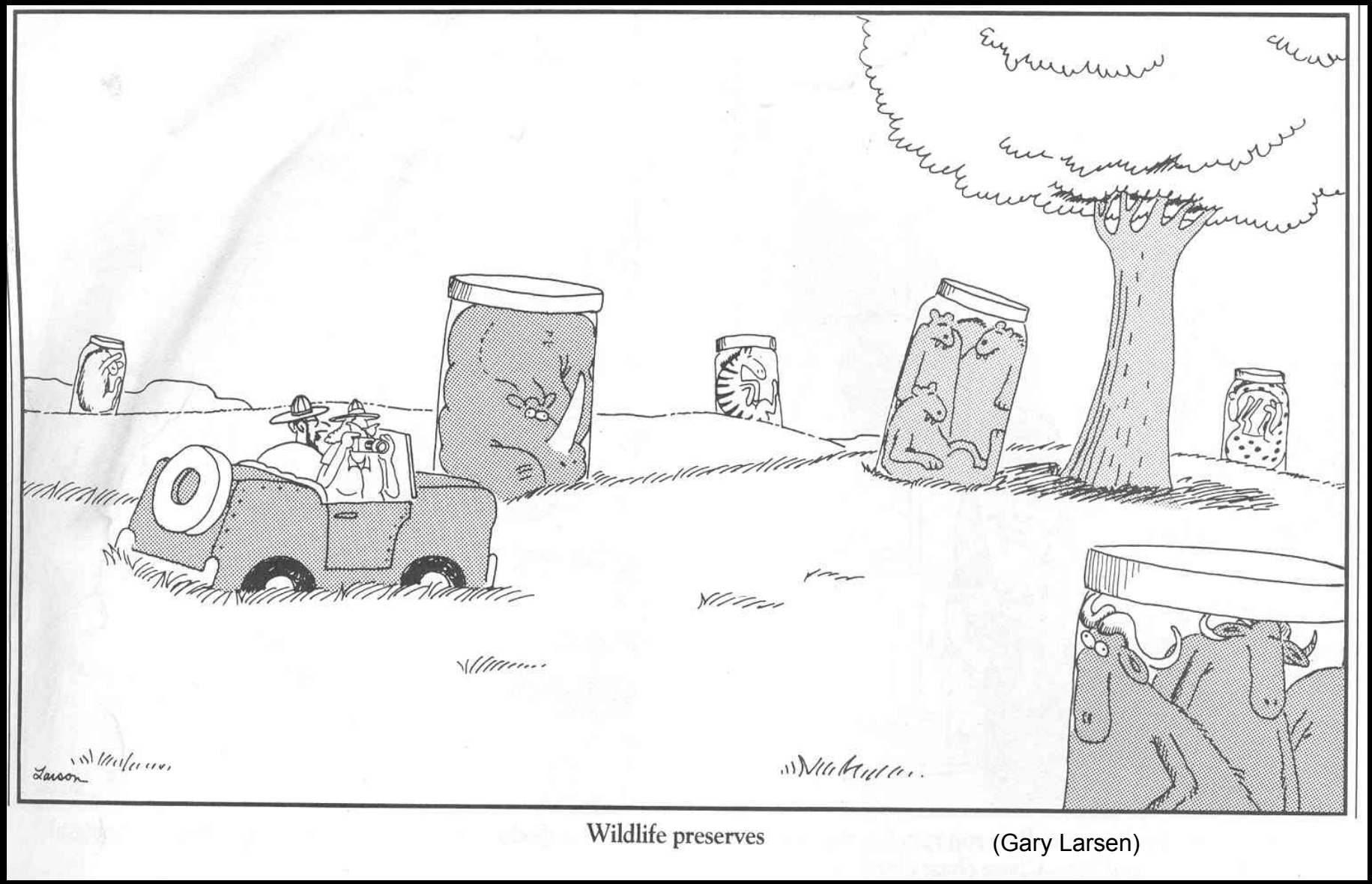

DEFORESTATION
SCIENCE
COST
POLITICS
POLICY
TECHNOLOGICAL POSSIBILITIES
PUBLIC WILL
SOLUTION

Land Use: A trade-off between meeting demands for basic human needs and unintended ecosystem consequences



(DeFries, Asner, and Foley, 2004, *Frontiers in Ecology and Environment*)


BIODIVERSITY CONSERVATION
SCIENCE
COST
POLITICS
POLICY
TECHNOLOGICAL POSSIBILITIES
PUBLIC WILL
SOLUTION



Wildlife preserves

(Gary Larsen)

ARE PROTECTED AREAS BECOMING SURROUNDED BY HUMAN LAND USE?

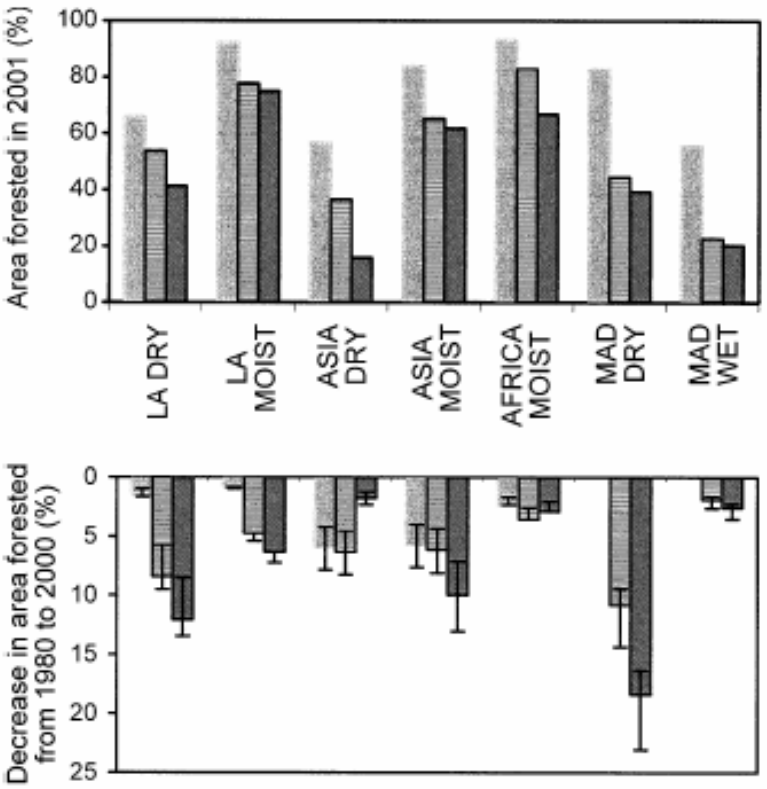


FIG. 2. (Top) Estimated percentage area forested in the year 2001 within the administrative boundaries of the protected areas (gray), within the 50-km buffer of the protected area (horizontal stripe), and within total ecoregion (diagonal stripe). (Bottom) The estimated decrease in percentage of area forested from the early 1980s to 2000.

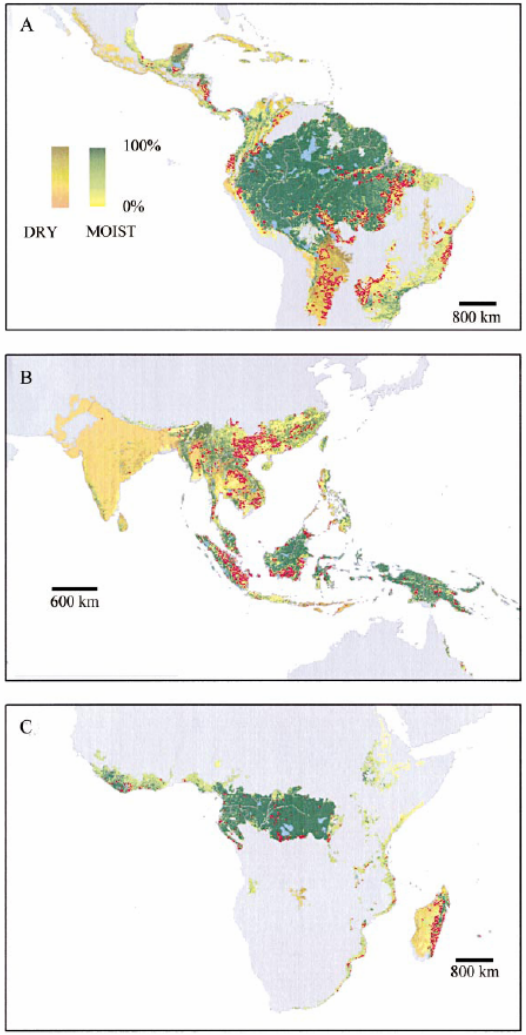


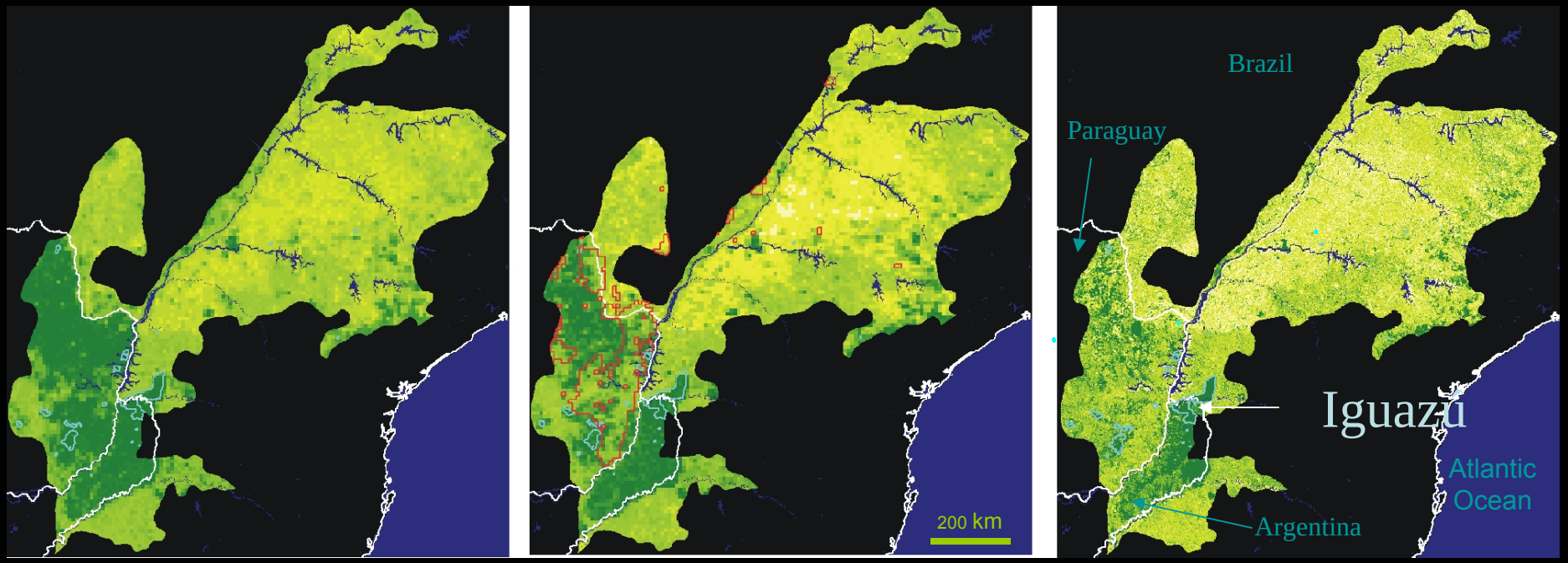
FIG. 1. Percent cover of forest estimated from 500-m MODIS data acquired October 2000–December 2001 in moist tropical and subtropical forest (yellow to green color bar) and dry tropical and subtropical forest (tan to olive color bar) as delineated by Olson et al. (2001) in Latin America (top), South and Southeast Asia (middle), and Africa (bottom). Locations of decline in forest cover between the early 1980s and 2001 are outlined in red. Protected areas included in this study are shown in blue.

Sample of 198 Protected Areas Pan Tropics:

Protected areas in Latin America reasonably intact within boundaries, less so in Asia

PAs with largest habitat loss in surroundings in dry forests

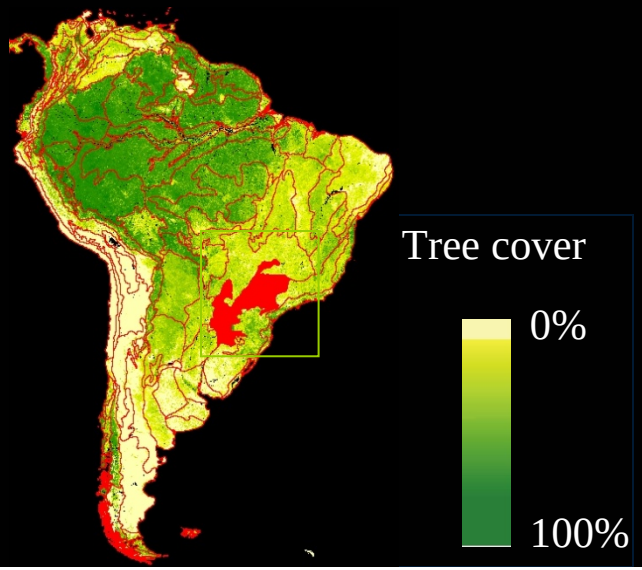
(From DeFries et al., *Ecol App*, 2005)



Early 1980s

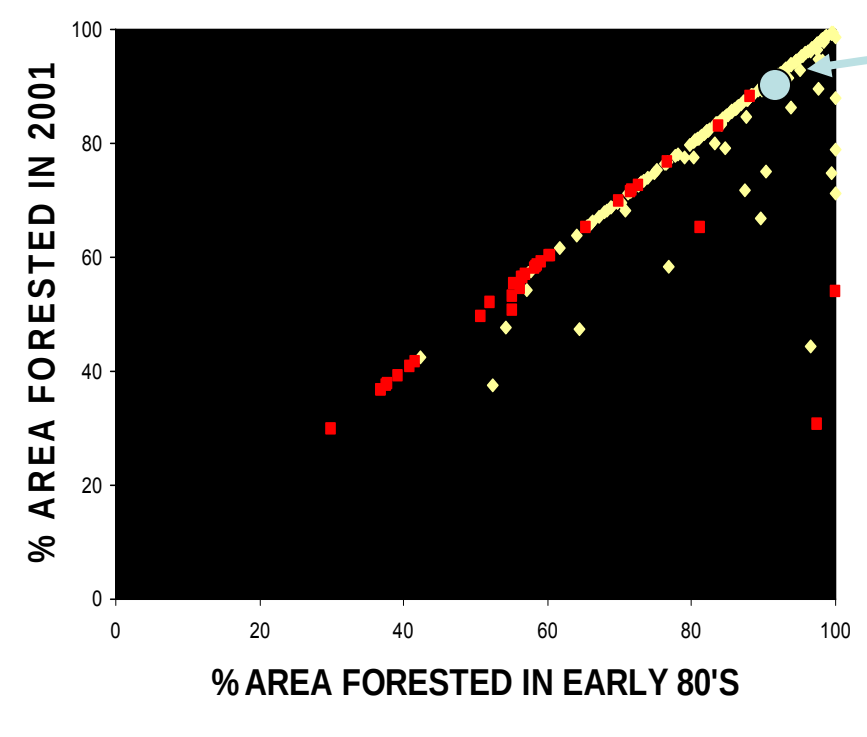
Circa 1990

2001



CHANGES IN FOREST COVER IN INTERIOR ATLANTIC FOREST ECOREGION

INSIDE PROTECTED AREAS



MOIST **FOREST**

DRY **FOREST**

Sample of 198 PAs pan-tropics

(DeFries et al., *Ecol Apps*, 2005)

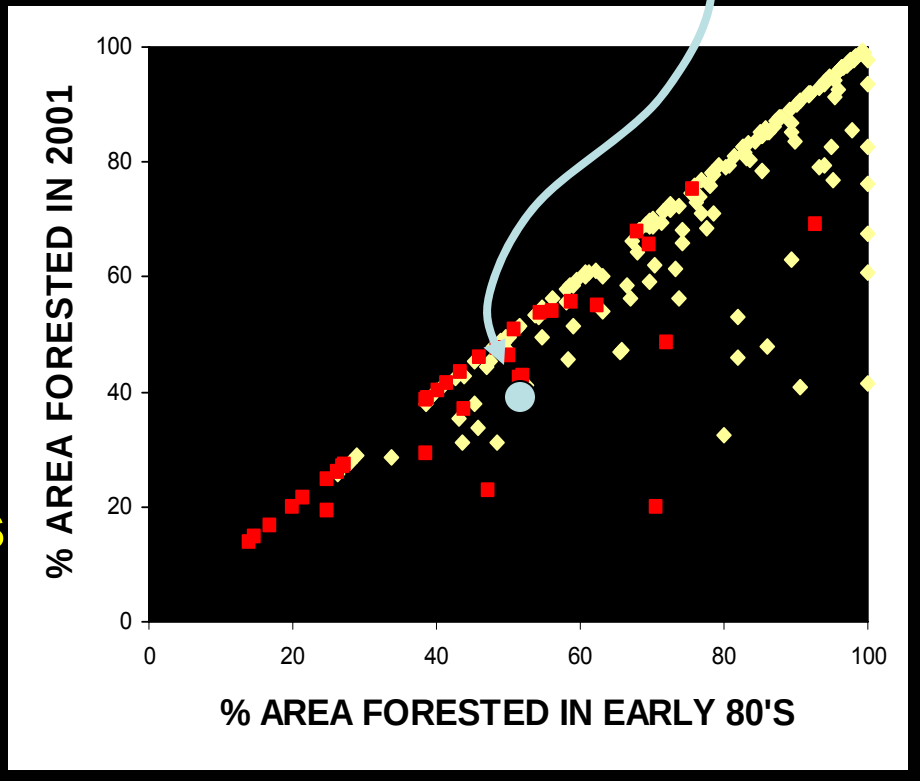
From 1980-2000:

-25% of PAs lost forest habitat inside administrative boundaries

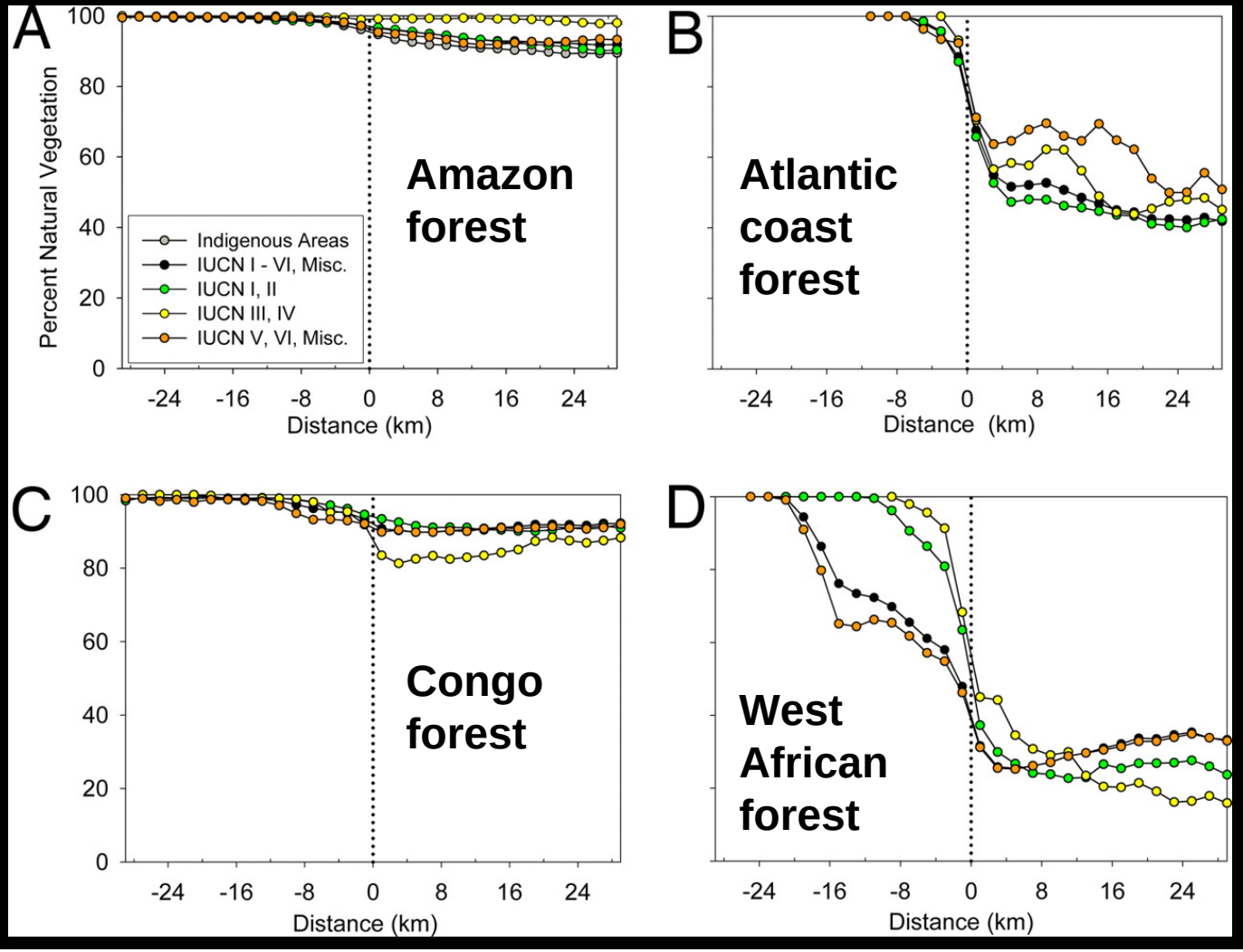
Iguazú

-75% lost forest habitat within 50-km surroundings

WITHIN 50 KM OF PROTECTED AREAS

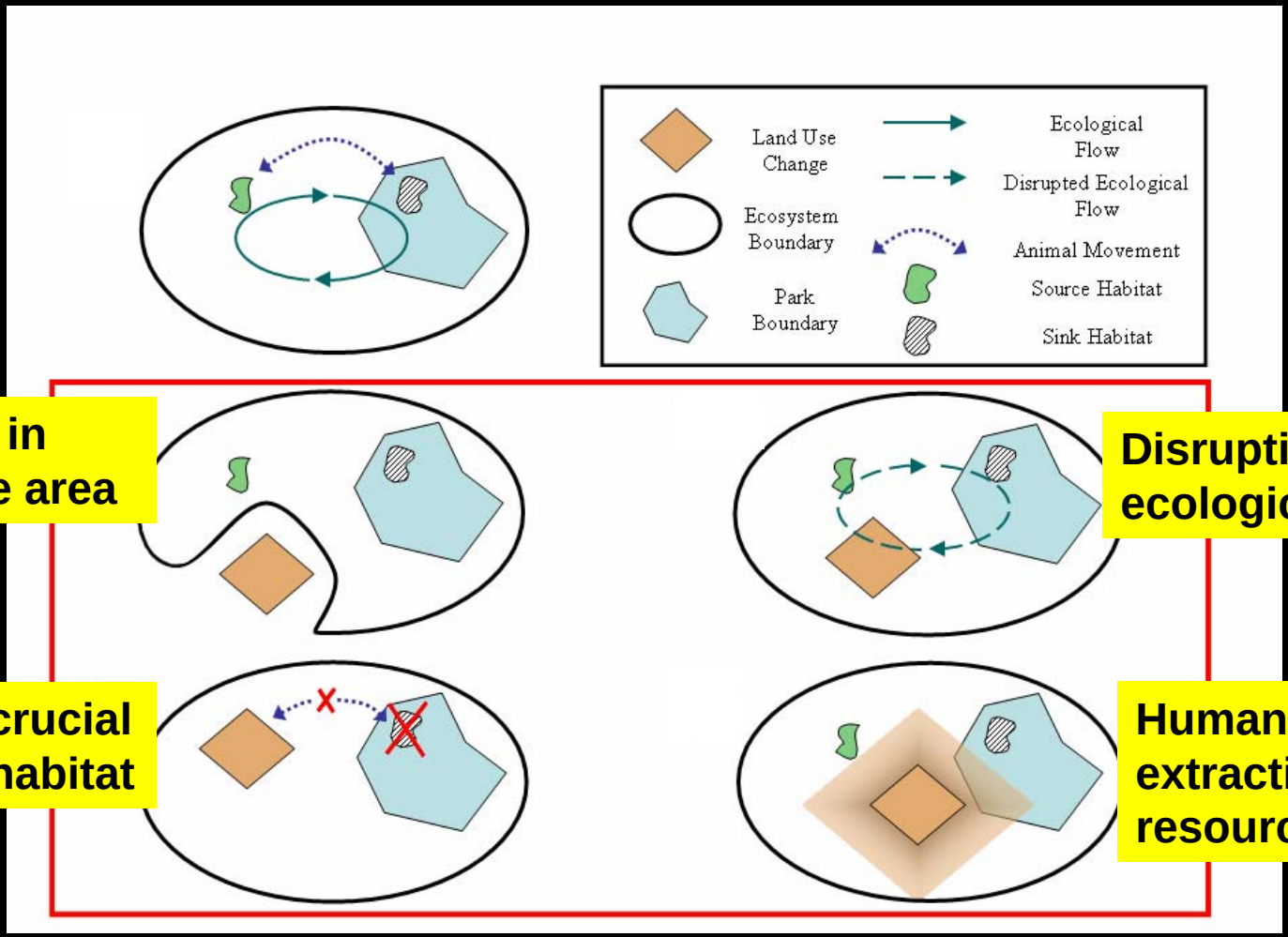


Percentage of natural vegetation inside and outside protected areas in the four geographic areas of analysis



Joppa L. N. et.al. PNAS 2008;105:6673-6678

ECOLOGICAL MECHANISMS LINKING PROTECTED AREA AND SURROUNDING LAND USE



Change in effective area

Disruption of ecological flows

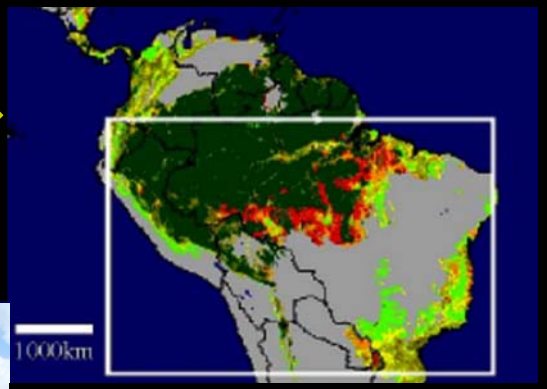
Loss of crucial outside habitat

Human extraction of resources

(from Hansen and DeFries, *Ecol Apps*, 2007)

BIODIVERSITY MEASUREMENTS AT PLOT-LEVEL INTEGRATE EFFECTS OF HUMAN INFLUENCES AT LANDSCAPE SCALES

1000s of kms



Red = 2000-05 deforestation
(Hansen et al., in press)

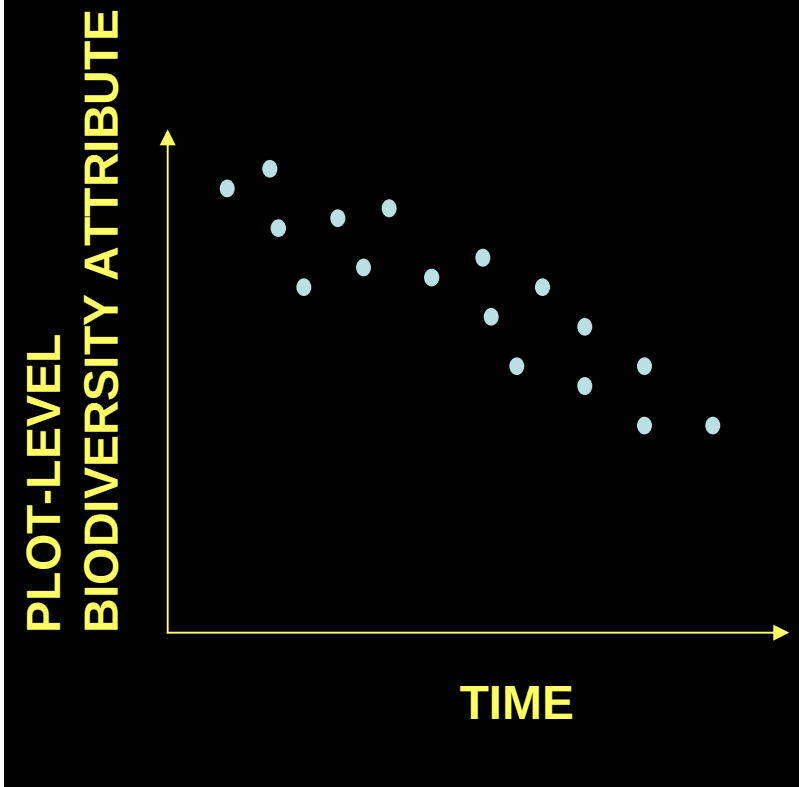
100s of kms

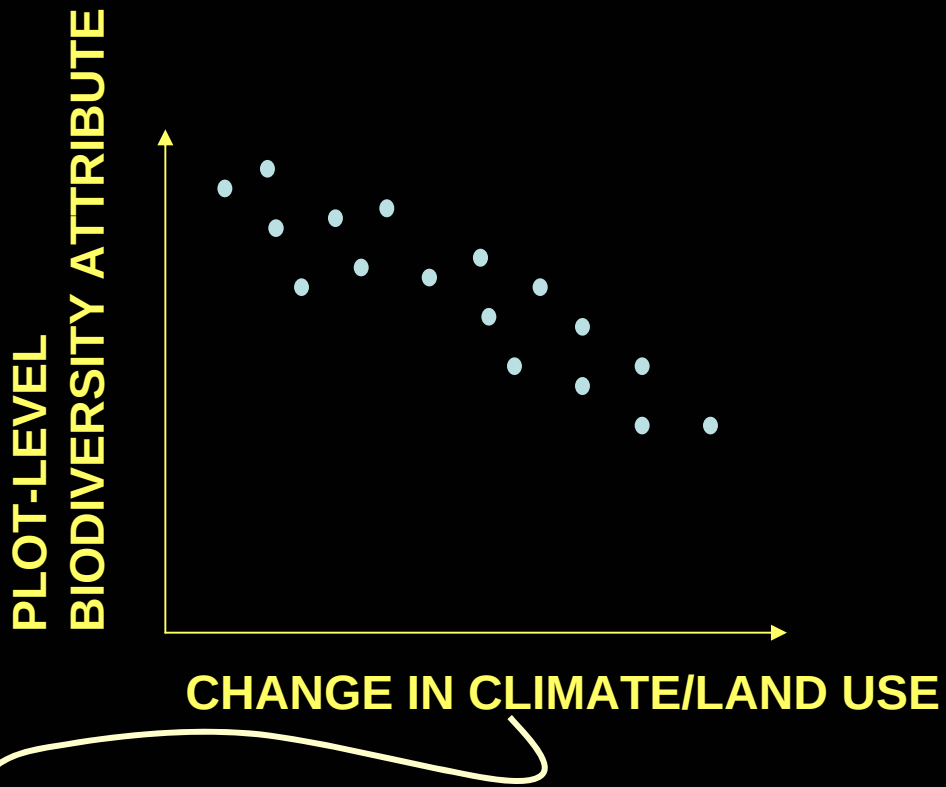
kilometers

meters

FROM OBSERVATION ……

…… TO EXPLANATION

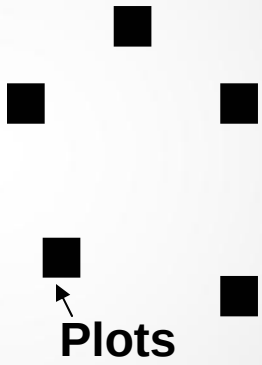


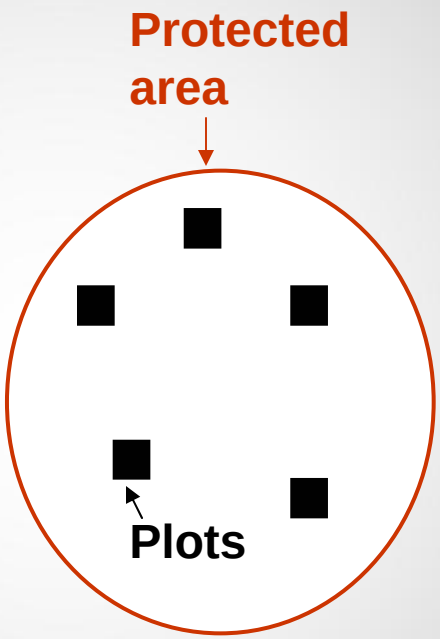


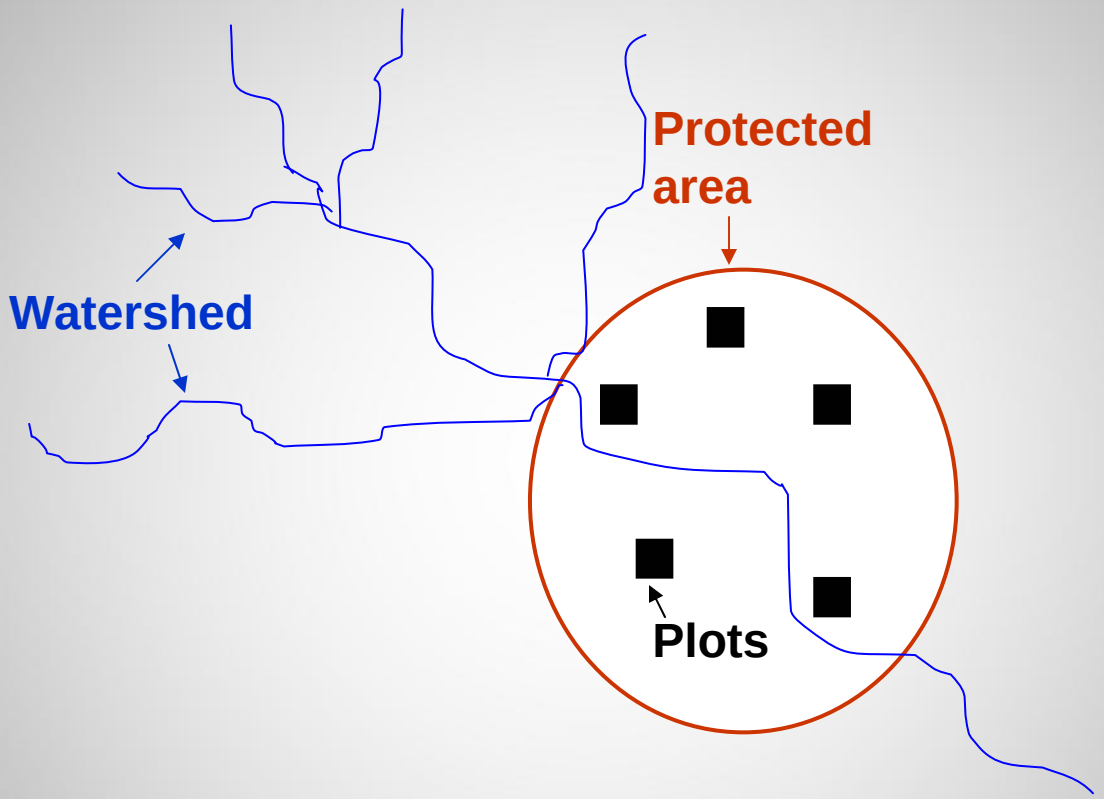
WHAT SPATIAL SCALES MATTER?

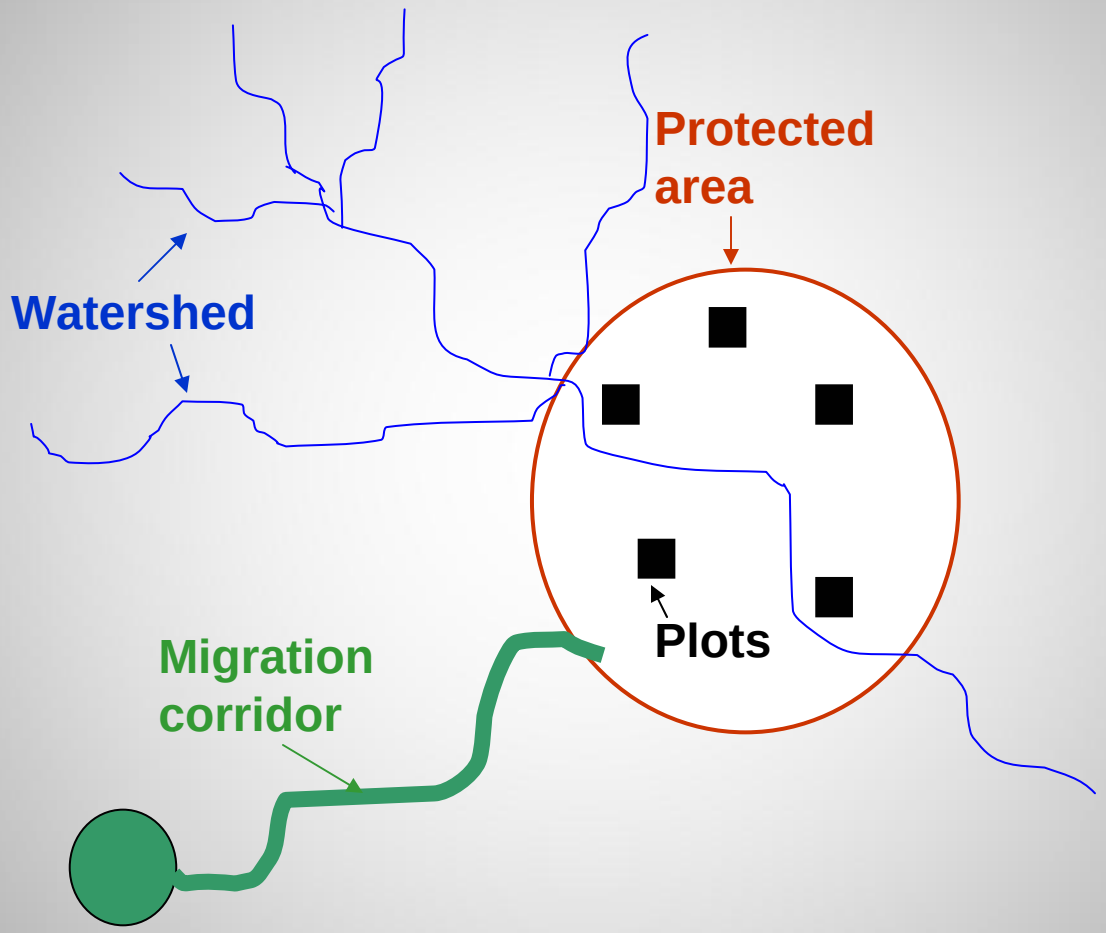
WHAT VARIABLES NEED TO BE MONITORED?

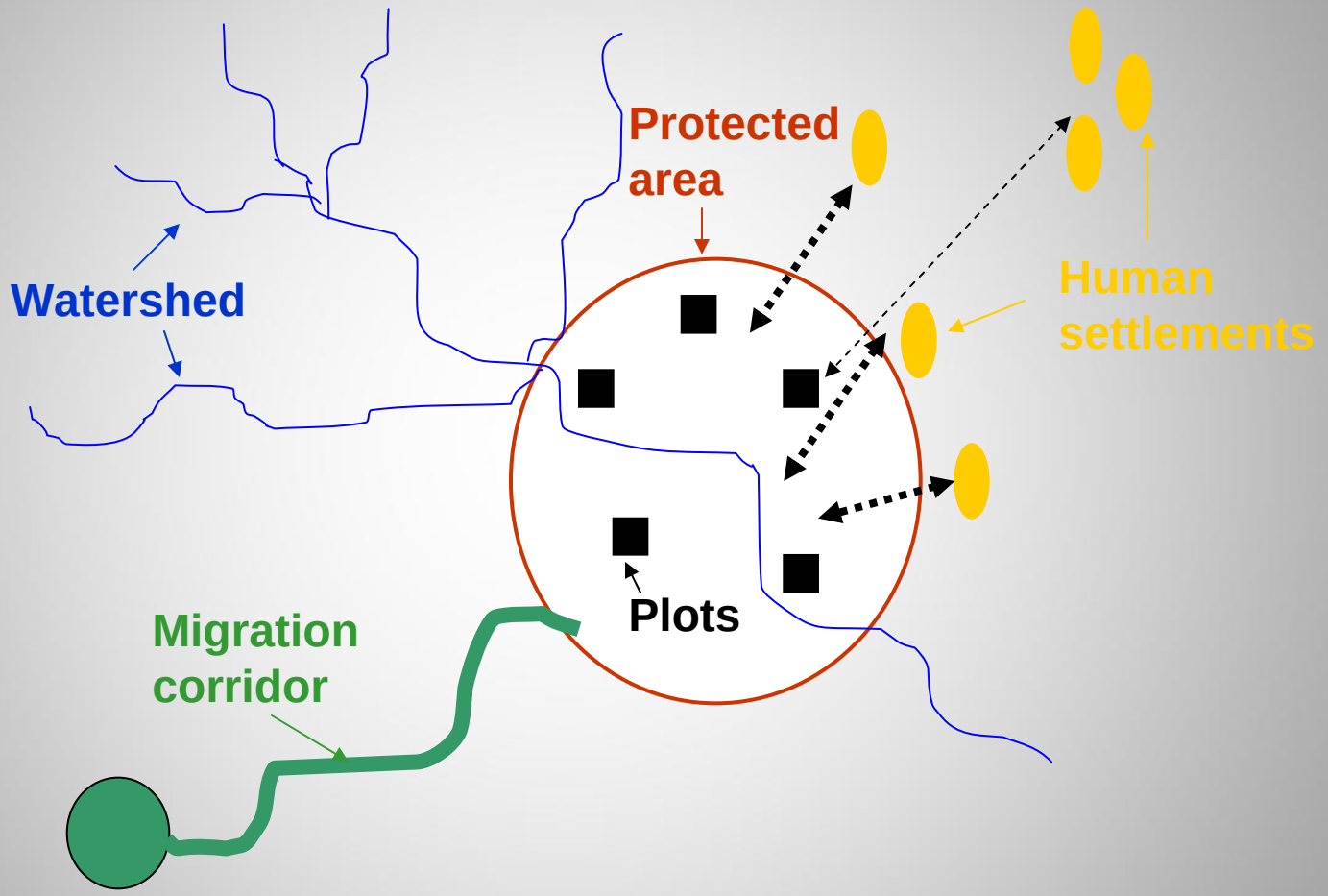
WHAT IS THE "ZONE OF INTERACTION" TO MONITOR AROUND PLOTS?

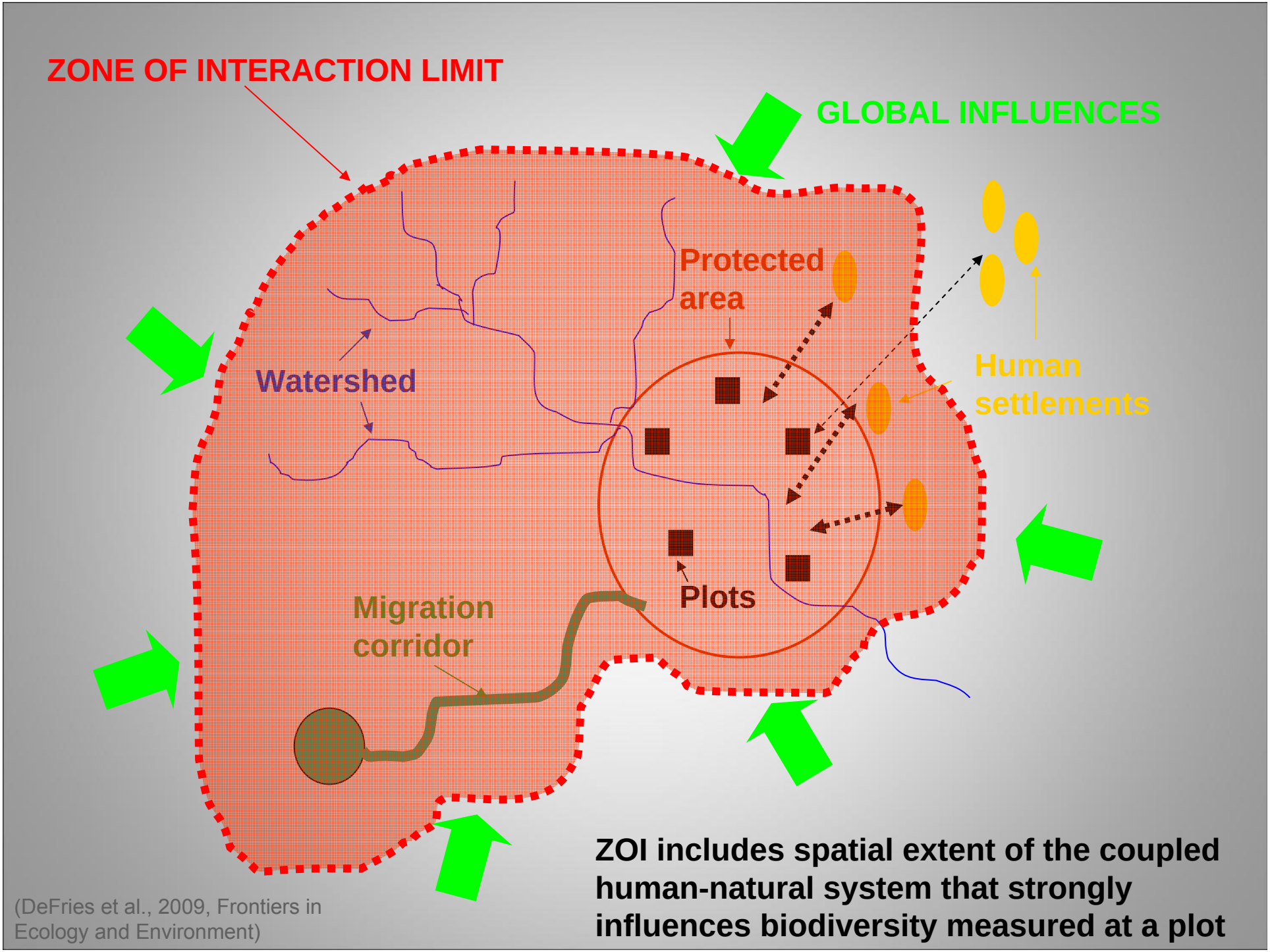

Plots


Protected area
Plots


Protected
area
Watershed
Plots


Protected
area
Watershed
Plots
Migration
corridor


Protected area
Watershed
Human settlements
Plots
Migration corridor



ZOI includes spatial extent of the coupled human-natural system that strongly influences biodiversity measured at a plot

(DeFries et al., 2009, Frontiers in Ecology and Environment)

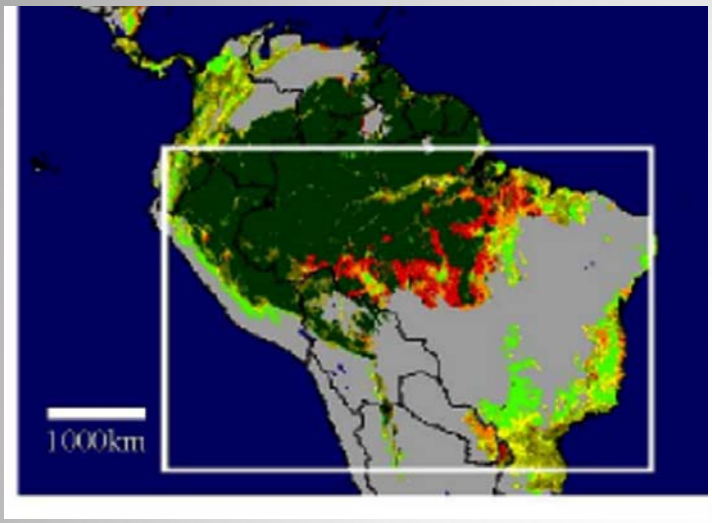
ATTRIBUTES TO MONITOR IN ZOI VARY ACCORDING TO SOCIOECONOMIC SETTING

Categories of socioeconomic settings for defining and monitoring zones of interaction around biodiversity measurement sites in tropical forests					
Socio-economic setting	**Characteristic landscape features**	**Monitoring needs**			**Site**
		Variables	**Frequency**	**Resolution**	
Remote, low human population density	Large tracts of contiguous habitat	Forest cover	Low (1x/yr)	Coarse	Suriname, Manu
Extractive frontier landscape	Partially fragmented, rapid change	Fragment-ation, human impact*	High (2x/yr)	Coarse large area/ fine where impact	Udzungwas, Manaus
Settled human land-use surrounding protected areas	Highly fragmented, "island" protected areas	Human impact*	Low, high in special circumstances	Fine	La Selva, Wolong, Ranomafana

* human impacts includes land use change, fire, number of settlements, infrastructure, and hunting

(from DeFries et al., 2009)

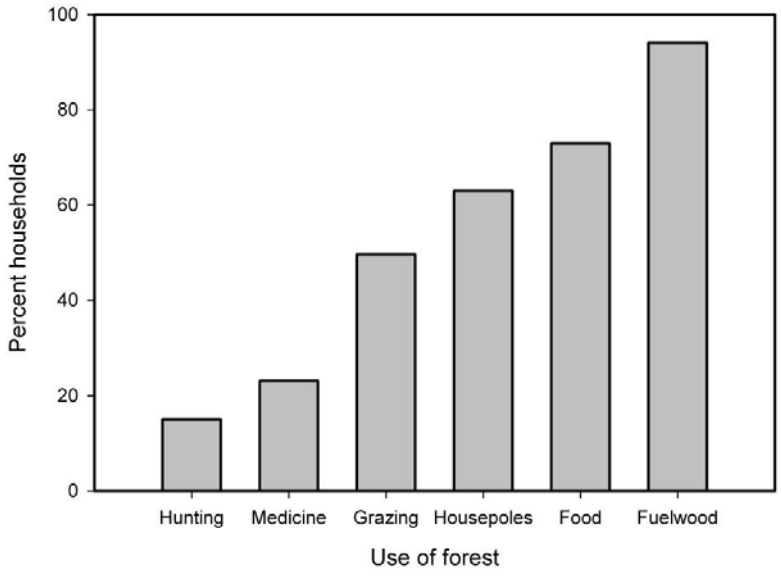
EXTRACTIVE FRONTIER LANDSCAPE: DUCKE RESERVE NEAR MANAUS, AMAZONIA



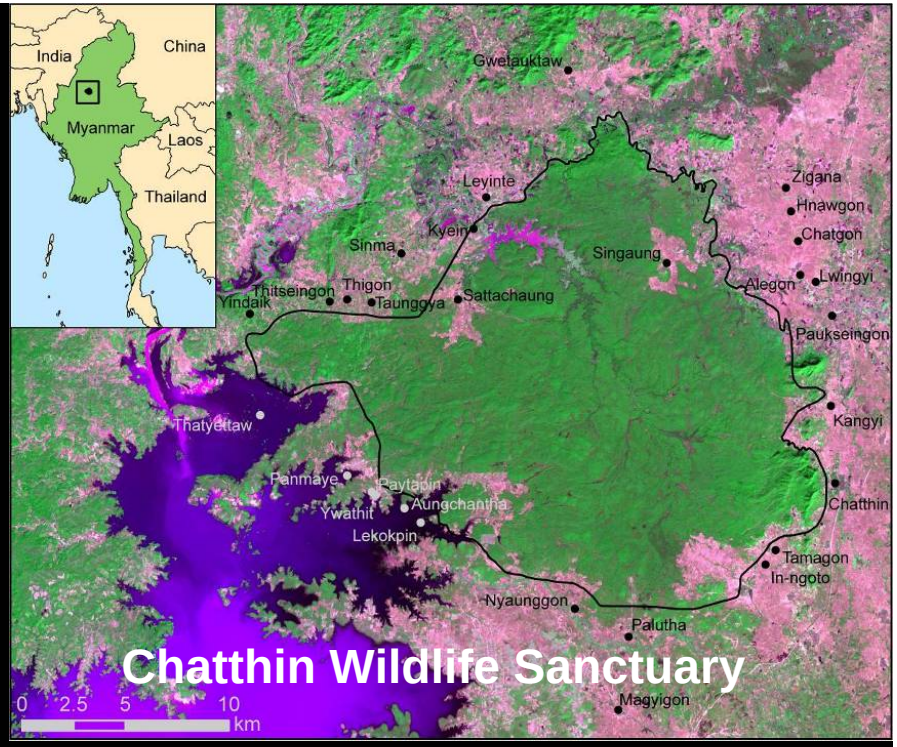
Red = 2000-05 deforestation
(Hansen et al., 2008)

Ducke Reserve near Manaus

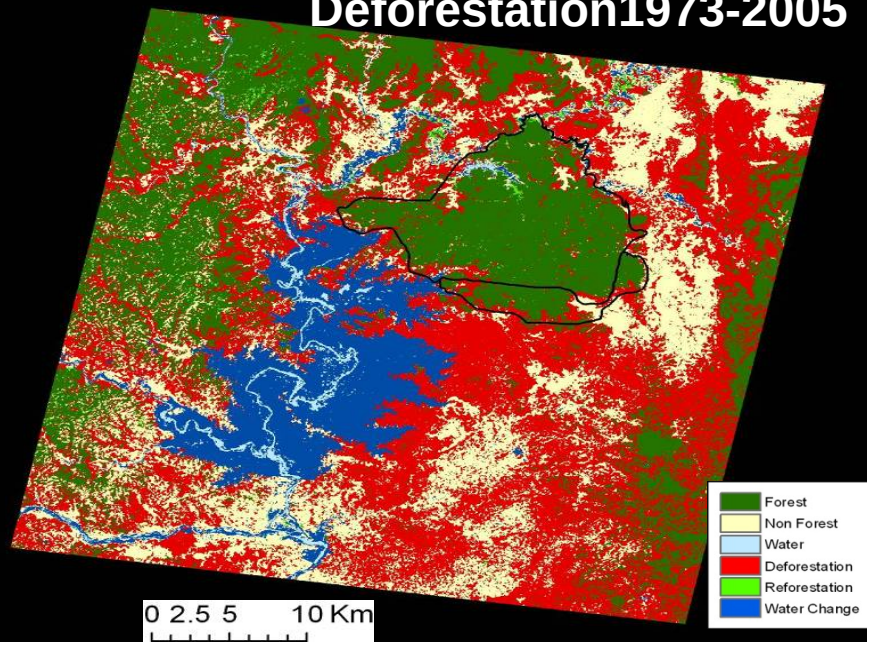
SETTLED HUMAN LAND USE: Dry Deciduous Forests of Upper Myanmar

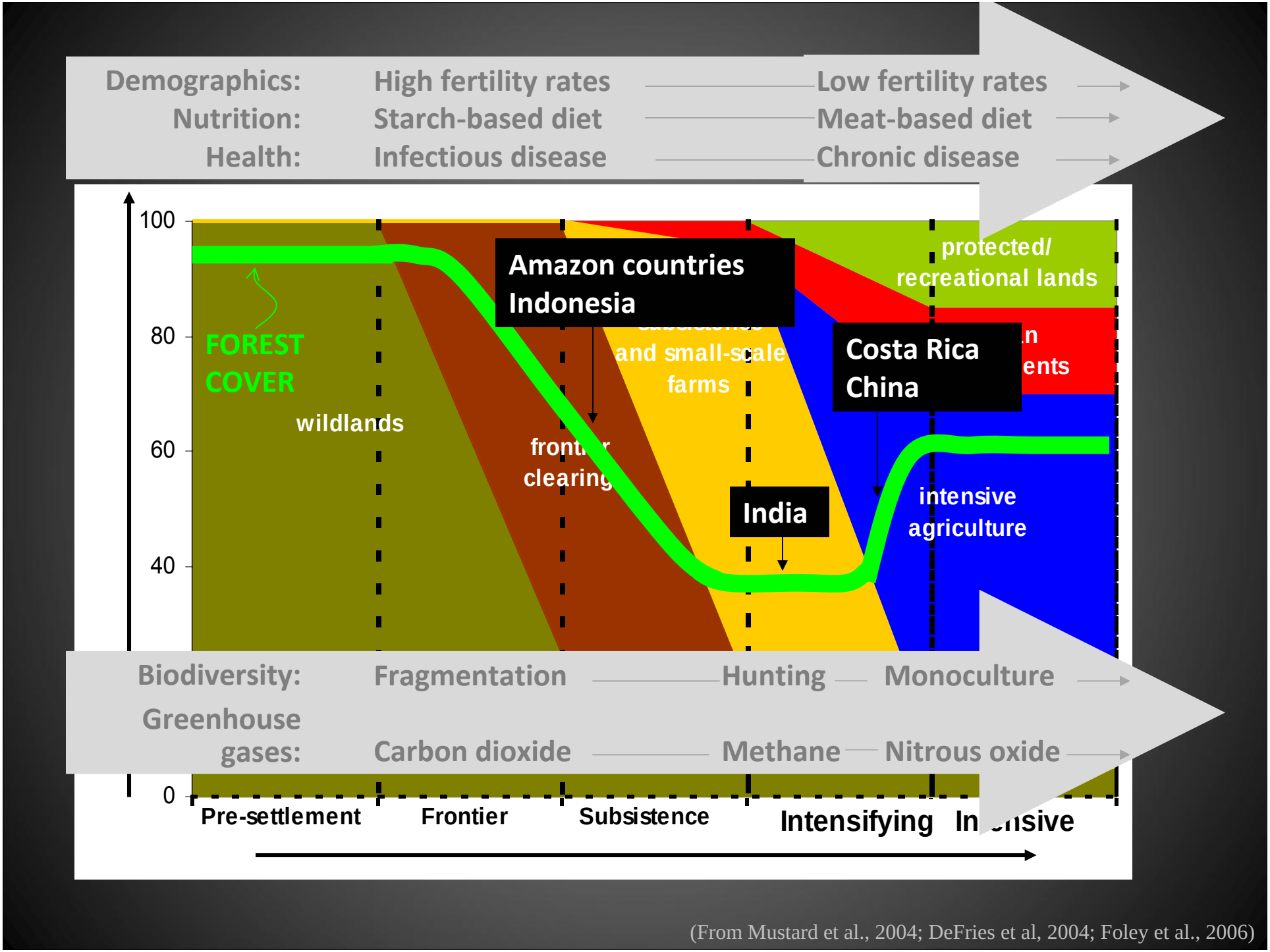


(Songer et al, 2009)



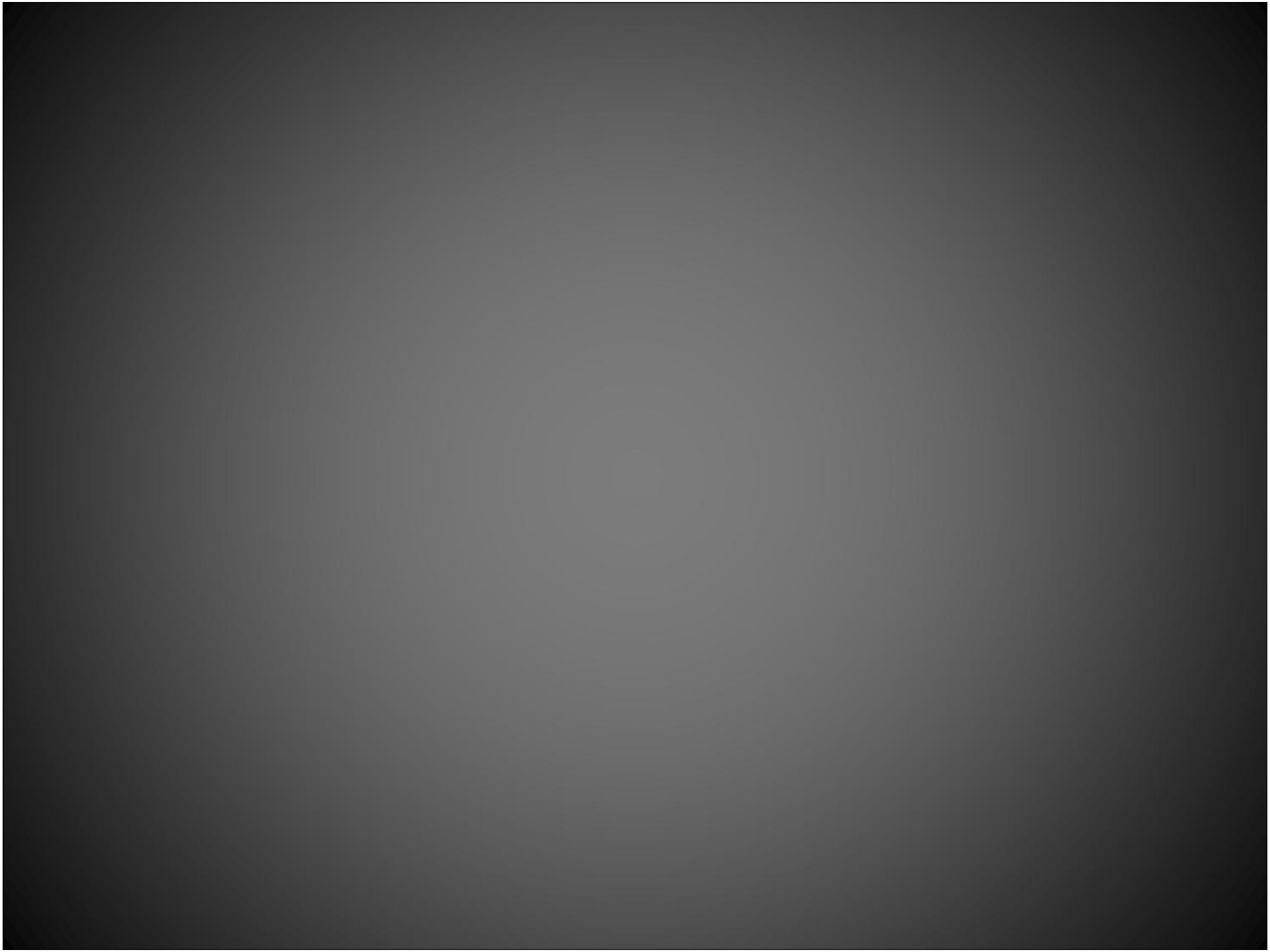
Deforestation1973-2005



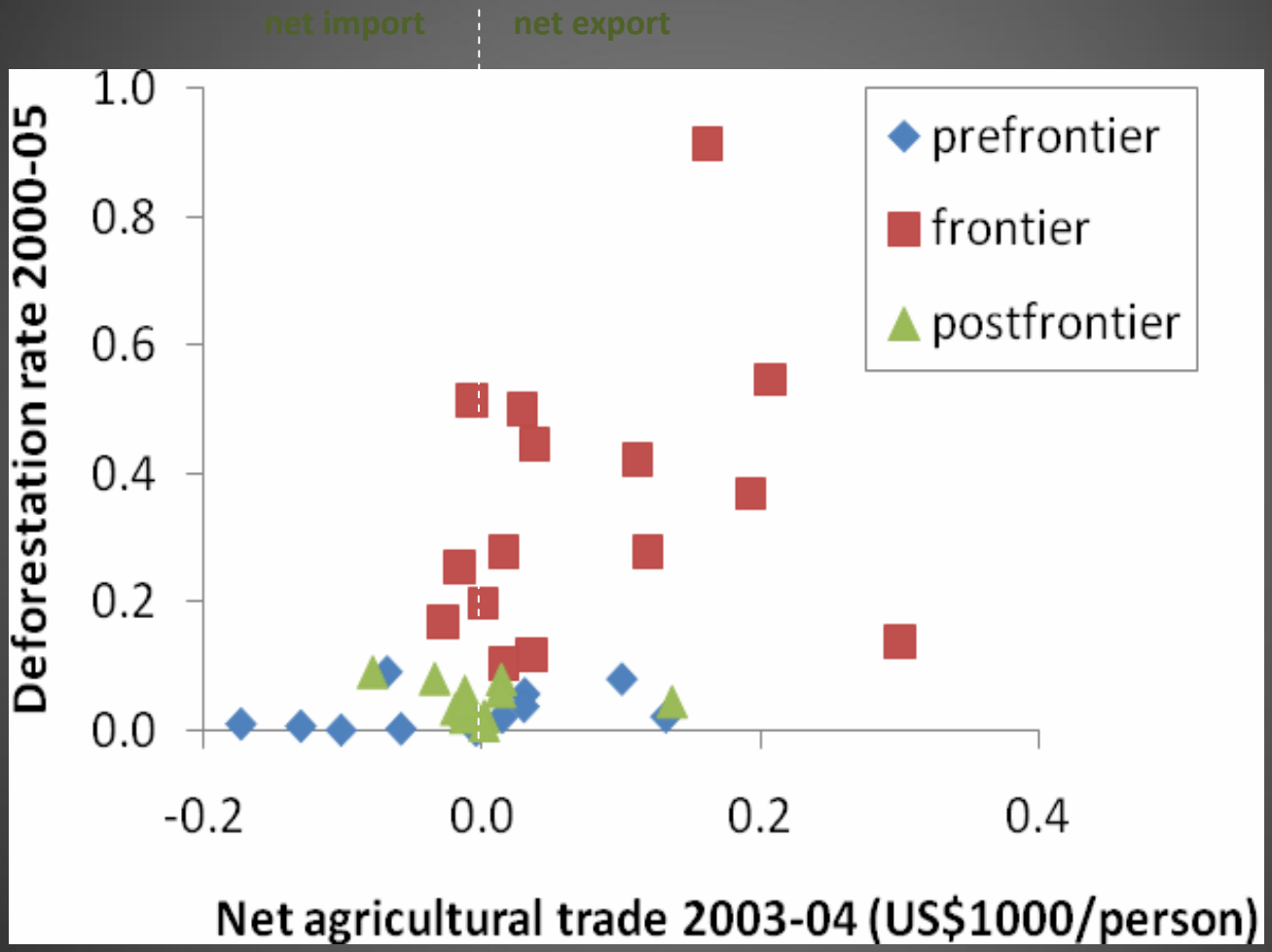


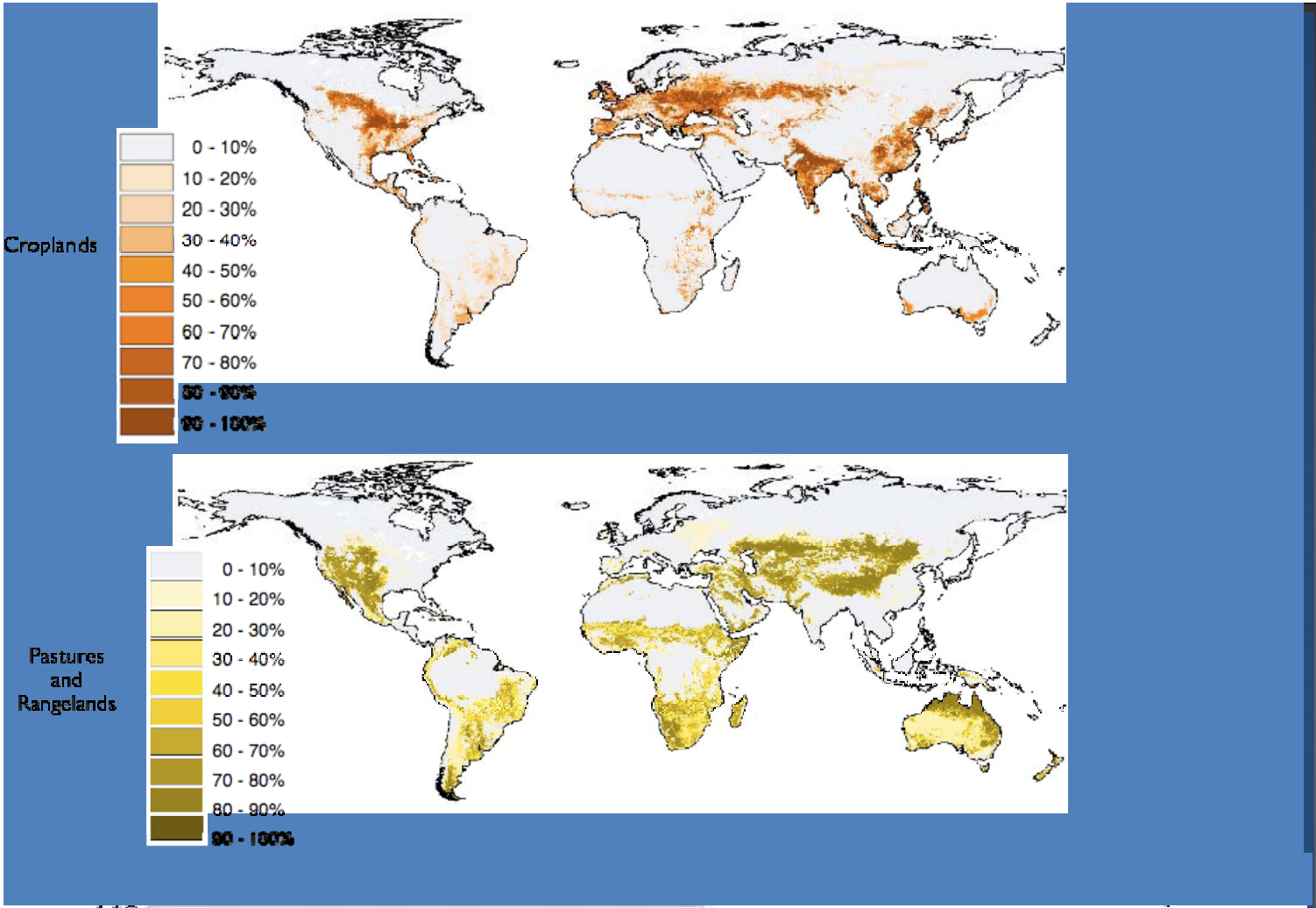
(From Mustard et al., 2004; DeFries et al, 2004; Foley et al., 2006)

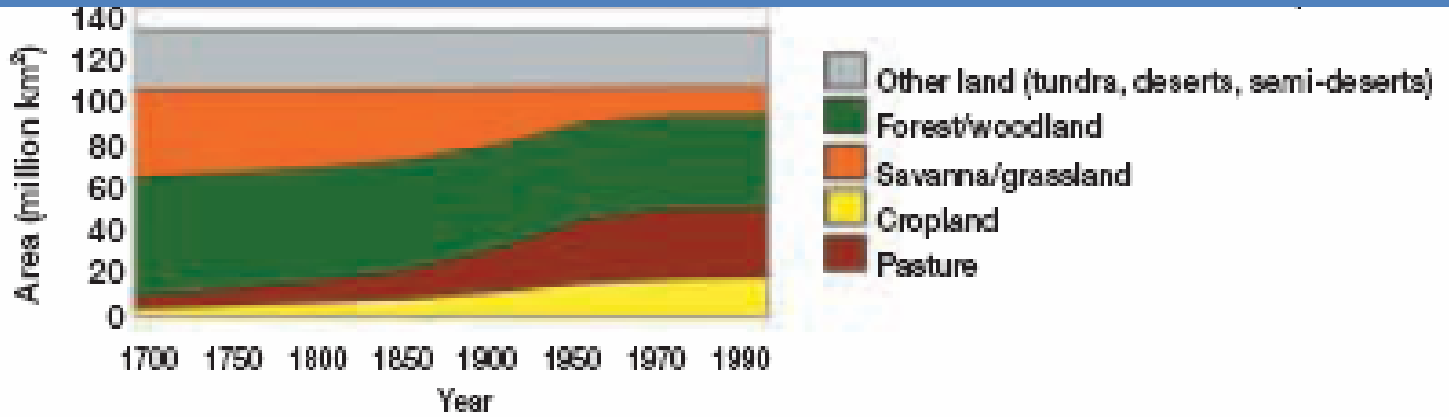

THANK YOU



Gross deforestation in 2000-05 positively associated with agricultural exports







~18 million km² in crops

~30 million km² in pastures

Foley et al., Science, 2005
DeFries et al., Frontiers, 2004