

Contributions to the FAO Forest Resource Assessment 2010 remote sensing survey and beyond

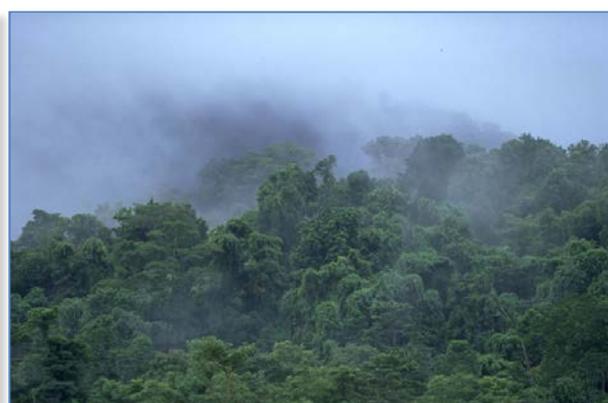
Alan Belward*, Fred Achard*, Hans-Juergen Stibig*, Philippe Mayaux*,
Rene Beuchle*, Hugh Eva*, Kenneth MacDicken**
and the TREES-3* and FRA 2010 RSS** staff

*Joint Research Centre, Ispra, Italy
<http://bioval.jrc.ec.europa.eu/>

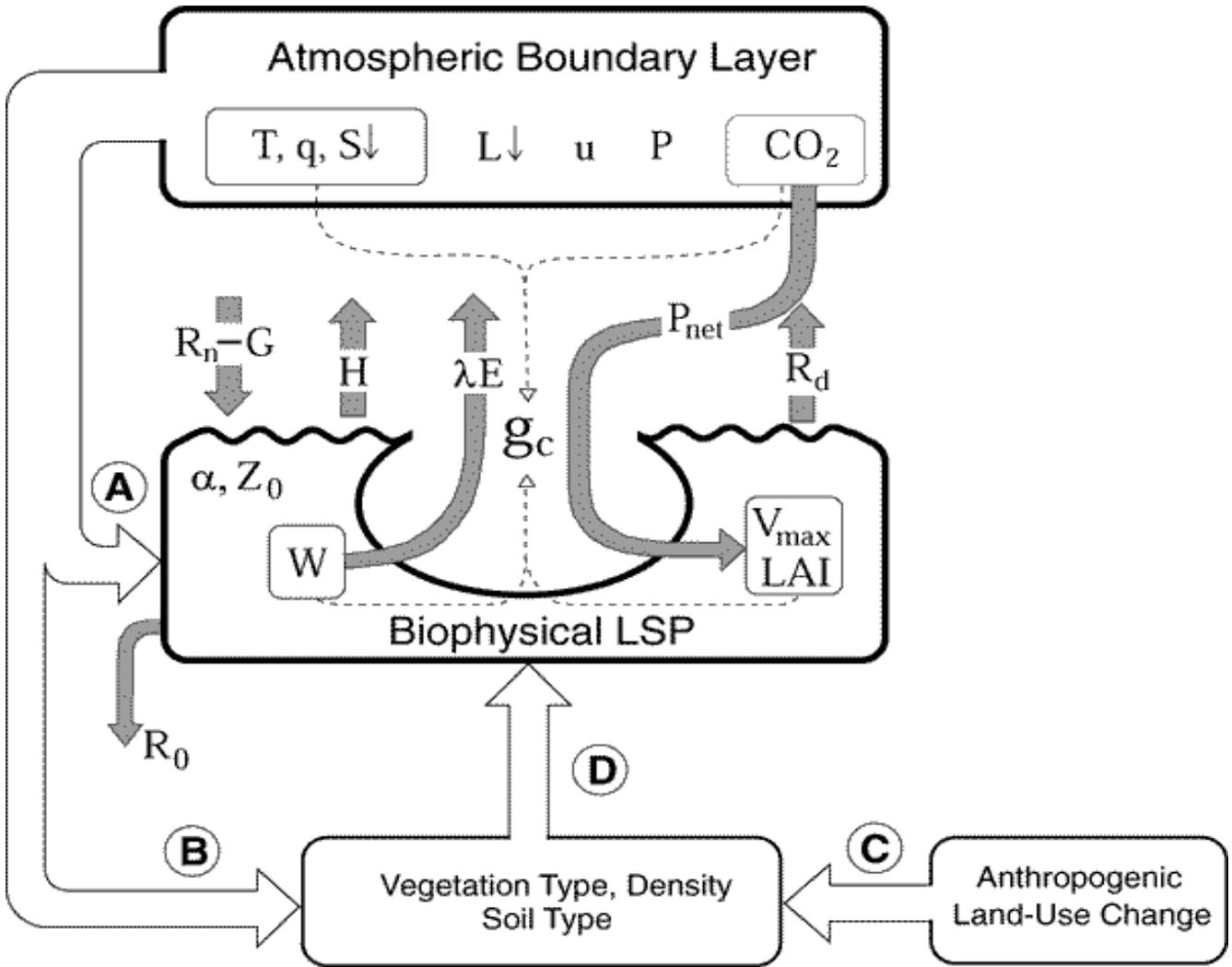
**Food and Agriculture Organisation of the UN, Rome, Italy
www.fao.org/forestry/fra2010

Why monitor forests?

- Income, taxes and jobs
- Social and esthetic value
- Hydrological cycle
- Soil formation and protection
- Habitats and mass extinctions
- Carbon sink, source and storage
- Climate system and climate change



31% of land surface covered by forest (4 bn ha)



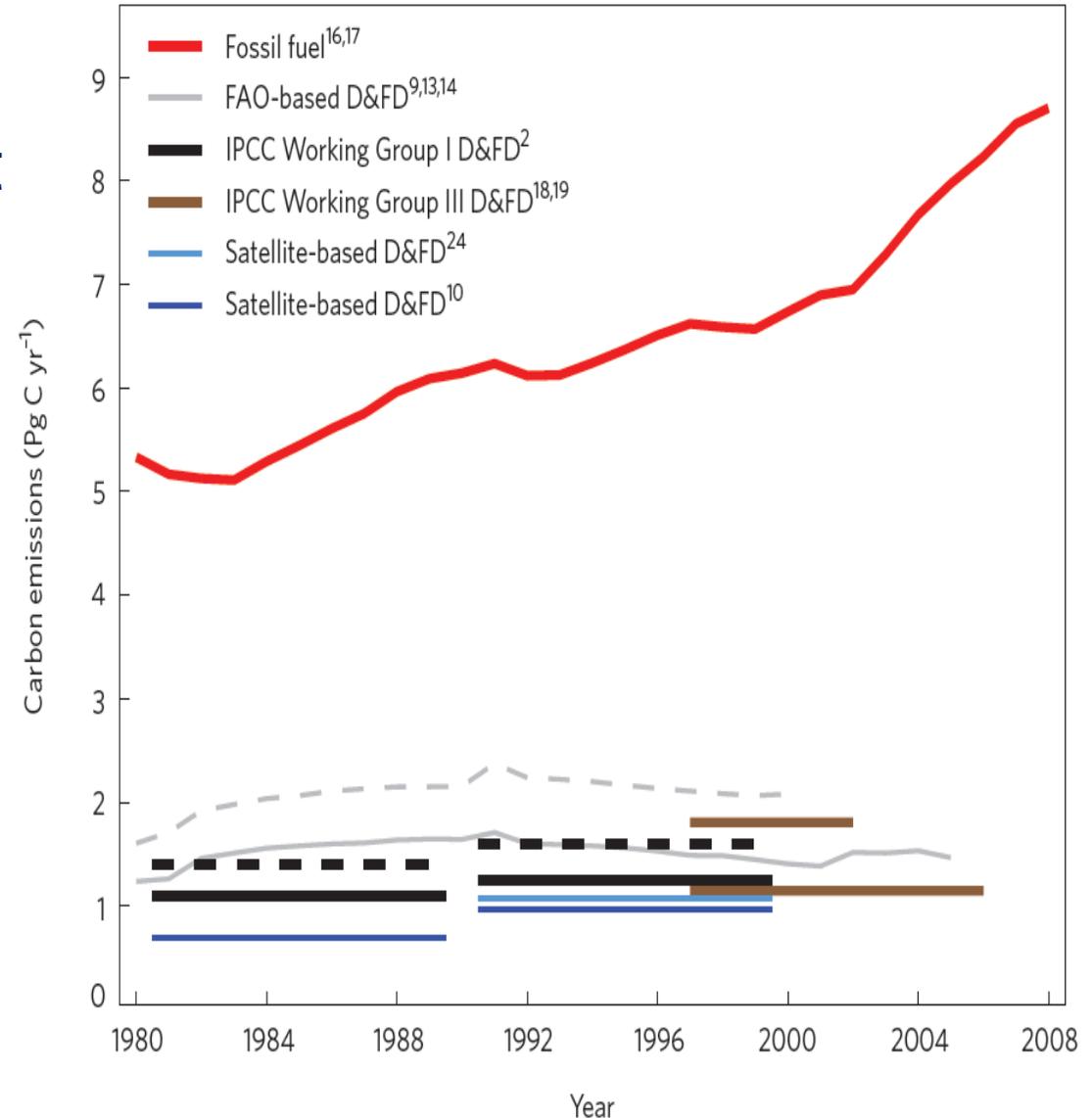
Source IPCC TAR, 2001, FAO FRA 2010

CO2 emissions from deforestation and forest degradation

- CO2 emissions from deforestation and forest degradation for 1997-2004:

~ 1.2 Pg C yr⁻¹

- (12% [6–17%] of total anthropogenic CO2 emissions)



Global Forest Resource Assessment

- Global forest resources assessments have been made every five to ten years since 1940's
- The FAO Constitution states
 - “The Organization shall collect, analyse, interpret and disseminate information relating to nutrition, food and agriculture. In this Constitution, the term ‘agriculture’ and its derivatives include fisheries, marine products, forestry and primary forestry products.”



UN Framework Convention on Climate Change

The Little REDD Book

GCP
Global Canopy Programme

A guide to governmental and non-governmental proposals for reducing emissions from deforestation and degradation

G GLOBAL
C CLIMATE
O OBSERVING
S SYSTEM

WMO UNESCO UNEP ICSU

WORLD METEOROLOGICAL ORGANIZATION INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

SYSTEMATIC OBSERVATION REQUIREMENTS FOR SATELLITE-BASED PRODUCTS FOR CLIMATE

Supplemental details to the satellite-based component of the "Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC"



Forest Law Enforcement, Governance and Trade

- Control of illegal logging in Cameroon and Indonesia avoided tax losses of \$4 billion between 2001 and 2006
- Forest reforms in Cameroon since 1994 saw tax revenues go from zero to \$50 m/yr in 2004

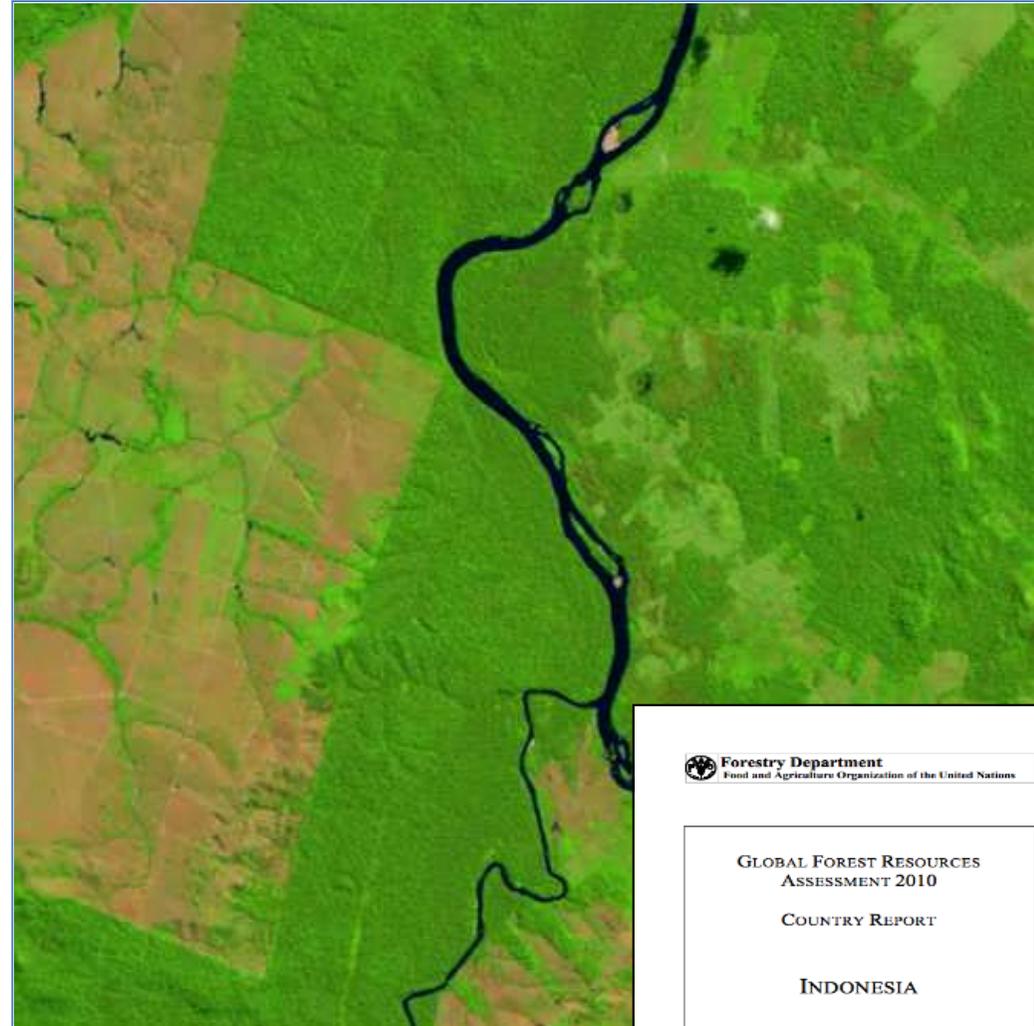


Source: Statistics - Illegal Logging and Related Trade: 2008 Assessment of the Global Response (Pilot Study), Chatham House, August 2008, <http://www.illegal-logging.info/indicators>

Photo: <http://www.africanews.com/> Cameroon introduces wood tracking system, posted 17th June 2010

Accurate reporting of global forest resources – the FRA

- Two approaches:
 - Country reports;
Essential basis for global reporting if more than land cover are desired
 - **Remote sensing;
Systematic grid using Landsat**



Picture credits FAO FRA 2010 Key findings
USGS Landsat 5 P231 R 67 22nd July 2011

 **Forestry Department**
Food and Agriculture Organization of the United Nations

GLOBAL FOREST RESOURCES
ASSESSMENT 2010

COUNTRY REPORT

INDONESIA

FRA2010/095
Rome, 2010

FRA 2010 scope

- 233 countries and areas from the United Nations Statistics Division list
- 7 themes covering 90 variables on forest extent, condition, uses and values
- 4 epochs: 1990, 2000, 2005 and 2010
 - 178 national correspondents
 - 10 regional workshops
 - Rigorous review > 900 specialists involved

- Extent of forest resources
- Forest biological diversity
- Forest health and vitality
- Productive functions of forest resources
- Protective functions of forest resources
- Socio-economic functions of forests
- Legal, policy and institutional framework



Forest loss, gain, net change

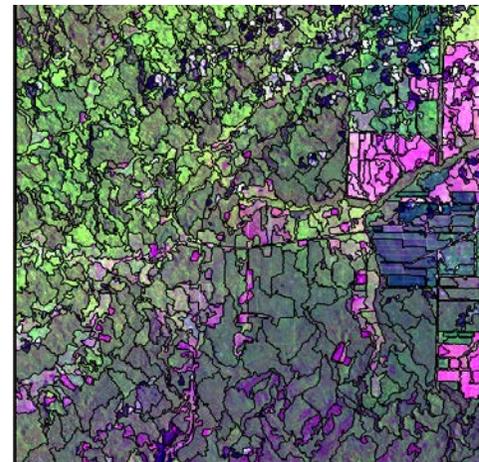
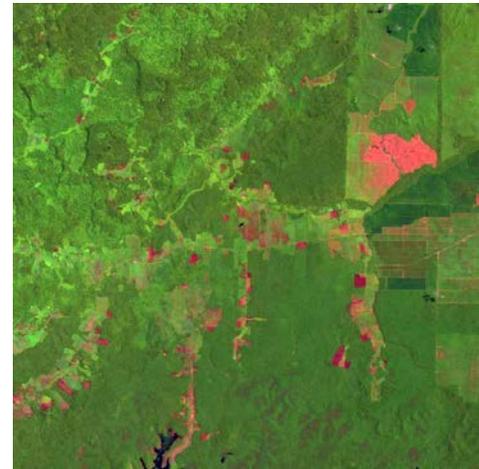
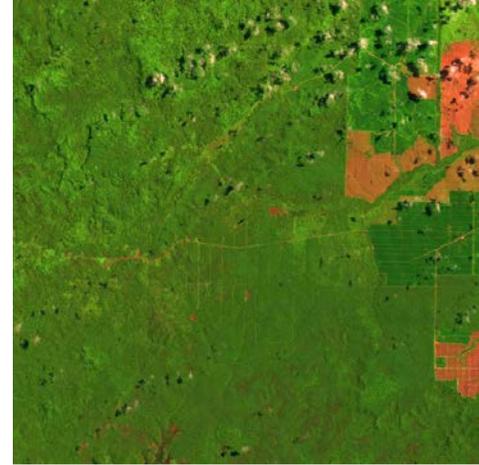
- Deforestation 1990-2000: 16 million ha/year
- Deforestation 2000-2010: 13 million ha/year
- Afforestation >7 million ha/year
- Net change 1990-2000: -8.3 million ha/year
- Net change 2000-2010: **-5.2 million ha/year**

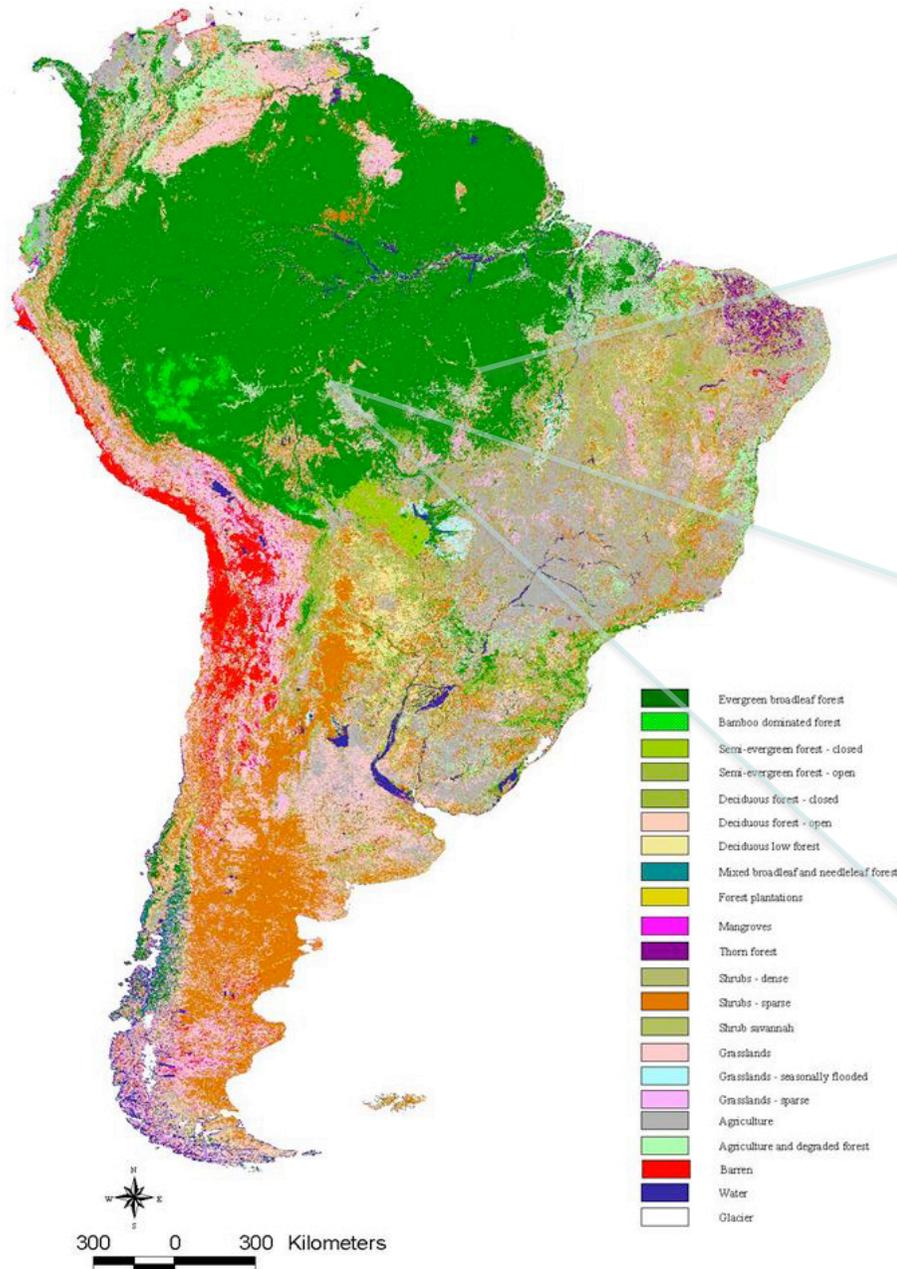


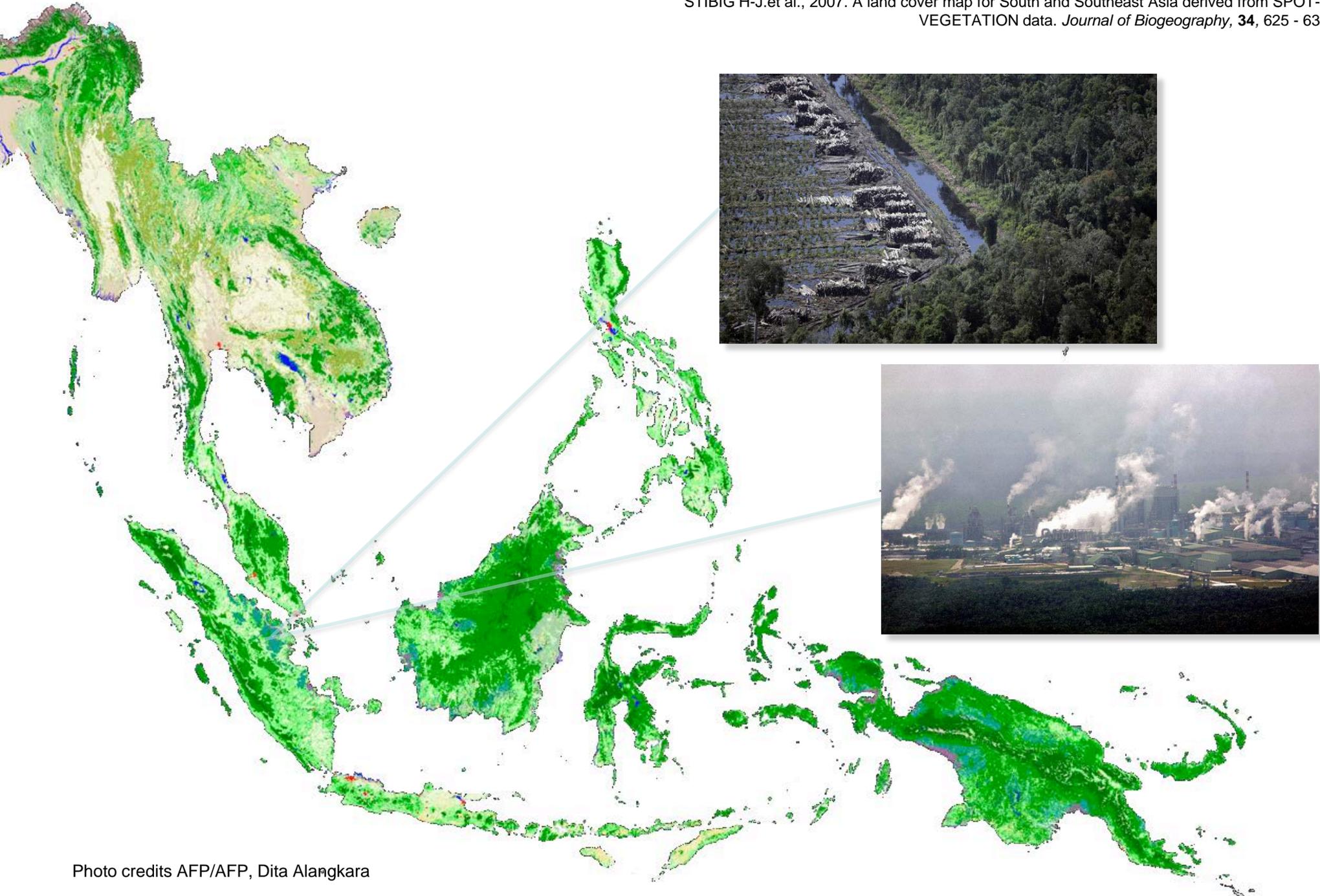
TREES-3

Source; USGS S01_W053_tm_226-061_23081986
S01_W053_etm_226-061_08042003; segmentation JRC

- Humid tropics
- Forest cover maps at regional scale
- Location of rapidly changing regions - hotspots
- Forest cover change measurements from 1990 to 2000 to 2005 to 2010
- Carbon emission estimates from forest cover changes
- Assessment of deforestation drivers at sub-regional levels





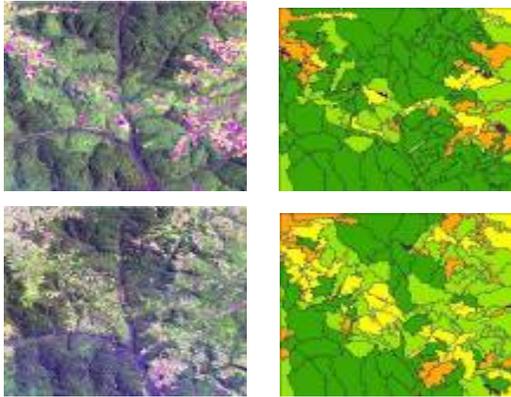
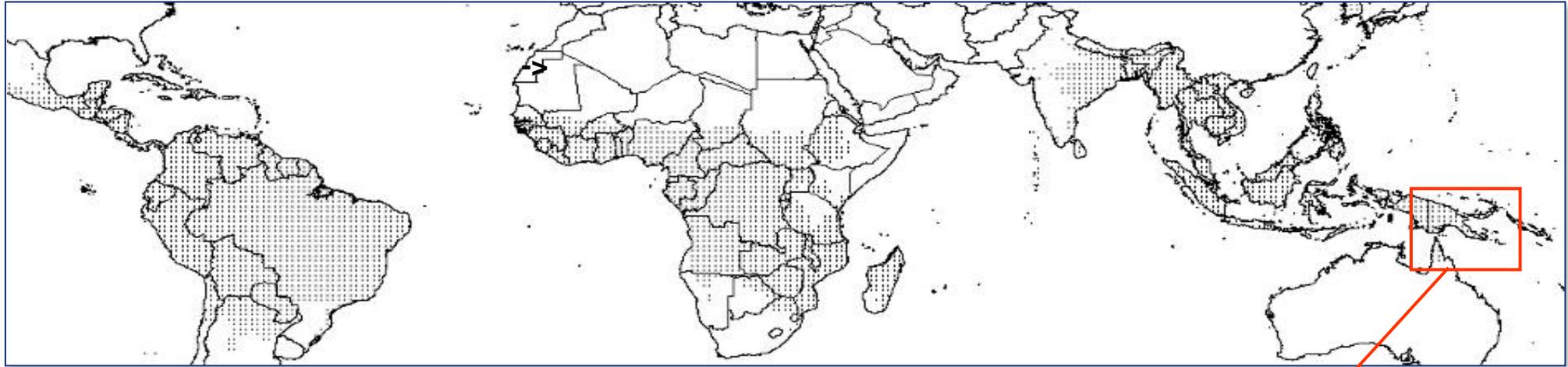


Systematic sampling - 4016 sample sites

Tropical Latin America & Caribbean (LAC):
1230 sample sites

Sub-Saharan Africa (AFR): 2045 sample sites

South and Southeast Asia plus PNG and the Solomon Islands (SEA):
741 sample sites



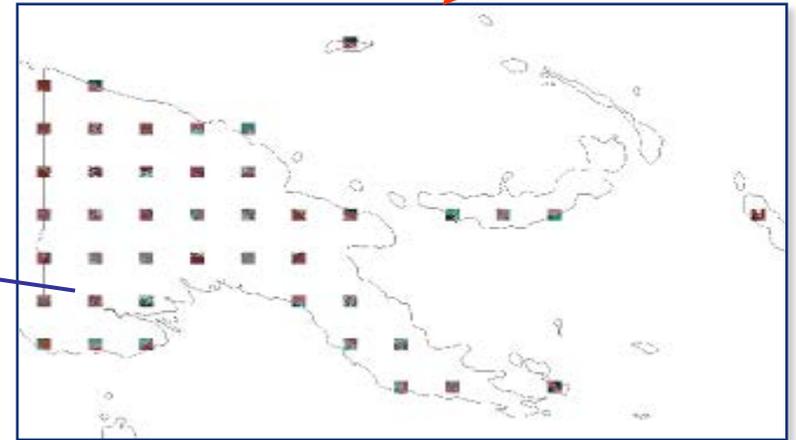
1990



2000

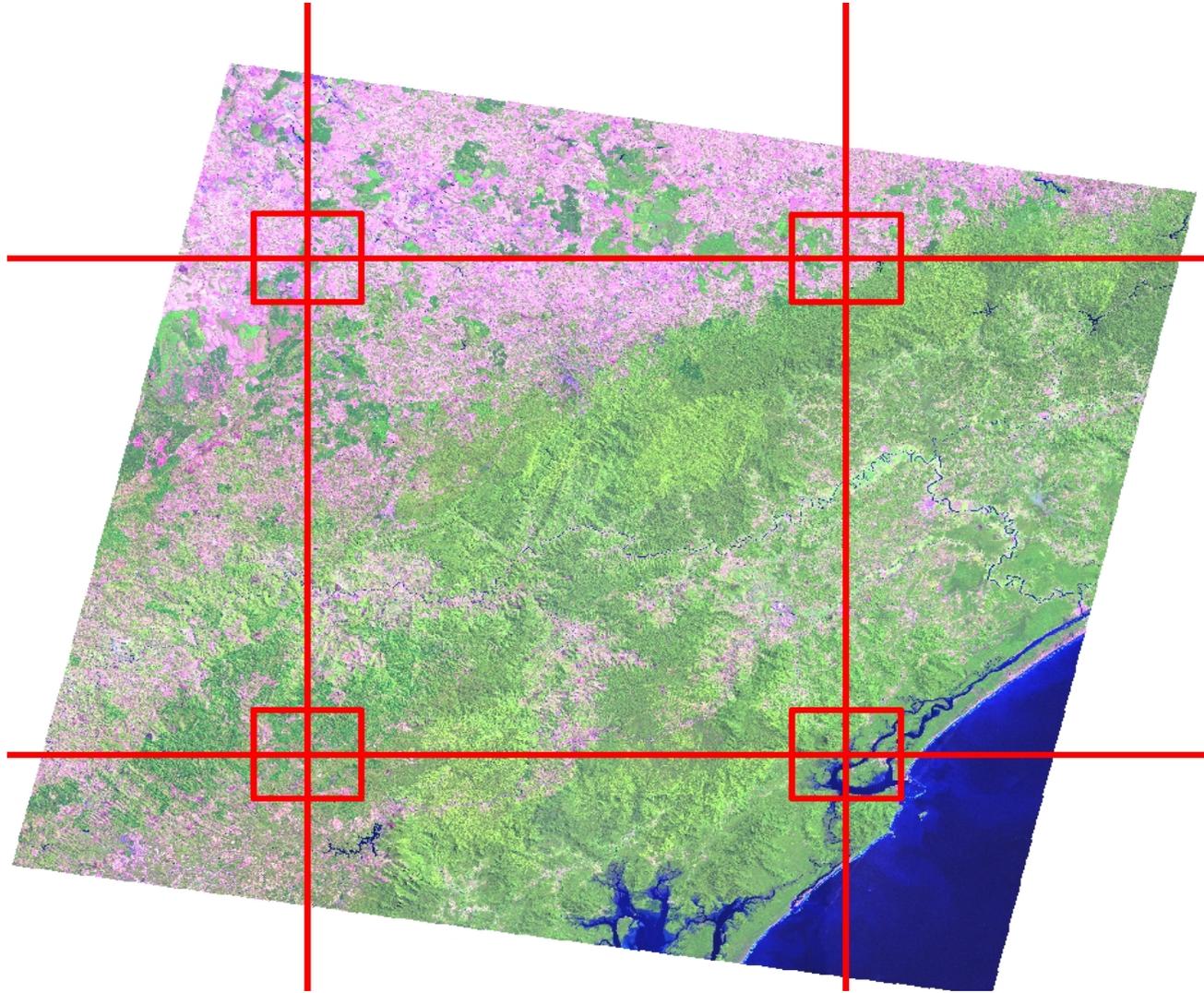


2010



Samples are 20km x 20km size

One scene = multiple sample sites (boxes)



Distribution of 20 km X 20 km sample sites for every degree confluence on Landsat scene Path-Row 220-077

Each site visually screened for best available image

WORKING ON : Brazil -> Brazil OUTPUT DIR Browse Export

S10_w063_tm_232-067_08071989.tif 4

R 5 G 4 B 3 Bands 6

Cloud % 0 0 value % 0 Stretch No

20x20 km 10x10 km

dd mm yyyy 08 07 1989

STATUS 1

Usage Quality Priority
 WHOLE Good 1
 MOSAIC Medium 2
 REPLACE Poor 3

EXTRA Haze Bias
 Stripe Season
 Topo Geolocation

CHANGE 90 - 00
 Yes No

S10_w063_etm_232-067_19092001.tif 3

R 5 G 4 B 3 Bands 6

Cloud % 0 0 value % 0 Stretch No

20x20 km 10x10 km

dd mm yyyy 19 09 2001

STATUS 1

Usage Quality Priority
 WHOLE Good 1
 MOSAIC Medium 2
 REPLACE Poor 3

EXTRA Haze Bias
 Stripe Season
 Topo Geolocation

CHANGE 00 - 05
 Yes No

GLC2000 classification

AGRI No Patch Large
FOREST No Patch Large

ZOOM
Next Close
Previous Save to file
Reset

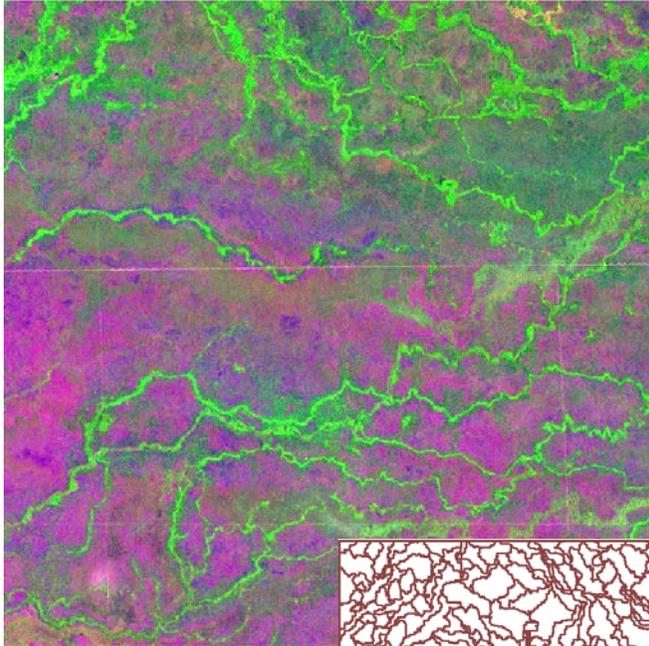
Lat lon S 10 W 063

B I N
F T I (90/00)
 A 1 GG
 B 2 MG
 C 3 GM
 Clear 4 MM

Add notes 2 Erase

Global Environment Monitoring Unit
gem

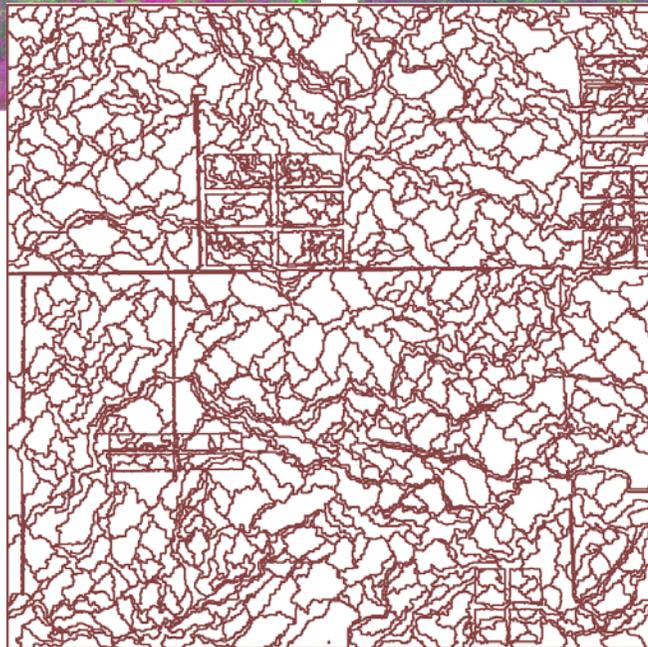
Segmentation



Historical

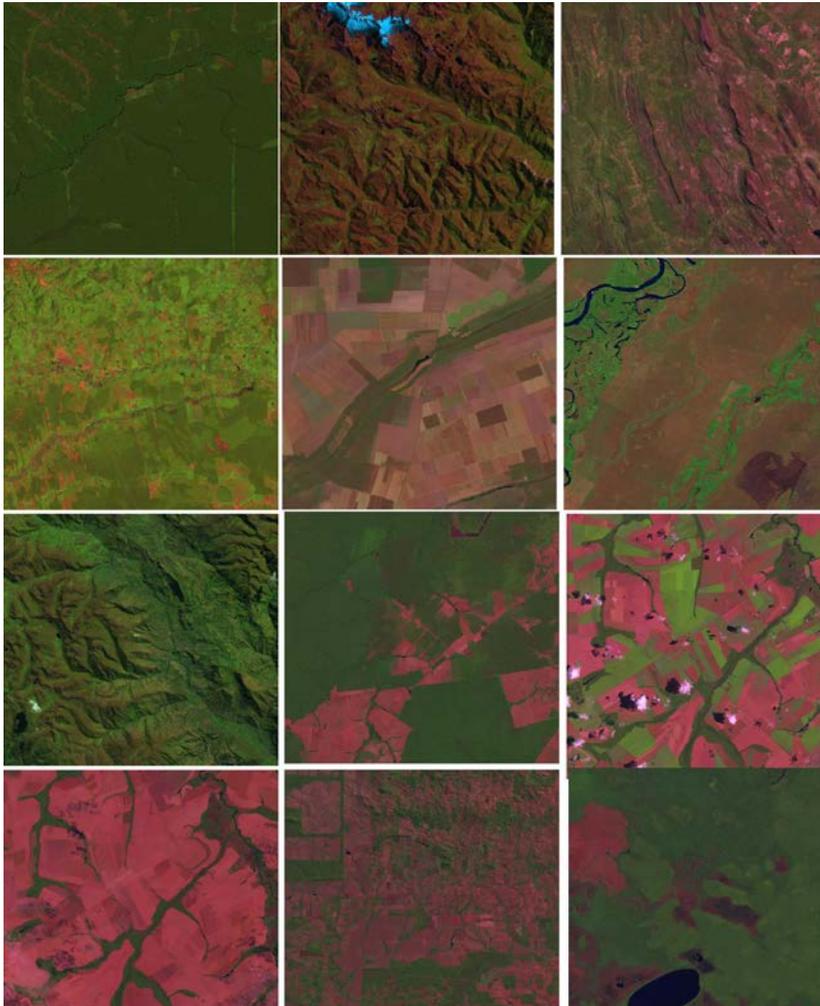


Recent

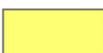


Classification

A regional subset is used to collect spectral signatures



Legend

-  TREE COVER
-  TREE MOSAIC - HIGH%
-  TREE MOSAIC - LOW%
-  SHRUB COVER
-  SHRUB COVER - REGROWTH
-  OTHER VEGETATION COVER
-  BARE OR ARTIFICIAL
-  BURNT
-  WATER
-  NON-TREE MOSAIC
-  CLOUD OR SHADOW
-  NO DATA

IDL 1990

UNKNOWN

VEGETATION Evergreen Dec

Vegetation with forest

Dense Open D

Regrowth Plantation

Mosaic Forest / Other Rural

Mosaic Other / Forest

Other vegetation

Shrubs Grasslands

Trees plant. Shrubs plant.

Arable Irrigated

Pasture Agri - mosaic

UNVEGETATED

Water Open

Water - flooded vegetation

Urban Infrastructure

Rocks Black

Bare soil White

Snow/ice

Other Cloud Cloud shadow

Observation condition

OK Shadow Burnt

Haze Sun facing slope Floded

Image season

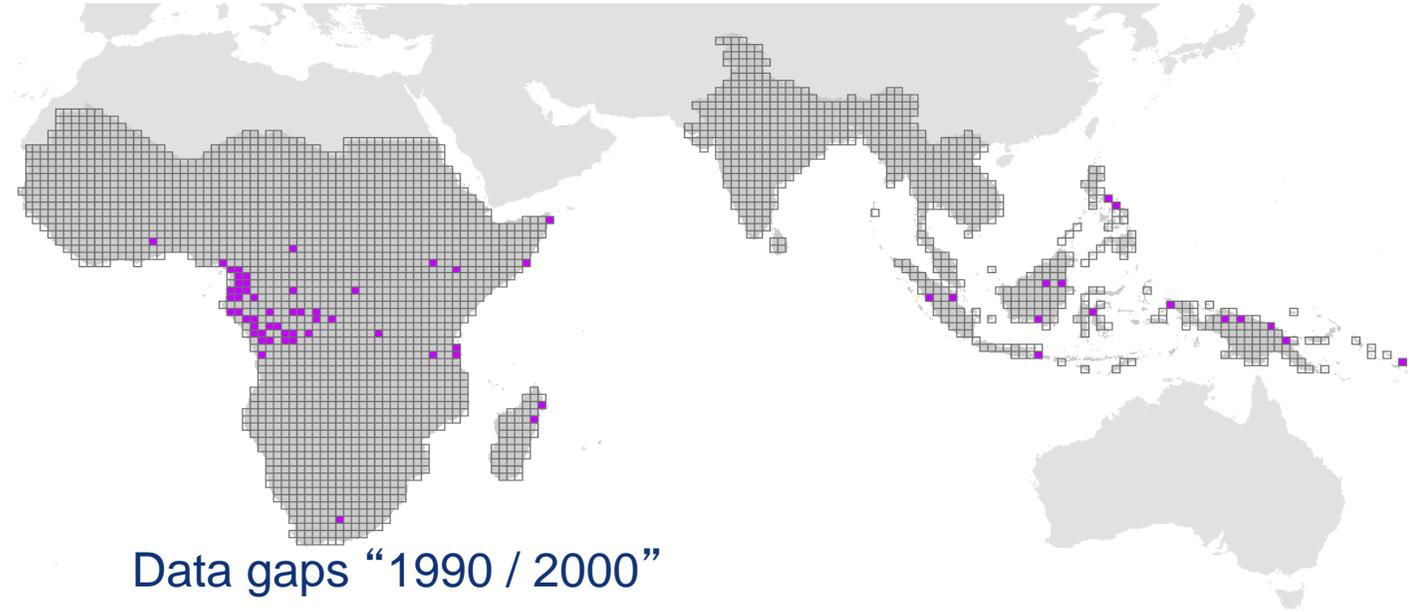
Dry Wet Undetermined

Pure spectral class in the box Yes No

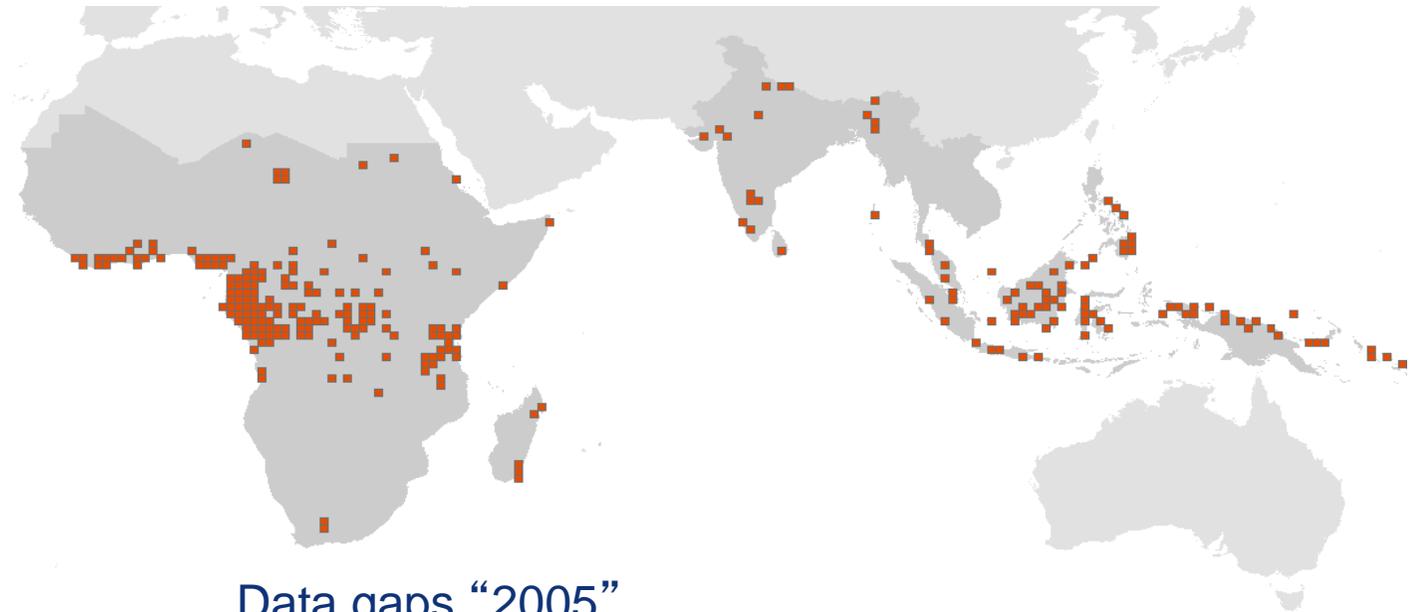
Comment on specific ecosystem

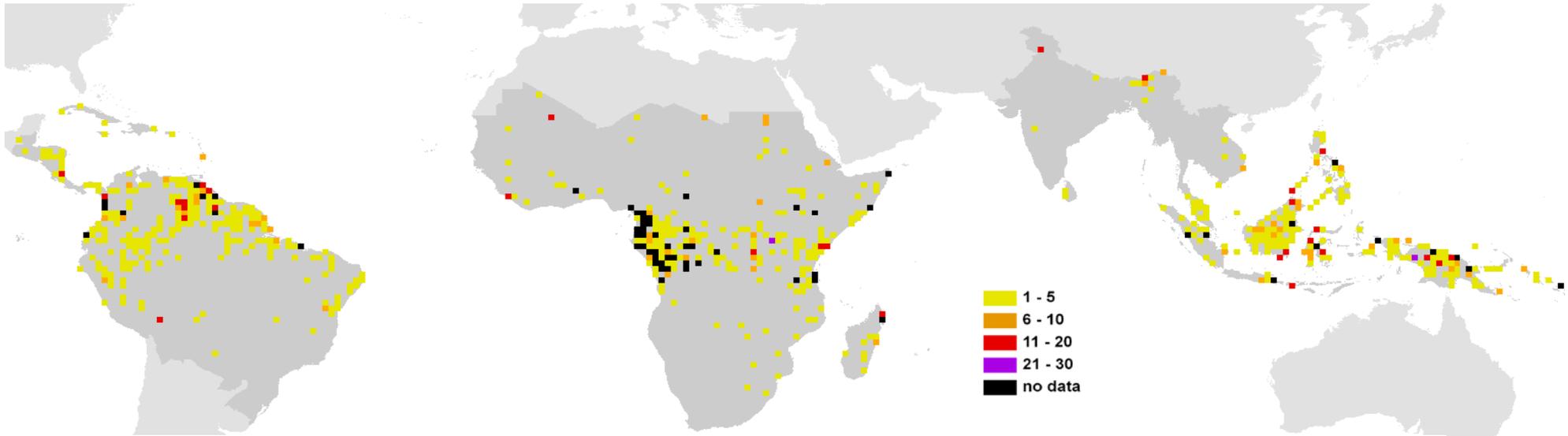


Data gaps "1990 / 2000"

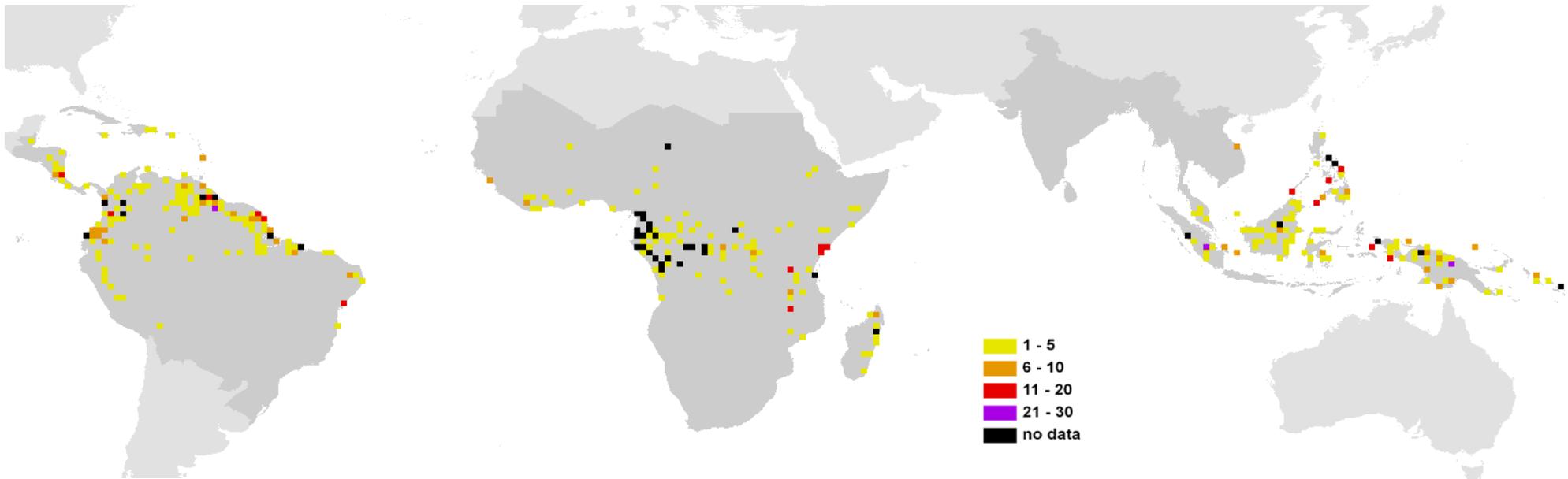


Data gaps "2005"





Cloud cover evaluation of TREES-3 sample sites for the “year 1990 period” (in percent)



Cloud cover evaluation of TREES-3 sample sites for the “year 2000 period” (in percent)

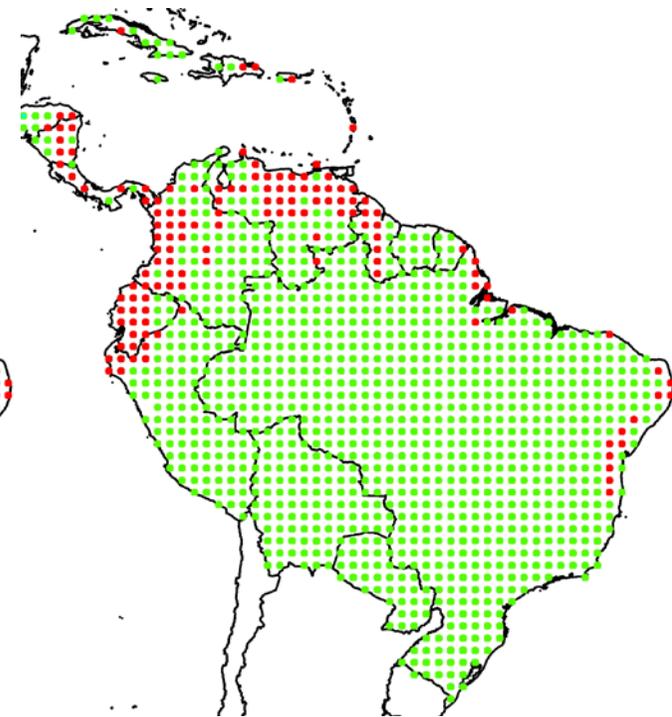
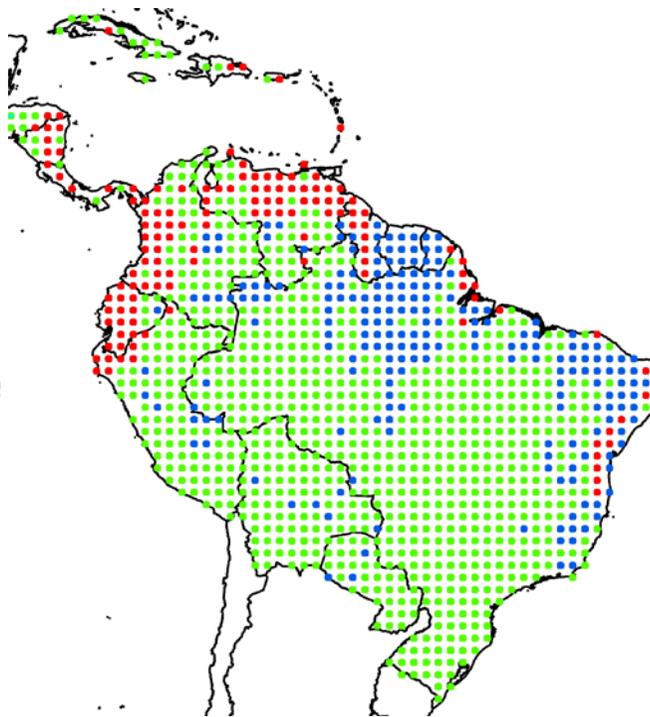
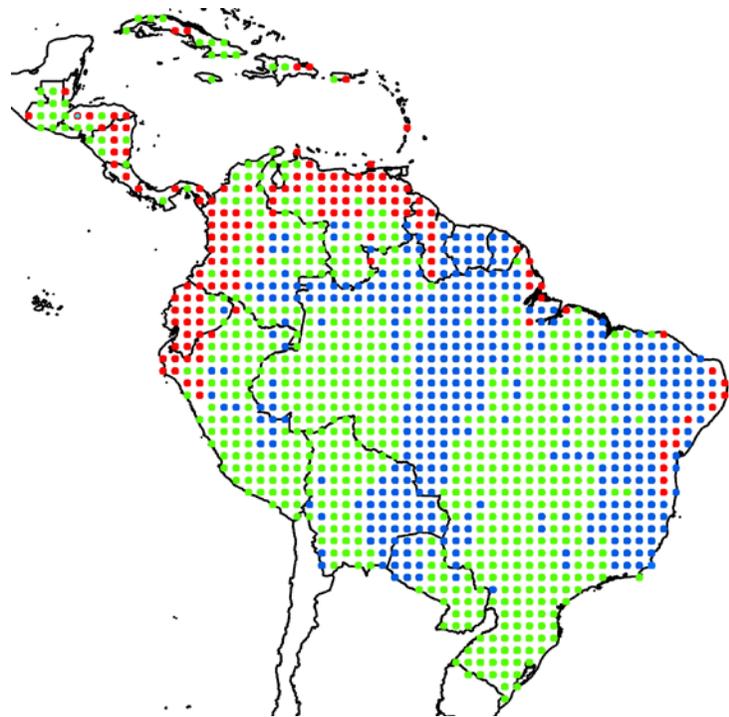
2010 updates (South America)

Source Beuchle JRC

6 months ago

3 months ago

11th August 2011

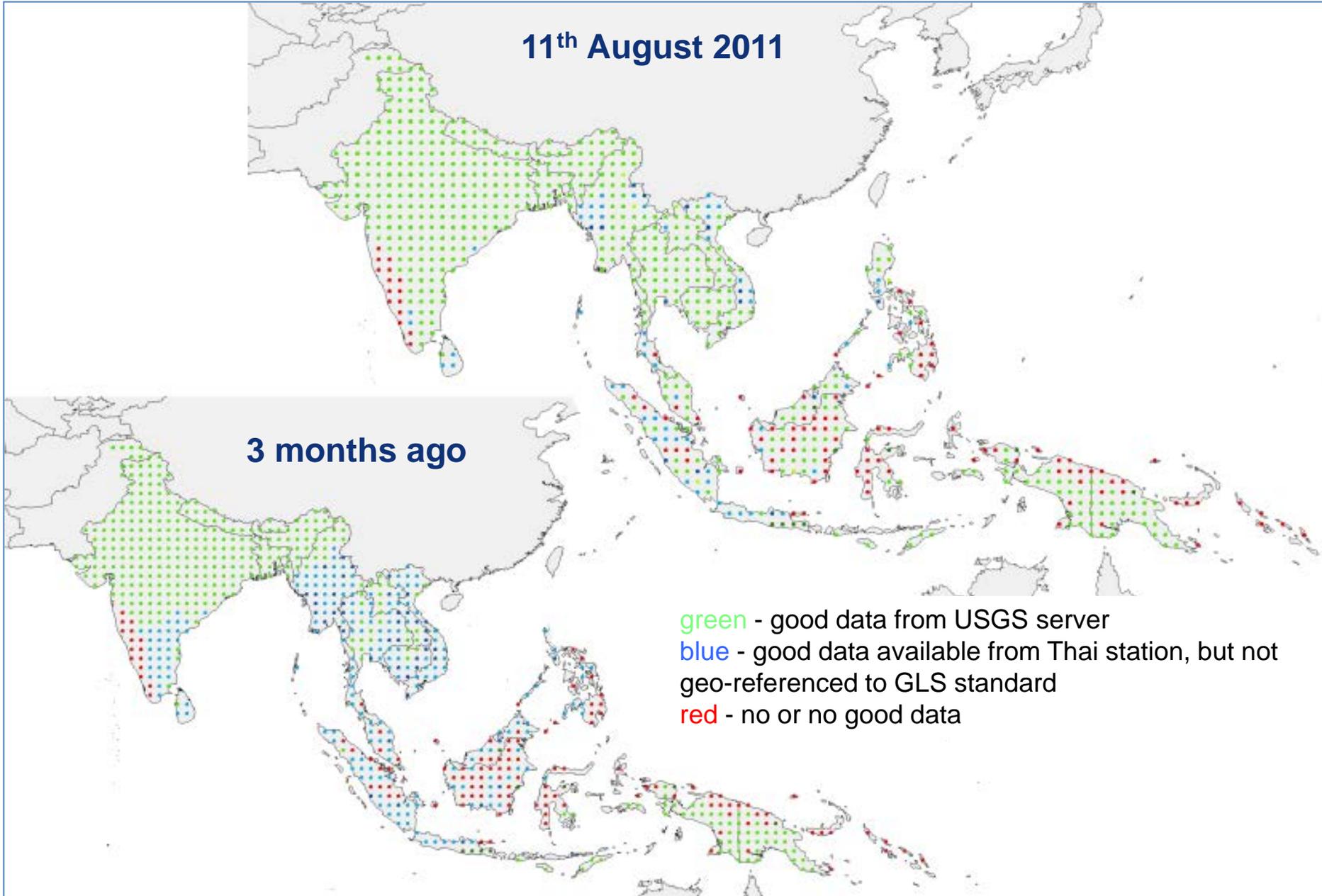


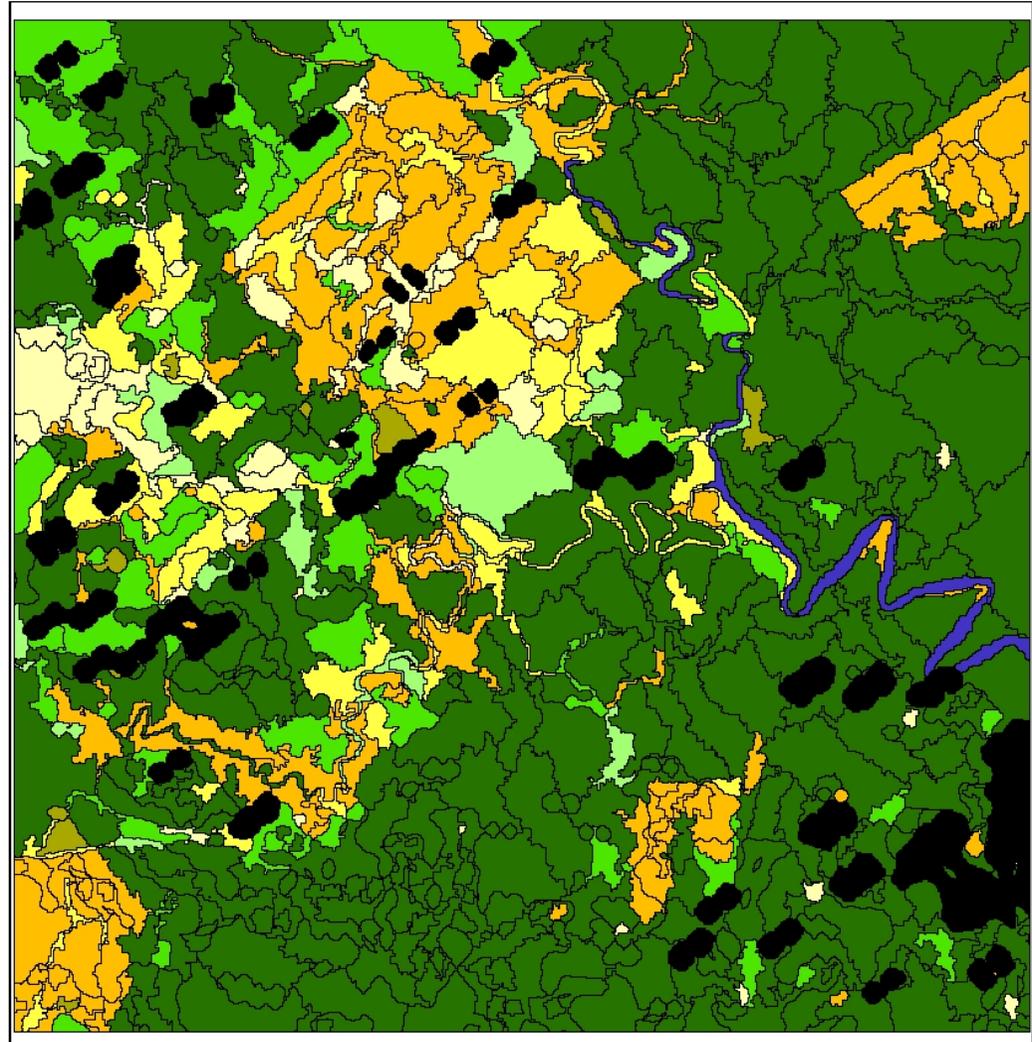
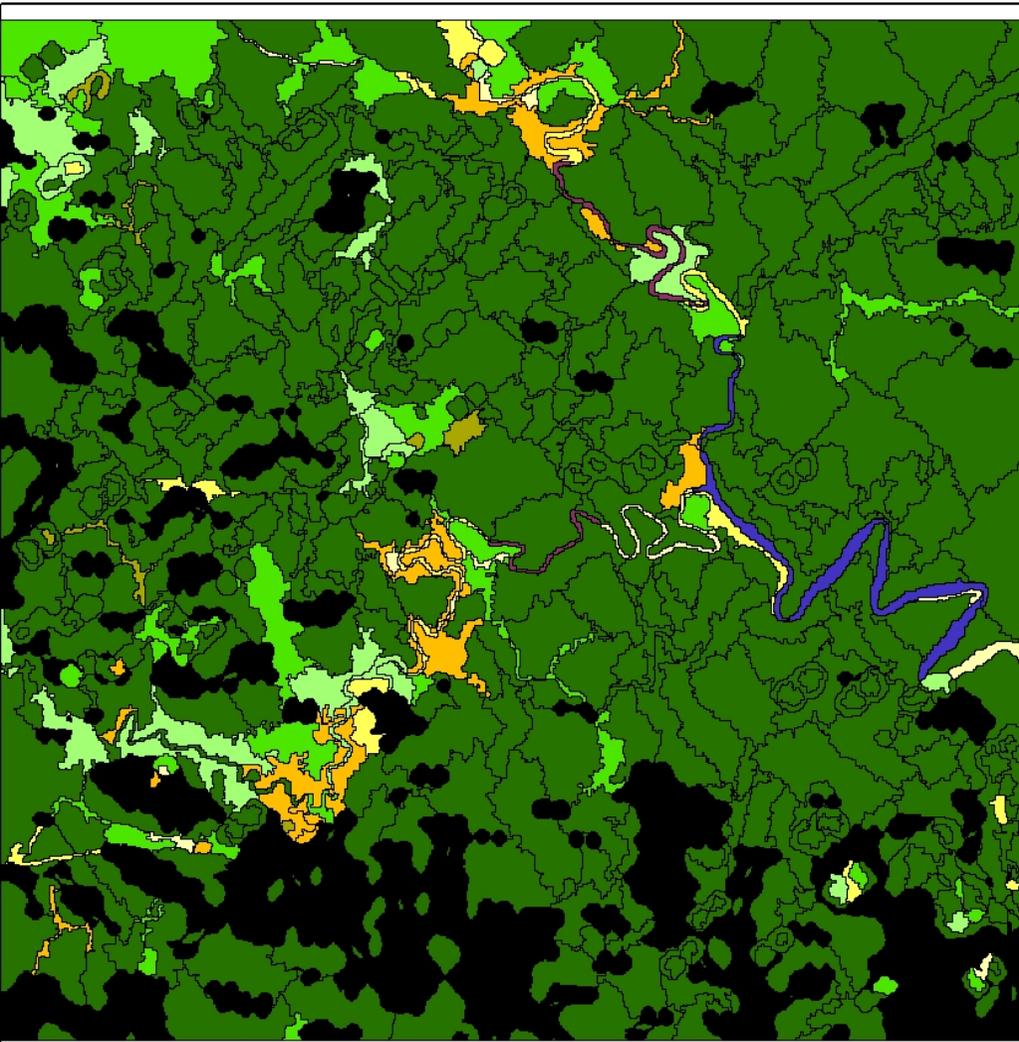
green - good data from USGS server

blue - good data available from INPE, but not geo-referenced to GLS standard

red - no or no good data

2010 updates (S.E. Asia)





N4 E117 Borneo / E-Kalimantan-North (Mentarang): Inland Swamp Forests / Oil Palm

Web based validation tool (and workshops)

European Commission
gem Global Environment Monitoring

European Commission > JRC > IES > GEM > Data & Products > TREES-3 > Access to dataset

Subarea:

Country:

Latitude	Longitude	Sensor	Path	Row	Date	Sensor	Path	Row	Date
-10	-55	tm	226	067	09 07 1987	etm	226	067	18 06 2000

S18_W042 S05_W045
S26_W052 S09_W039
S04_W047 S05_W064
S01_W048 S10_W048
S11_W063 S06_W039
S16_W049 S07_W051
S05_W047 S04_W050
S20_W049 S15_W049
S16_W048 S11_W048
S11_W044 S16_W042
S20_W041 S04_W041
S17_W040 S04_W040
S26_W051 N00_W056
S16_W045 N01_W060
N00_W060 S13_W061
S10_W068 S08_W051
S30_W055 S10_W055
S18_W054 S01_W053
S10_W051 S10_W063

Map data ©2009 Google Technologies - Terms of Use

Class Names

- Outside LSA
- Dry and Cropland and Pasture
- Impacted Cropland and Pasture
- Mixed Dryland/Irrigated Cropland
- Grassland/Cropland and Mixed
- Woodland/Cropland/Mixed
- Grassland
- Desert Shrubland
- Mixed Shrubland/Grassland
- Chaparral
- Savanna

<http://bioval.jrc.ec.europa.eu/TREES/>

Validation and ownership

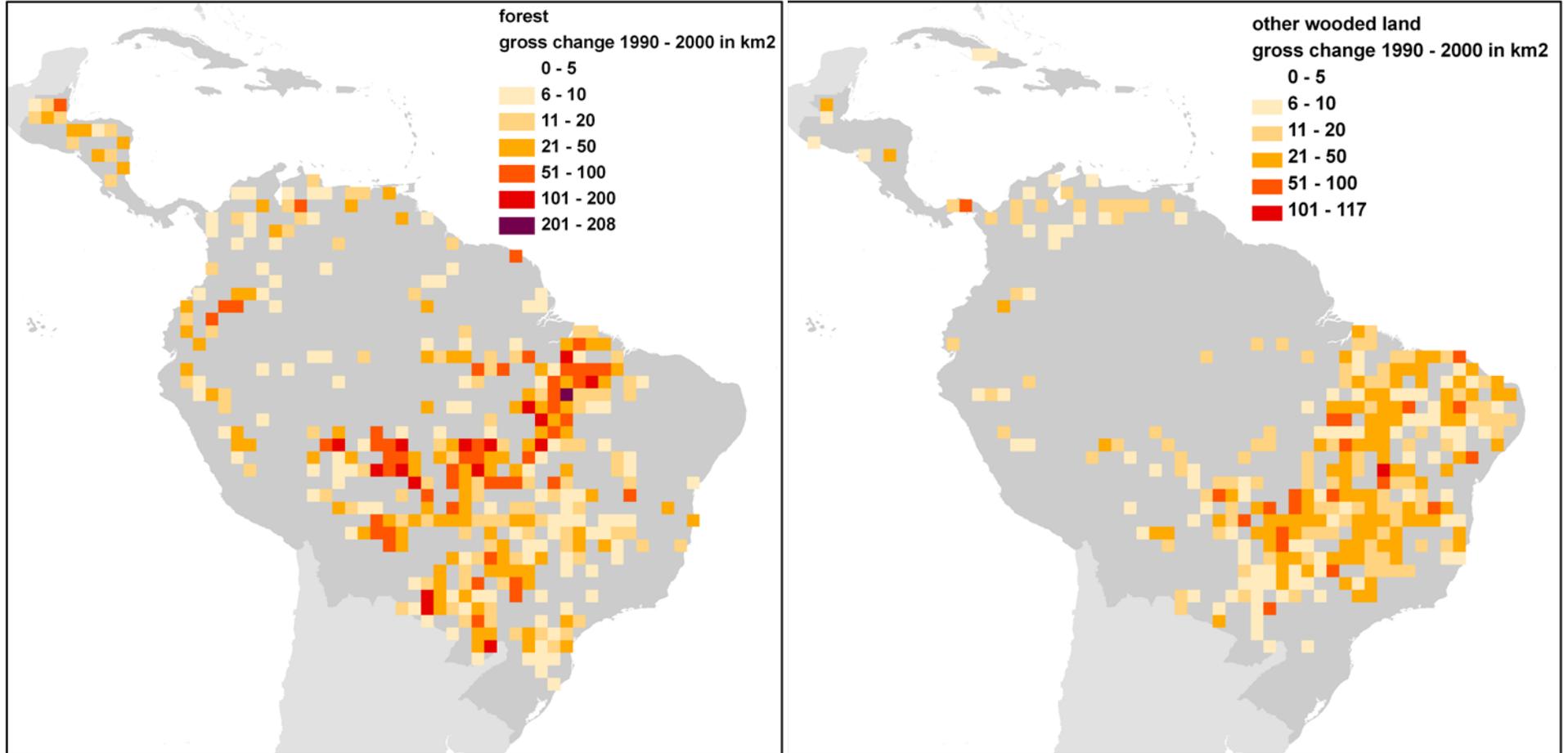
1. Campinas, Brazil; June 2009
 2. Kinshasa, D.R.Congo: September 2009
 3. La Molina, Peru: October 2009
 4. Santa Cruz, Bolivia: October 2009
 5. Nairobi, Kenya: October 2009
 6. Campinas, Brazil: November 2009
 7. Brazzaville, Congo: February 2010
 8. Pathumthani, Thailand: February 2010
 9. Dakar, Senegal: March 2010
 10. Dhera Dun, India: April 2010
 11. Cape Town, South Africa: May 2010
-
1. Panama City, Panama: July 2010
 2. Himalayan States: August 2010
 3. Cayenne, French Guyana: October 2010
- Plus 12 sessions at Ispra, Italy

Angola	Ethiopia	Nicaragua
Bangladesh	French Guyana	Niger
Belize	Gabon	Nigeria
Benin	Ghana	Peru
Bolivia	Guatemala	Philippines
Botswana	Guinée-Conakry	PNG
Brazil	Guyana	Rwanda
Burkina Faso	India	Senegal
Burundi	Indonesia	Sierra Leone
Cambodia	Kenya	Somalia
Cameroon	Laos PDR	South Africa
CAR	Lesotho	Surinam
Chad	Liberia	Swaziland
Colombia	Madagascar	Tanzania
Congo	Malaysia	Thailand
Costa Rica	Mali	Togo
Côte d'Ivoire	Mauritania	Uganda
DR Congo	Mozambique	Venezuela
Ecuador	Myanmar	Viêtnam
Eq. Guinea	Namibia	Zambia

137 regional experts from 60 countries

South America 1990 – 2000 reporting on gross forest loss

Source Eva et al, JRC



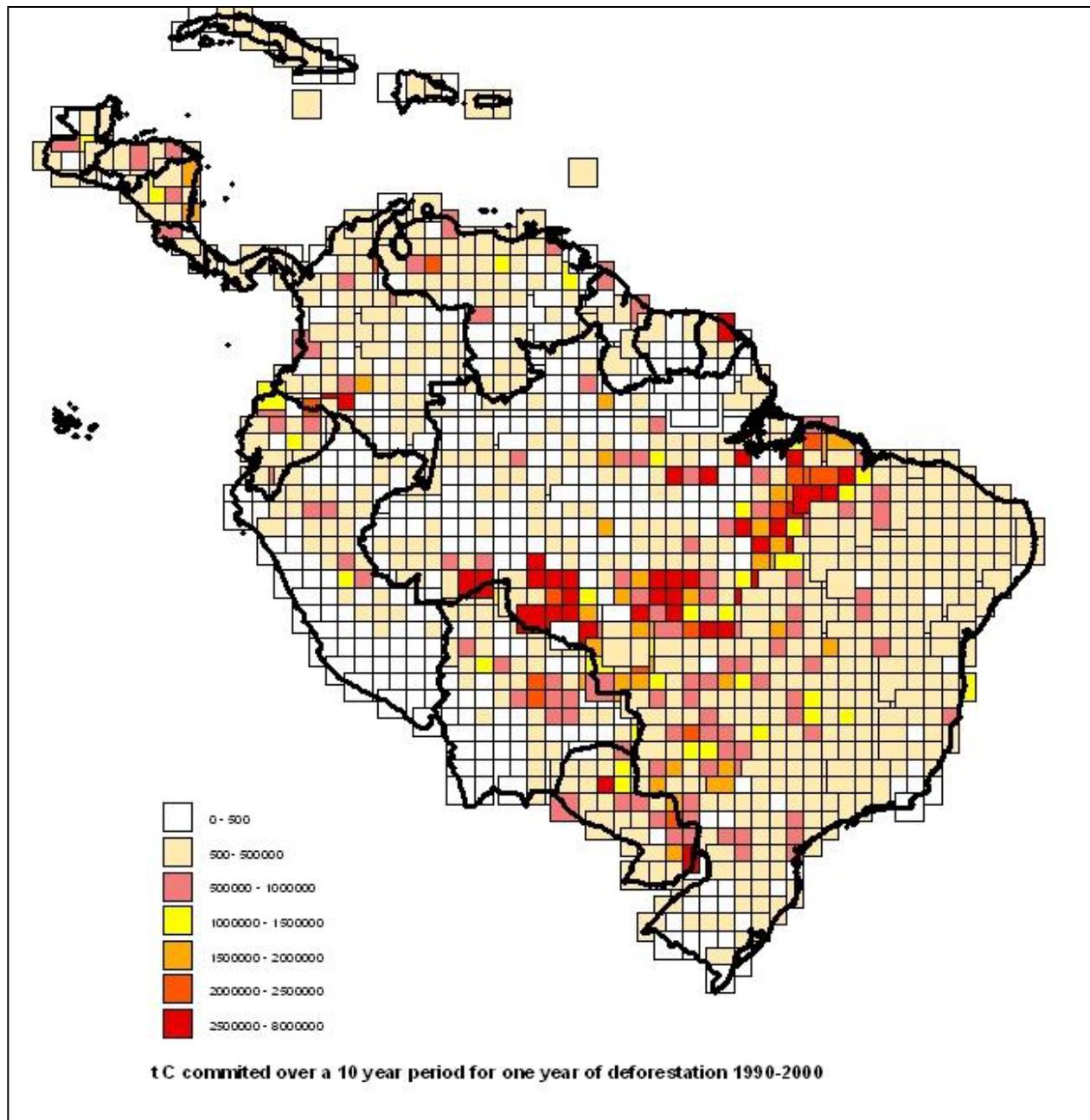
First estimates of C emissions for South America

Annual C emissions
(Million t C per year)

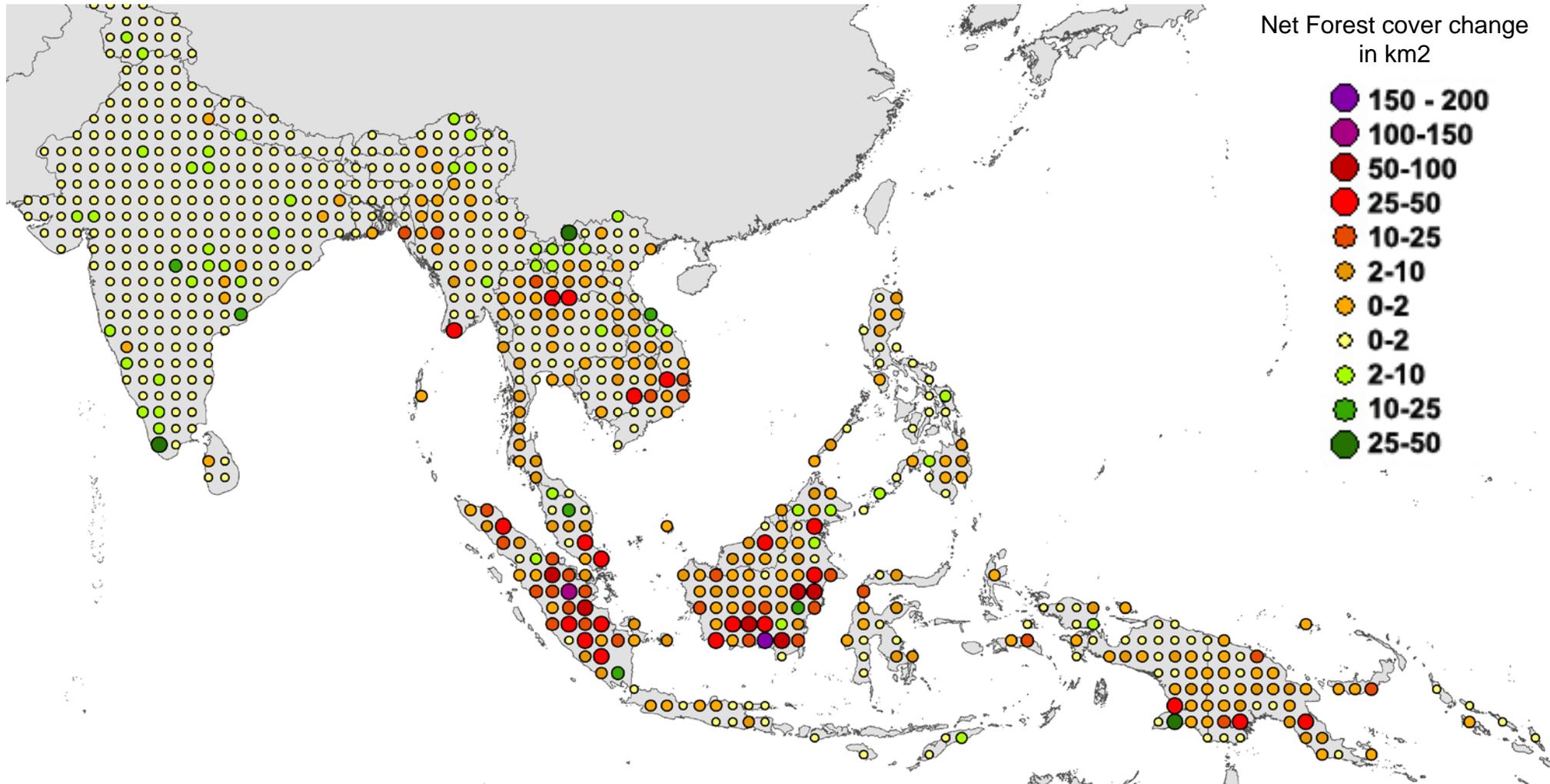
	TREES-II (2004)	TREES-3 (2011)
<i>1990-2000</i>	441	427
<i>2000-2005</i>		518

*(C committed over 10 years from
1 year deforestation
Representing loss of 69% biomass)*

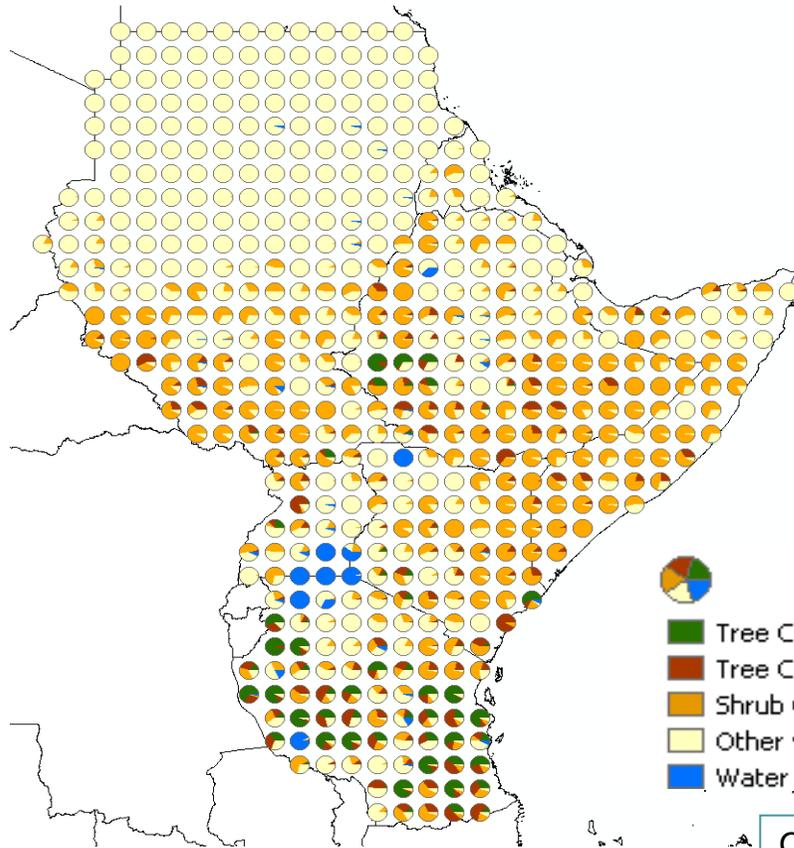
Source: Eva, Beuchle et al. in prep.



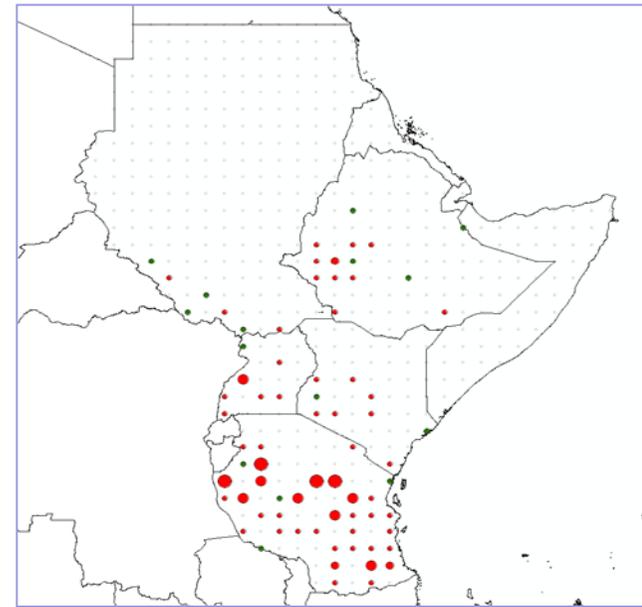
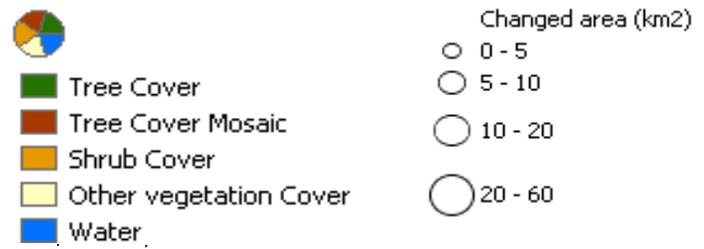
South East Asia 1990 – 2000 reporting net forest cover changes



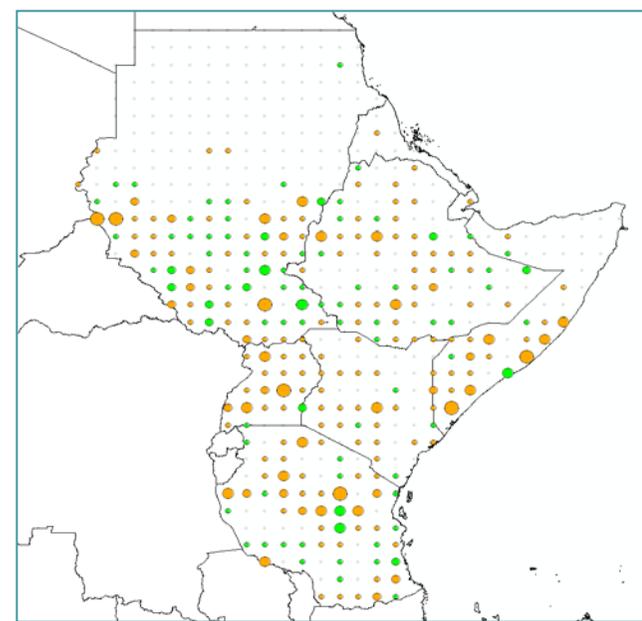
East Africa 1990 – 2000 reporting other land cover changes



Tree cover loss
 Tree to other wooded land and other vegetation
 (red = deforestation
 green = afforestation)

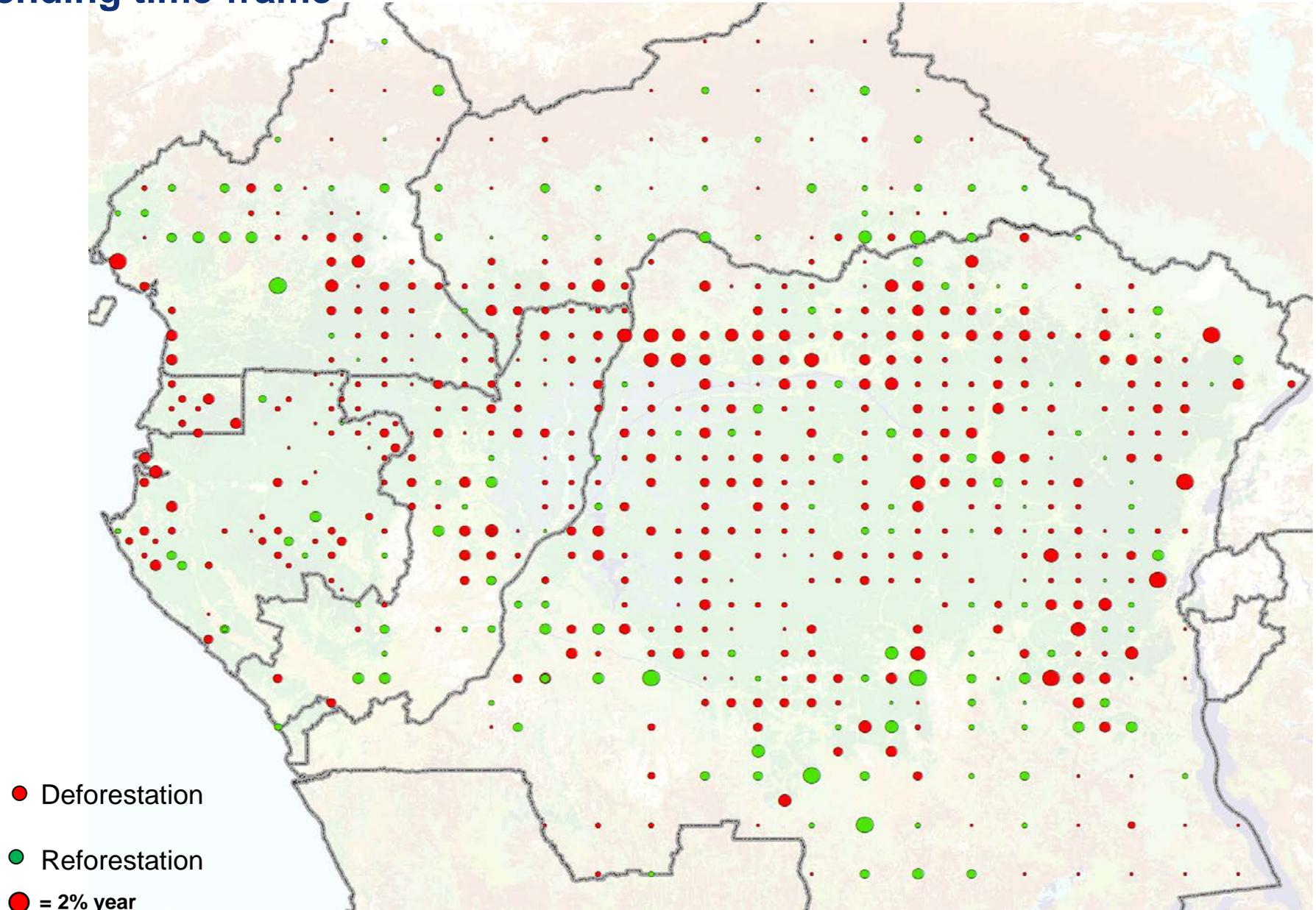


Other wooded land loss
 Other wooded land to other vegetation
 (orange = loss of other wooded land
 green = gain of other wooded land)



Distribution of Land cover in 1990

Central Africa 1990 – 2005 national reporting; intensifying sample and extending time-frame



Source Mayaux et al JRC and UCL



Deforestation (State of the Forest 2010) % annual

	1990-2000				2000-2005			
Country	<i>n</i>	Gross Deforest.	Gross Reforest.	Net Deforest.	<i>n</i>	Gross Deforest.	Gross Reforest.	Net Deforest.
Cameroon	51	0.10 ±0.05	0.02 ±0.01	0.08	20	0.17 ±0.14	0.14 ±0.19	0.03
Congo	70	0.08 ±0.03	0.04 ±0.02	0.03	40	0.16 ±0.06	0.08 ±0.05	0.07
Gabon	58	0.08 ±0.03	0.03 ±0.01	0.05	12	0.07 ±0.05	0.07 ±0.07	0.00
Eq. Guinea	8	0.13 ±0.09	0.11 ±0.18	0.02	0	-	-	-
CAR	26	0.09 ±0.05	0.02 ±0.02	0.06	23	0.10 ±0.06	0.04 ±0.05	0.06
DRC	334	0.15 ±0.02	0.04 ±0.01	0.11	242	0.32 ±0.05	0.10 ±0.03	0.22
Congo Basin	547	0.13 ±0.02	0.04 ±0.01	0.09	337	0.26 ±0.04	0.09 ±0.02	0.17

Information used by countries in UNFCCC preparation

Source Mayaux et al JRC



Photo credits Background stadium Thomas Faivre-Duboz, forest taken from H.-D. Viktor Boehm globalcarbonproject, labeled free for illustrative purposes, Photo montage by Alan Belward, Joint Research Centre

Deforestation; emissions ~ 1.2 Pg C yr⁻¹



Photo credits Background stadium Thomas Faivre-Duboz, forest taken from H.-D. Viktor Boehm globalcarbonproject, labeled free for illustrative purposes, post-harvest brush taken from CIFOR
Photo montage by Alan Belward, Joint Research Centre

5.8 mha/yr, 13 mha/yr globally



...less than 3 seconds to clear a sports field



...every 3 seconds of every day



Conclusions

- 39 satellites carrying optical imagers with better than 100m resolution currently fly
- 4 had analogues flying in 1990 (a possible forest cover change baseline)
- 1 provides free and open access to a global archive – Landsat
- The GLS and L1T have proven robust, reliable and immensely valuable
- The US Landsat open archive policy and data acquisition program have had profound impacts
 - Influencing factor in EU data policy discussions
 - a crucial enabling factor for internationally mandated forest monitoring and governance programmes (input to Multilateral Environmental Agreements (UNFCCC, UNCBD))
 - helping build knowledge bases in developing countries

Thank you USGS, NASA and especially the EDC

