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Joint Research Centre

Global Forest Monitoring- Reducing the Uncertainties An outline of the EC Joint Research Centre's TREES project objectives 2007-2013

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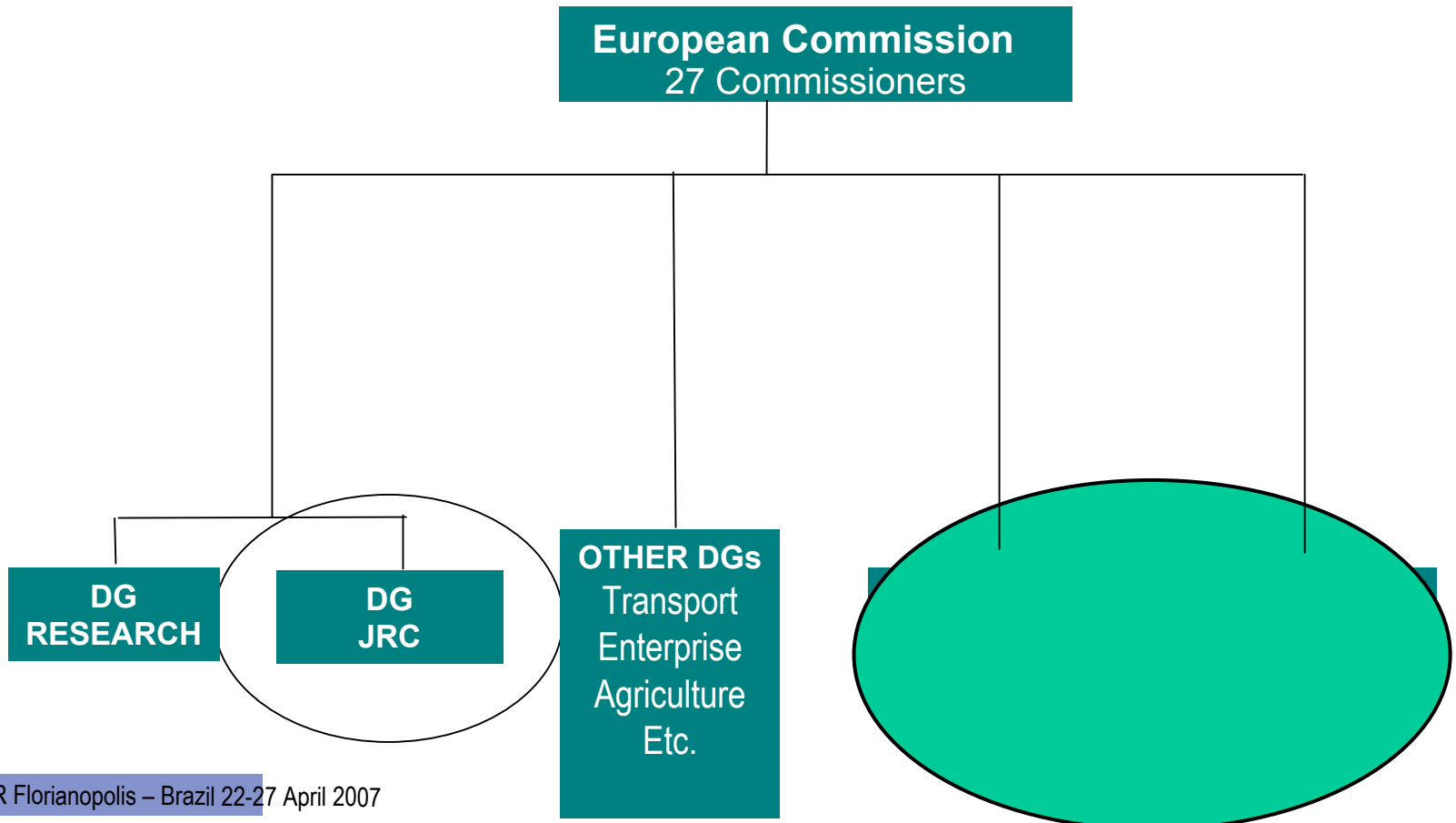
Joint Research Centre

What is the Joint Research Centre?

The JRC is a Directorate General of the European Commission



Part of the JRC's work program is:

- to provide Scientific & Technical support to EU policies for
  - the Protection of the Environment,

- to contribute to the EU Strategy on
  - Sustainable Development

The JRC has therefore been active in monitoring tropical forests for over 20 years

-Why is the European Commission interested in forests outside Europe (notably Tropical forests and Siberia)?

European Commission and global forest monitoring:

Concerns about:

-preservation of biodiversity

-indigenous and forest peoples rights

-reduction of rural poverty

-sustainable forest management

-Support countries in benefiting from post-Kyoto initiatives

Climate Change

-reducing the uncertainty in emissions from land cover change

European Commission and global forest monitoring

External funding for projects relating to sustainable forest management etc.

Internal projects relating to monitoring the extent and changes in forests, and technical support for international discussions on forest questions (including Land use change impacts)

Funding to tropical forest preservation initiatives 2004 (40M €)

Country	Project title	Contractor	Amount (in €)
Africa	Développement d'alternatives communautaires à l'exploitation forestière illégale (DACEFI)	**World Wide Fund For Nature (WWF) - Bureau pour l'Afrique centrale**	1,534,200
Brazil	Systèmes intégrés de gestion participative des ressources forestières et agricoles par les populations rurales en Amazonie	**Centre de coopération internationale en recherche agronomique pour le développement (CIRAD)**	2,043,879
Brazil	Building consensus on access to natural resources in the Brazilian Amazon	**World Wide Fund For Nature (WWF) - Brasil**	3,325,944
Brazil	Sustainable use of forests in the Serra das Lontras-Una forest complex in Bahia State, Brazil: organic cacao production through farmers cooperatives	**BirdLife International**	1,526,819
Brazil	Bridging the Divide: Enhancing Forest Tenure, Management and Marketing in the Brazilian Amazon	**Instituto do Homem e Meio Ambiente da Amazônia (IMAZON)**	2,296,300
Brazil	Promotion de l'aménagement forestier durable par la production et la commercialisation de bois dans l'Etat de l'Amazonas	**Groupe de Recherche et d'Echanges Technologiques (GRET)**	1,412,053
Brazil	Mainstreaming Market Services, Certification and Codes-of-Conduct in Brazilian Forests and Fringe Areas	**Amigos da Terra - Amazônia Brasileira**	2,526,797
Cambodia	Promoting Community Forestry in Cambodia	**Oxfam GB**	1,298,823
Ecuador, Peru	Programa binacional para la conservación y gestión participativa de los bosques tropicales de la cuenca del Chinchipe, Perú - Ecuador	**Intermediate Technology Development Group (ITDG)**	1,563,400
Ecuador, Peru	Red comunitaria e institucional para la conservación del bosque tropical amazónico de la zona fronteriza nororiental Ecuador - Perú, basada en el	**Solidaridad Internacional, Fundación Española para la Cooperación**	1,554,788
El Salvador	Gestión comunitaria para la conservación y uso sostenible del Bosque de Cinquera, El Salvador	**Paz y Tercer Mundo (PTM)**	1,100,000
Global	Regional Processes for Forest Law Enforcement and Governance - FLEG	**The World Bank**	3,100,000
Global	Timber Trade Action Plan for Good Governance in Tropical Forestry	**The Tropical Forest Trust**	3,499,999
Honduras	Proyecto de comanejo sustentable de la biosfera Tawahka Asangni (BTA) y parte Sur de la biosfera de Río Plátano	**Trócaire**	1,623,838
Indonesia	Improving governance of forest resources and reducing illegal logging and associated trade with full civil society participation in SE Asia	**Environmental Investigation Agency (EIA)**	2,057,376
Indonesia	Pioneering a new way to conserve rainforest: from illegal logging to good governance	**BirdLife Indonesia**	2,560,516
Liberia	Strengthening Forest Management in Post-Conflict Liberia	**Fauna & Flora International (FFI)**	1,833,659
Peru	Modelo de gestión comunal sostenible de bosques inundables en la Amazonía andina peruana	**Instituto de Investigaciones de la Amazonía Peruana**	2,427,261
Peru	Fortalecimiento del Manejo Forestal Sostenible en Territorios Amazónicos de Pueblos Indígenas en el Perú	**World Wide Fund For Nature (WWF) - Peru**	1,835,755

Internal Research effort on global forests have been led by the JRC - These activities have a large proportion carried out under the TREES project

TREES I – (1992-1996) Funded by the European Parliament

TREES II – (1997-2001)Funded by DG Environment

TREES 3- (2007- 2013) Funded by DG JRC

TREES I / TREES II 1992 - 2002

Mapping

- baseline inventory of the distribution of pan tropical forests (extended to global forests in 2000 - GLC2000)

Monitoring

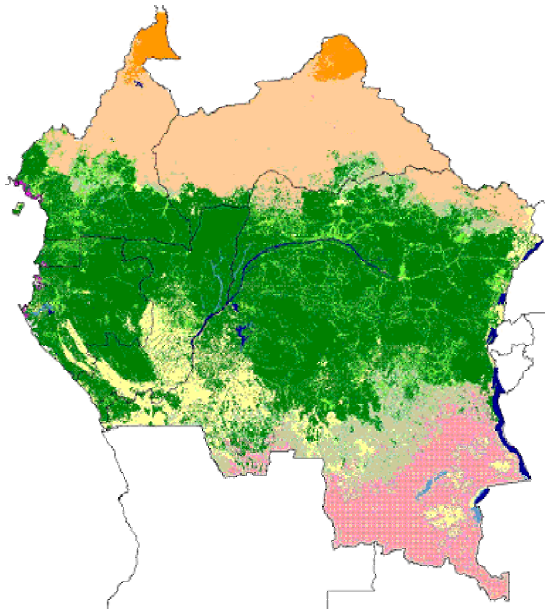
-methods to highlight areas of rapid change

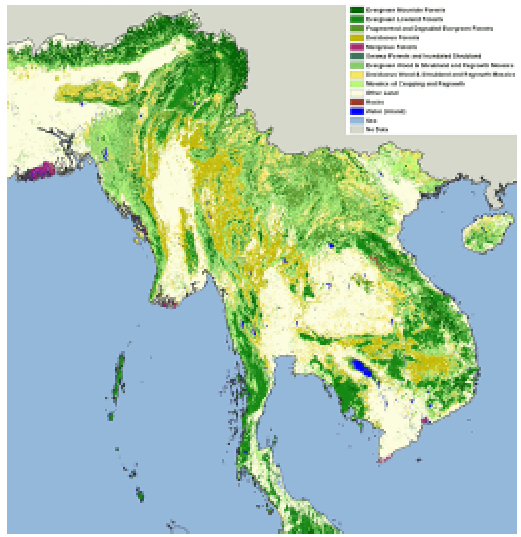
Measuring

-Quantification of pan tropical forest change for the period 1992 to 1997 using a sample of high resolution satellite data

TREES I
1992-1996

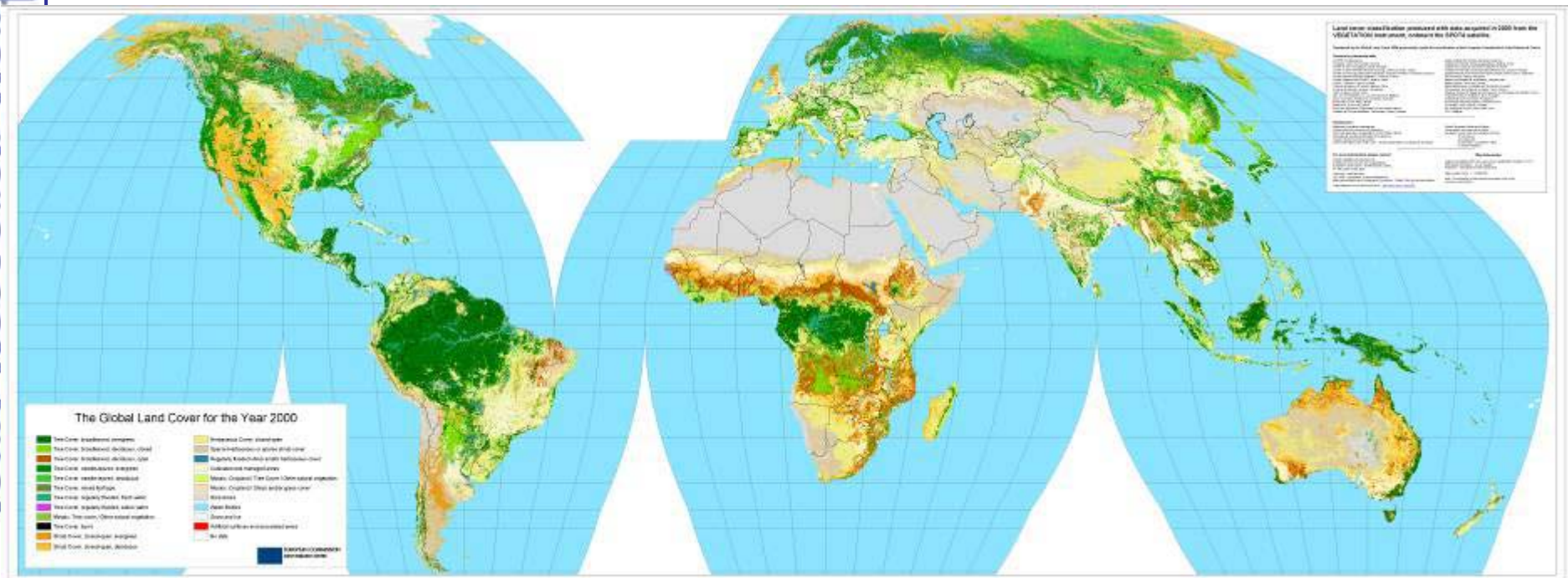
The first Pan-tropical maps of the humid forest domain from satellite data (early 1990s)



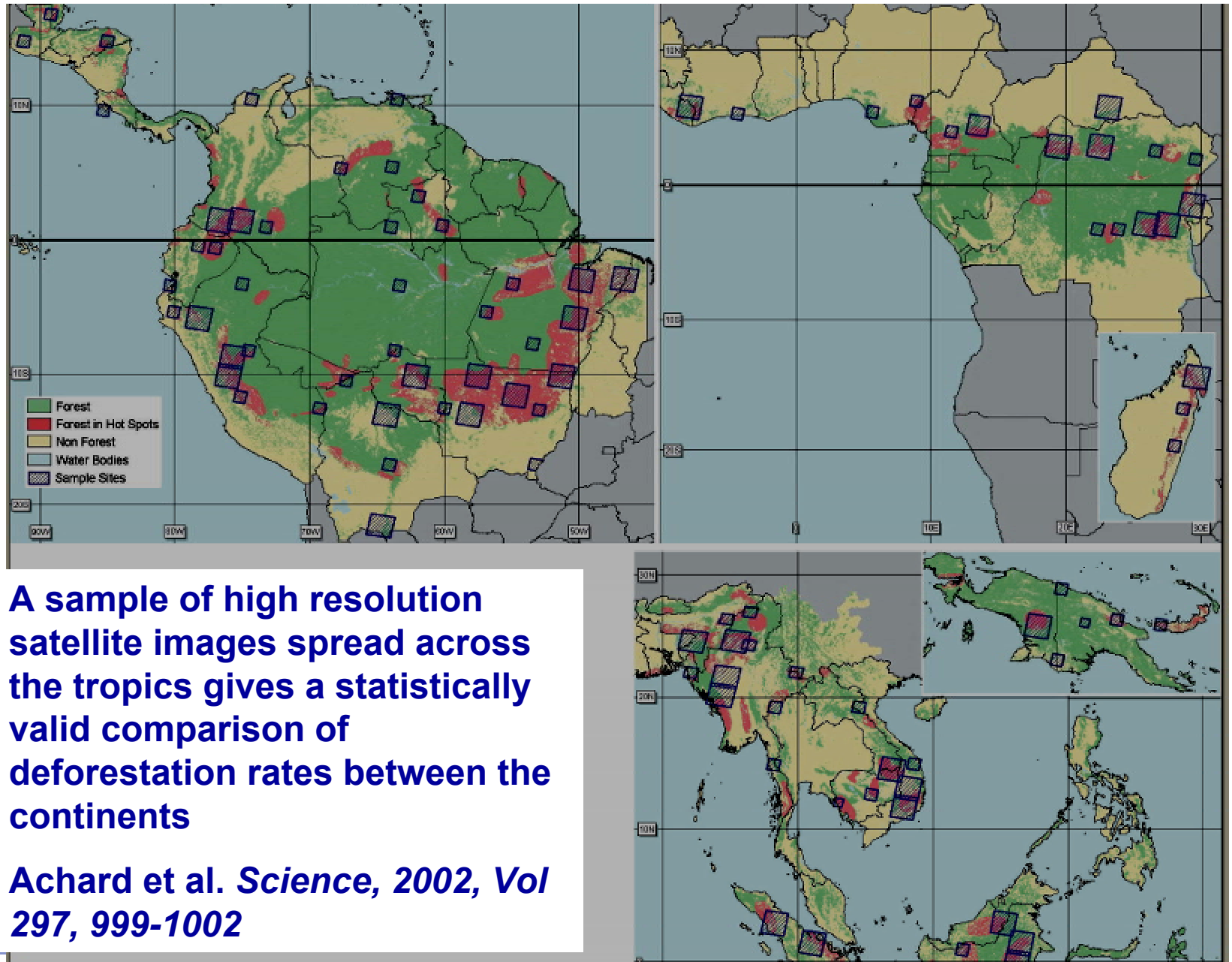


Available both as digital and cartographic products

GLC 2000 – Global Land cover map for the year 2000 derived from SPOT VGT at 1km grid resolution



TREES II



A sample of high resolution satellite images spread across the tropics gives a statistically valid comparison of deforestation rates between the continents

Achard et al. *Science, 2002, Vol 297, 999-1002*

Results at pan-tropical level of the TREES monitoring system

	Latin America (10^6 ha)	Africa (10^6 ha)	Southeast Asia (10^6 ha)	Global (10^6 ha)
Forest cover in 1990	669 ±57	198 ±13	283 ±31	1,150 ±54
Annual deforestation	2.5 ±1.4	0.85 ±0.30	2.5 ±0.8	5.8 ±1.4
Annual regrowth	0.28 ±0.22	0.14 ±0.11	0.53 ±0.25	1.0 ±0.32
Annual degradation	0.83 ±0.67	0.39 ±0.19	1.1 ±0.44	2.3 ±0.71

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TREES-3 2007 - 2013

Global forest change assessment: 1990 – 2000 - 2005 – 2010

These dates are set to coincide with UNFCC baselines and reporting periods

- **Phase I: tropical humid forests (start 2007)**
- **Phase II: tropical dry forests and Eurasian boreal forests**

Changes assessments are only valid at the continental scales

The survey is to be carried out in co-operation with FAO Forest Resource Assessment (FRA) and the FAO FRA regional and national networks

Why? - Reducing Uncertainty in global forest change estimates

Emissions from Land cover / Land use change have been estimated to be around 1.6 Gt C y^{-1} +/- 0.8 Gt C y^{-1}

(Houghton et al., 1999, 2000).

Uncertainties both in activity (change) and constants (biomass).

Key Questions to be addressed

What is the global contribution of deforestation towards anthropogenic emissions?

What is the extent of the remaining forest area?

Is deforestation increasing, decreasing , stable …?

Are the forests changing faster in one area (e.g. Siberia) than another (e.g. Central America or Asia)?

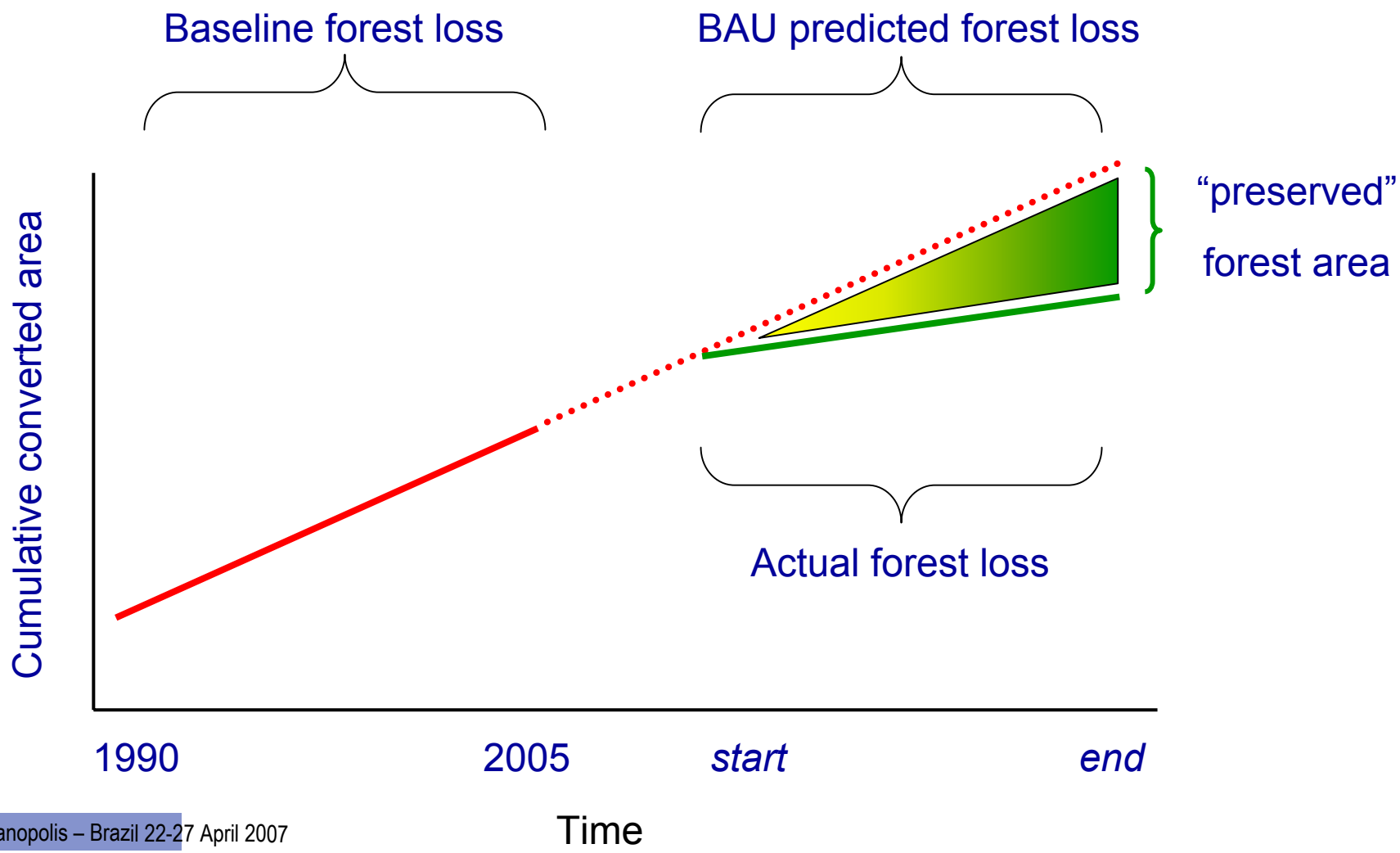
Can we provide multi-national conventions (e.g. Post Kyoto) with data on which to base global forest change baselines?

A contribution to REDD

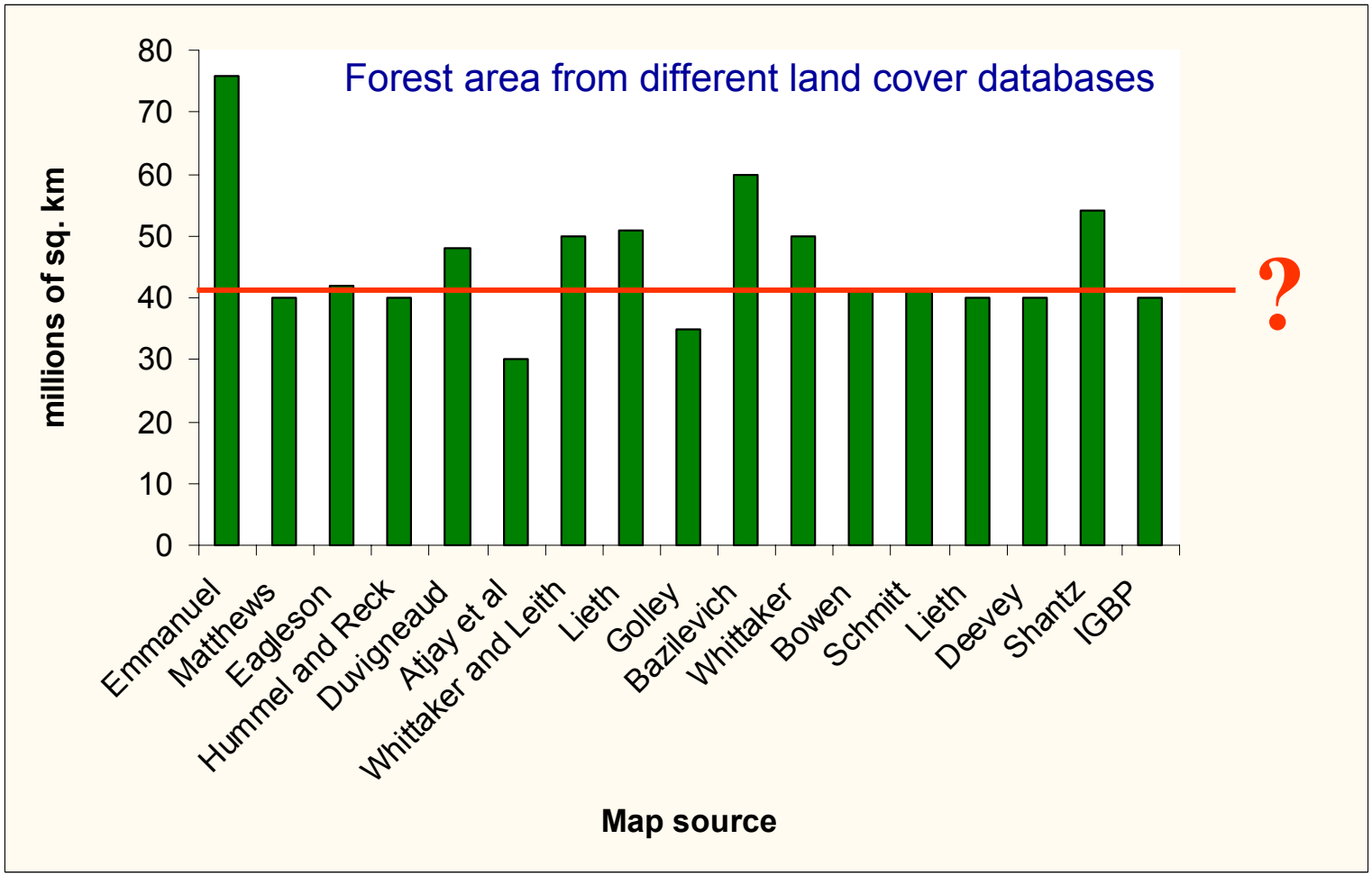
*Some countries feel it is right to obtain carbon credits for Reduced Emissions from Deforestation and Degradation (**REDD**) ...*

-We therefore require baseline inventories / national and global (or regional)

What is considered as "avoided forest conversion"



Uncertainty in global land cover



A demonstration of the uncertainty

Two methods of estimating forest area and area change carried out by the same organisation: FAO

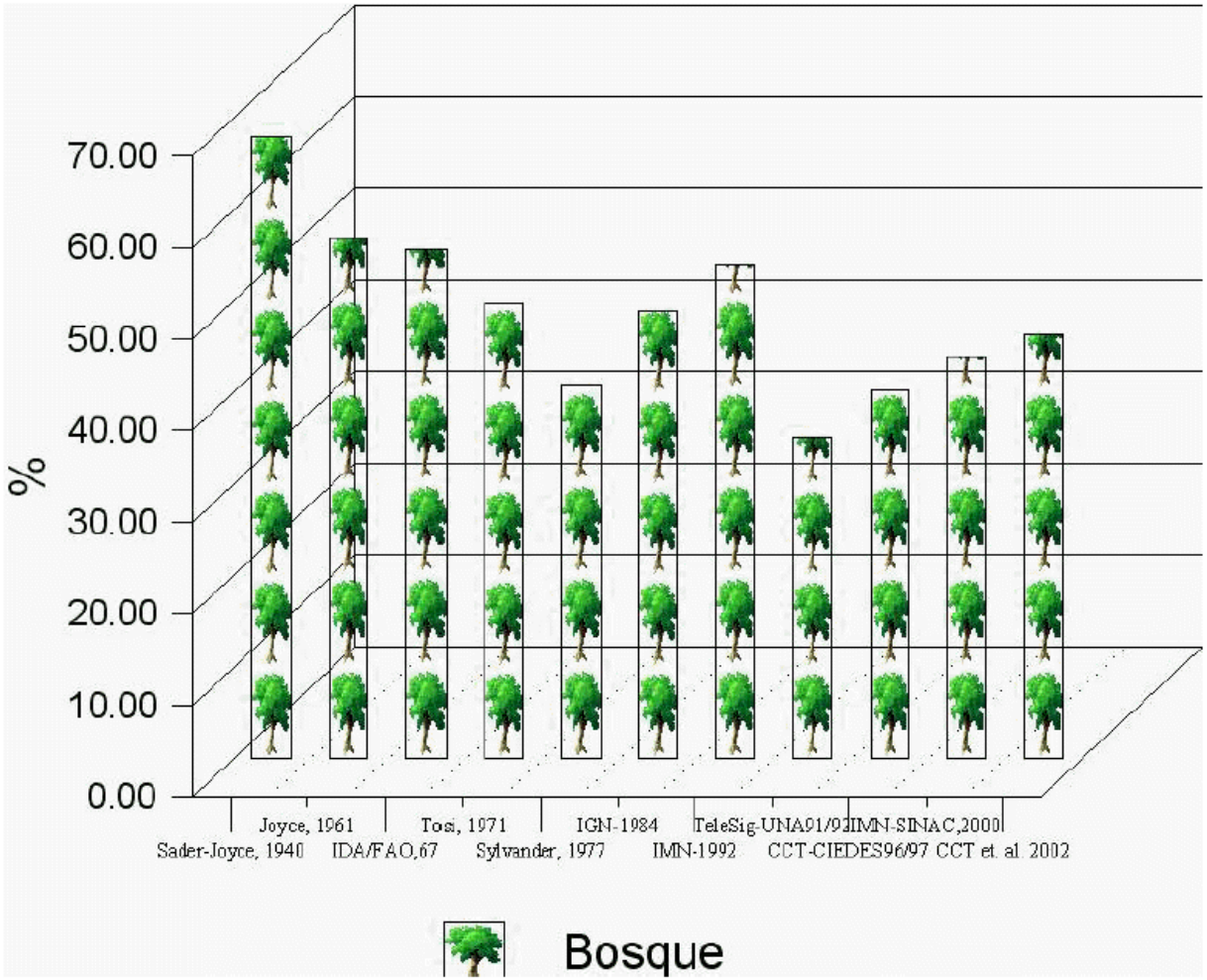
-Compilation of country statistic

-A sample of high resolution satellite images spread across the tropics covering the same countries

	Forest Area 2000 10^6 ha Country Statistics	Forest Area 2000 10^6 ha Remote Sensing
Asia	289	224
Africa	622	484
Latin America	892	767
Total	1803	1475

Similar discrepancies between changes rates and between TREES II results and FAO : FAO, *Forestry Paper 140*, 2001.

At national levels – the trends are not always clear



Evolution of national forest cover 1961-2002 – S.Velasquez CATIE

To reduce uncertainty

There is a need for:

An improved analysis of the extent and changes in global forest areas - notably in the tropics and Siberia

Approach needs to be a common one – based on repeatable, robust methodology

Could be compatible with National inventories

Does not compete with National inventories

Show the general trends over the last 20 years

Could also serve as a baseline for global / regional forest changes (important in the framework of a post-Kyoto REDD)

JRC TREES-3 Project

TREES-3 main objective:

Updating and improving forest change estimates at global to regional levels for the periods: (mid 1975)-1990-2000-2005(-2010)

Approach:

Intensive use of Earth Observation data: a sample of 20-30m resolution satellite imagery

Implementation:

Collaborative partnership with FAO FRA 2010 programme

TREES 3 Global forest assessment

What data will be used?

What sampling?

What legend is appropriate?

How will the satellite data be processed?

Can one validate such an exercise?

Data sources

(1980) 1990 and 2000
Historical Landsat images from Geocover decadal data sets

2005
Mid-Decadal Global Land Survey – problematic

2010…..

Approach- Global Sampling

Full coverage is not possible (not appropriate?) – image costs / processing / storage

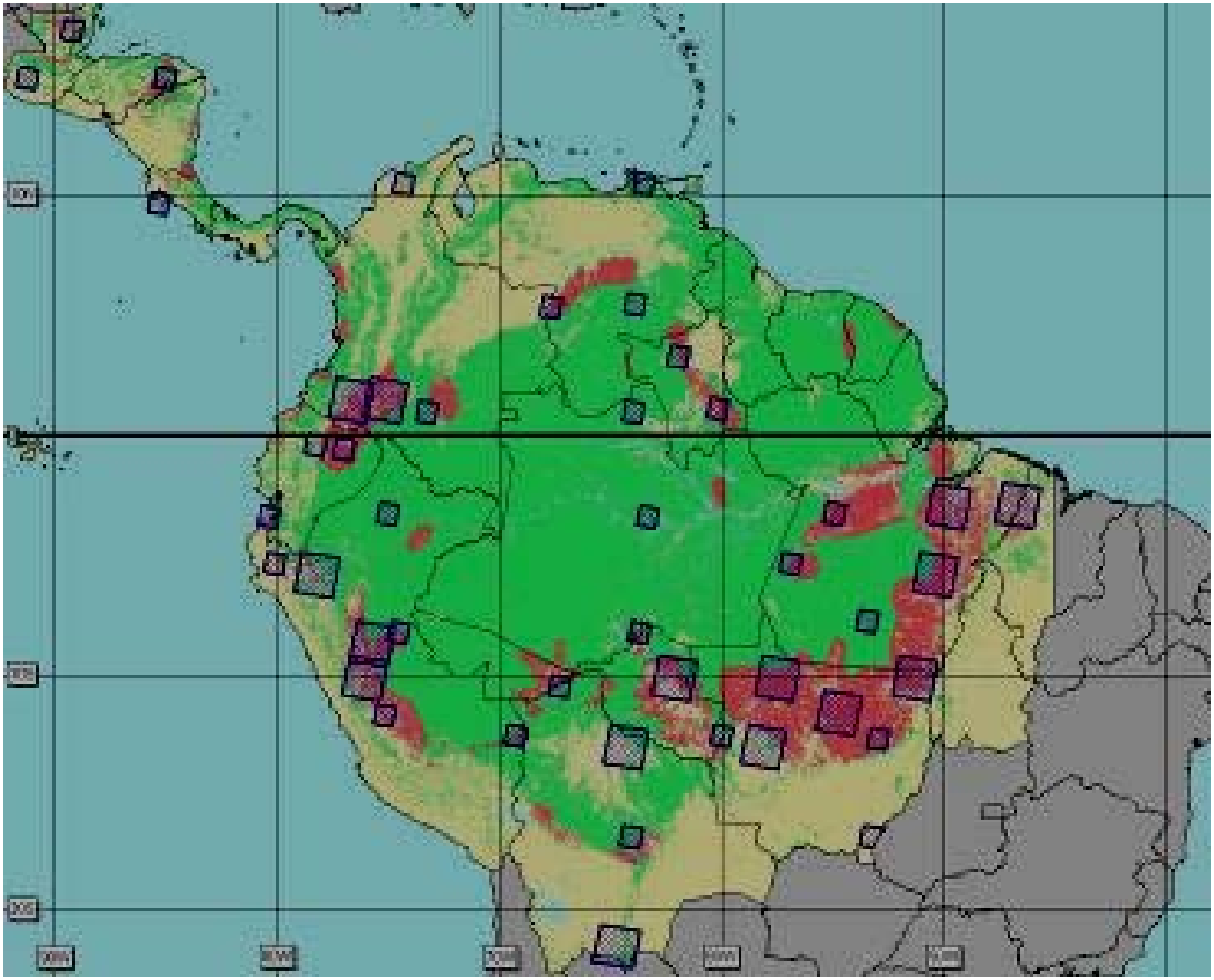
In the tropics sample sites at the confluence of the geographic (lat/long) grid.

Outside the tropics a reduction of samples (due to over sampling)

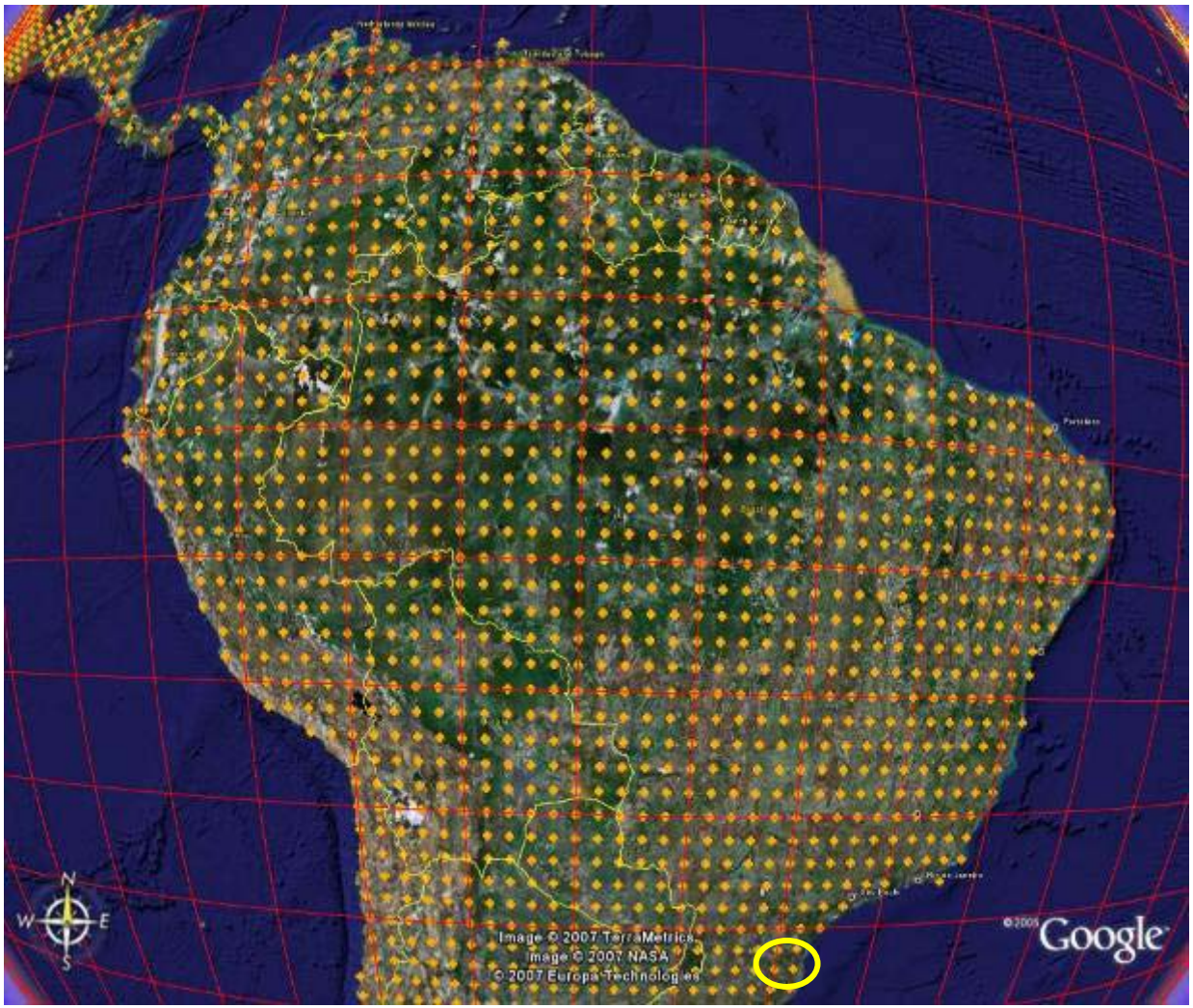
At each sample point a 20km by 20km sub-image will be extracted from the Landsat image database

Stratify?

Stratification will not be used (in the past 'intensive areas' of deforestation were used – but they move….)



TREES / FAO sampling scheme over South America




Governador Celso Ramo
Major Gercino
Imbuia
Leoberto Leal
Chapadão do Lageado
Florianópolis
São José
Palhoça
Águas Mornas
Santa Rosa de Lima
São Martinho
Braço do Norte
São Ludgero
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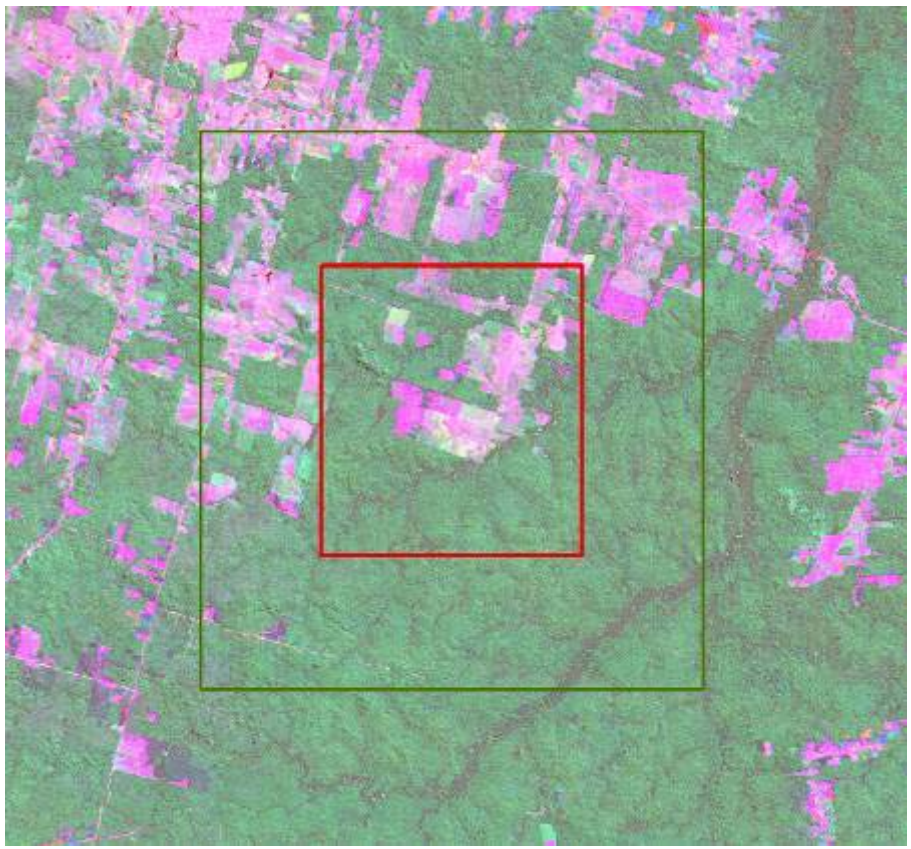
©2007 Europa Technologies
Image © 2007 TerraMetrics
©2005 Google
Pointer lat -27.817609° lon -48.836041° elev 1723 ft
Streaming 100%
Eye alt 77.17 mi

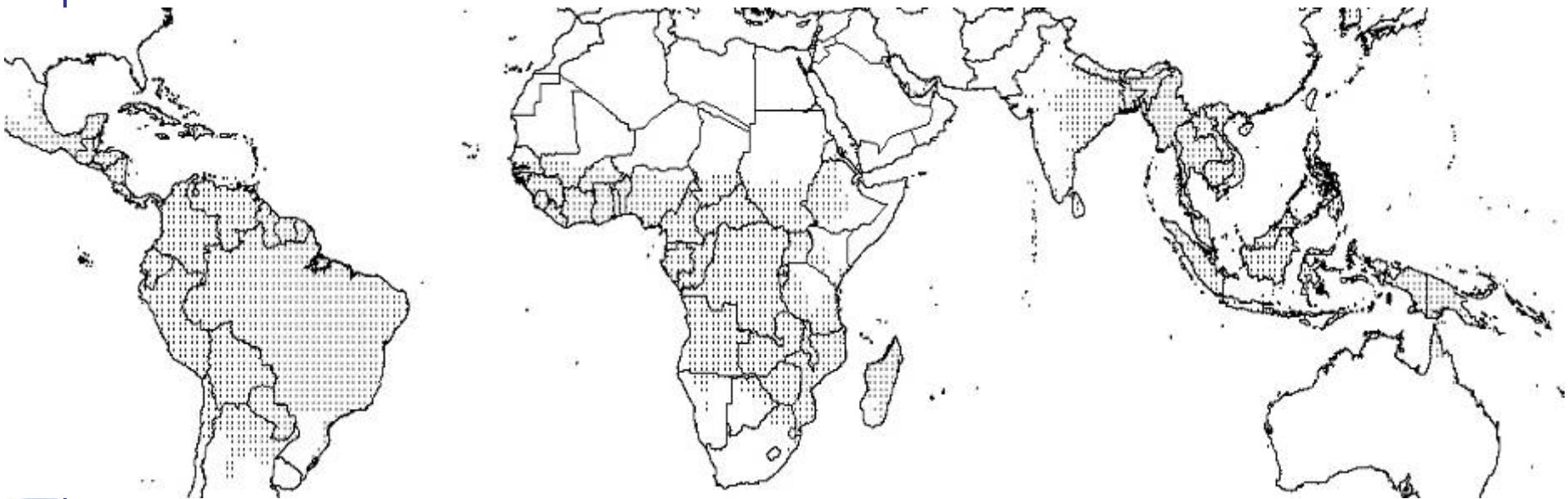
Forest change assessment method

- **20km x 20km sample units at each 1º lat-long grid intersection**
- **based satellite imagery (Landsat TM, SPOT, ASTER, similar..)**

Forest cover change assessment 1990-2000-2005-2010



Systematic sampling using the geographical grid (lat /long) in the tropics

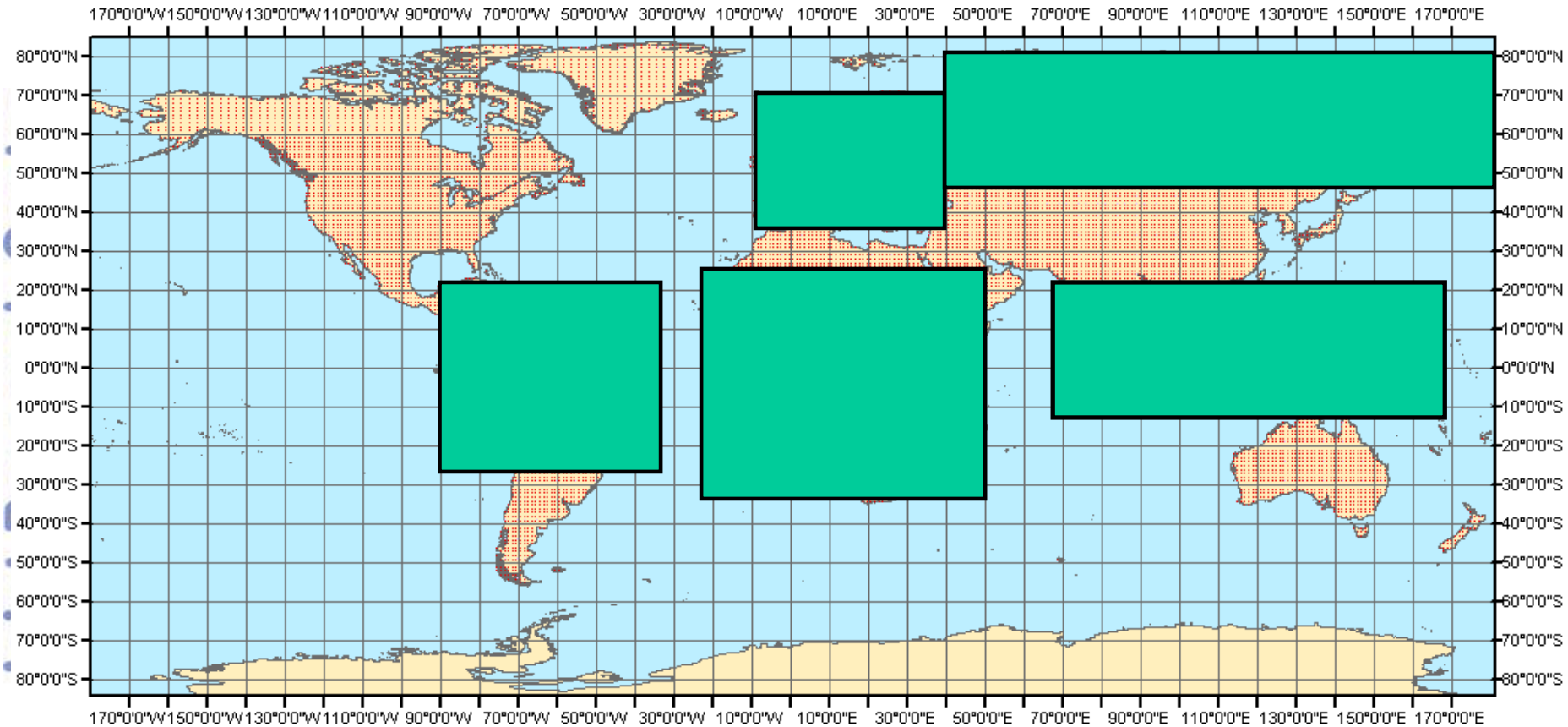


With distance between sample units = 1 degree

→

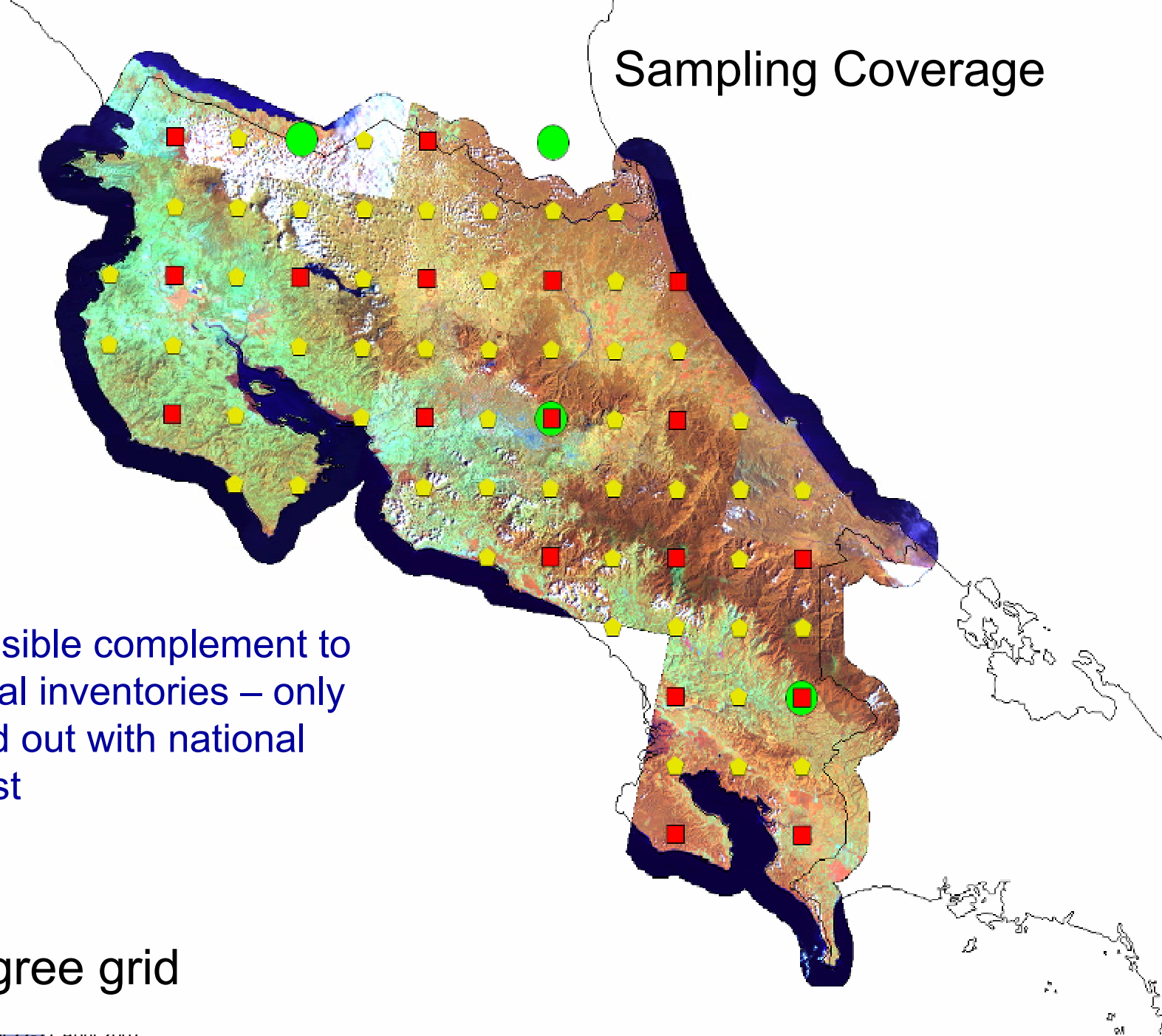
Number of sampling units in the tropics: ~ 3000

Areas to processed by the JRC



FAO will process / find partnerships for the rest of the world

Sampling Coverage



A possible complement to national inventories – only carried out with national request

0.25 degree grid

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How will the samples be processed?

- the past we used on-screen digitising and expert labeling

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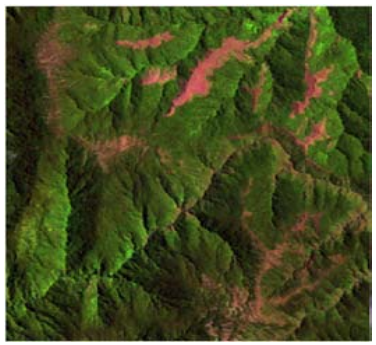
- **Disadvantages of on screen digitising**
  - **quality control on line precision**
  - **quality control on minimum mapping unit**
  - **digitiser 'fatigue' with large scenes**
  - **software vagaries (limitations on points in polygon / attributes in coverage)**
  - **labour intensive and time consuming**
  - **Cross calibration of digitisers and interpreters from different teams**

Proposed method – forest change assessment

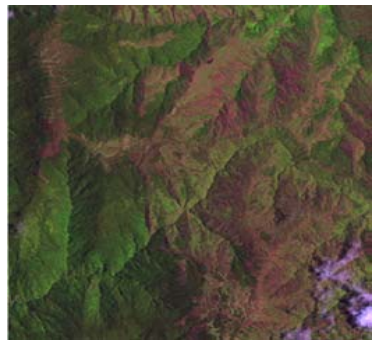
- Paired historical and recent image are segmented – automatic Minimum mapping unit assigned (5 ha) (A 1 ha layer will be produced for IPCC)
  - The use of segmentation is to obtain standard , repeatable delineations
- Resulting segments are automatically assigned to classes
- Interpreter corrects
- Regional experts carry out a quality control
- 10% sample is independently assessed.

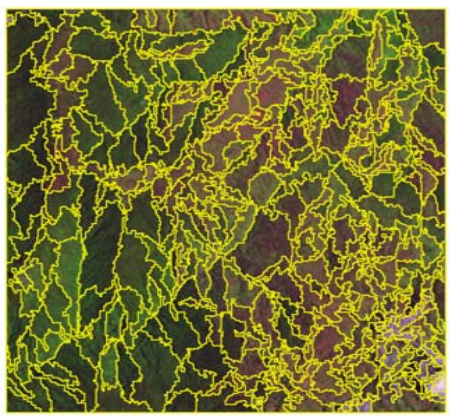
Segmentation - paired approach

Historical



Recent





Class labelling

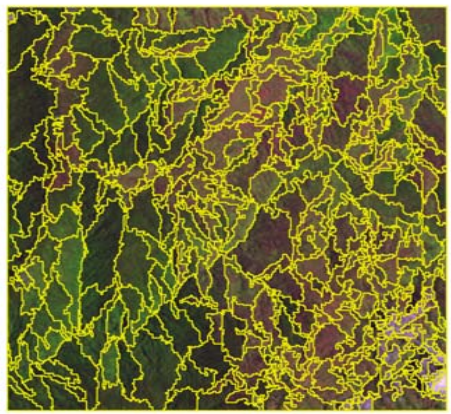
-Clustering of similar segments – available software

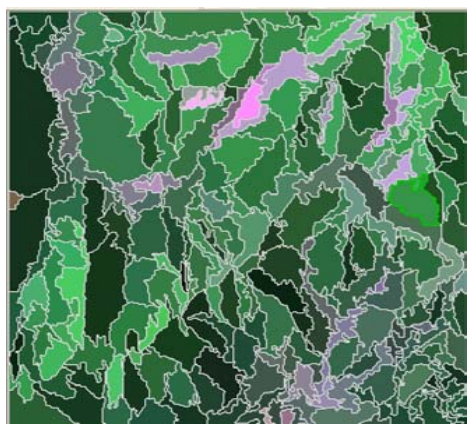
-Spectral library –tested one approach

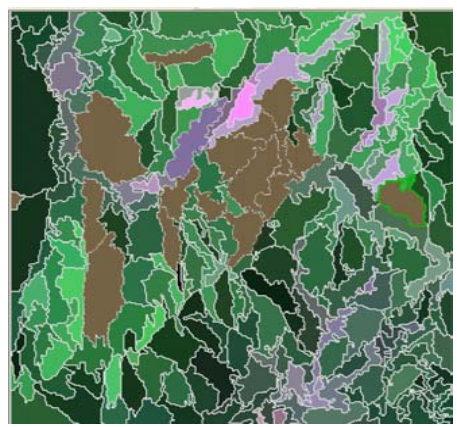
-Automatic Spectral Rule-Based Preliminary Mapping of Calibrated Landsat TM and ETM+ Images

-Baraldi, A. et.al. 2006

-Geoscience and Remote Sensing, IEEE Transactions on







1990 classes

2000 classes

Proposed legend

Tree cover > 5 m	Continuous (ff > 70%) Fragmented (ff 40-70%)	Closed (cc > 40%) Open (cc 15-40%)	Needleleaved Broadleaved	Evergreen Deciduous
Mosaic (ff 10-40%)	Tree cover – shrub or herbaceous (Grassland) Tree cover – cropland (permanent and intensive) Tree cover – cropland (extensive = shifting) – shrub/regrowth			
Shrub cover (inc. regrowth <5m)	Evergreen Deciduous			
Herbaceous cover (incl. lichen and moss)				
Cultivated & Managed	Shrub or herbaceous crop Tree crop (plantations)			
Non vegetated				
Water bodies				
Clouds & no data (no LCCS code)				

1/. Automated processing chain

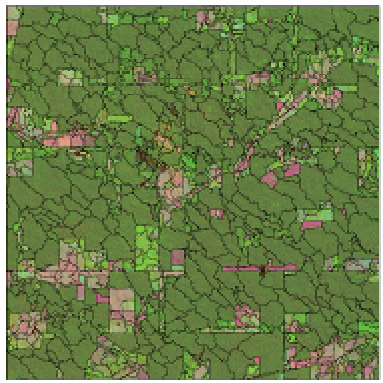
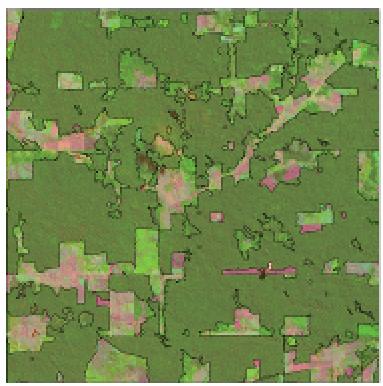
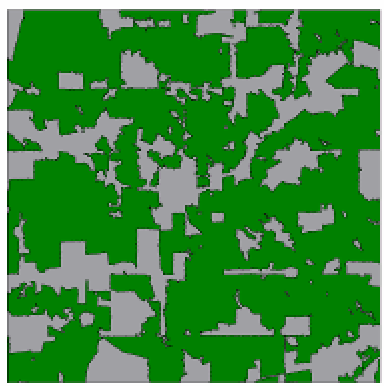




Image.....Segmentation.....Classification

2/. Inter-active interpretation and correction

Interpreters provided with aggregated polygons to correct labels and point out spatial problems

Current work on the methodology

Comparing in-house and commercial (Definiens) segmentation software

computer performance / robustness / capacity to change parameters etc.

-Testing the implications of different minimum mapping units

-Testing the impact of different sampling intensities on assessing key ecosystems – e.g. Congo Basin

-Assessing possibility of automatic class labels – for so many biomes!!!

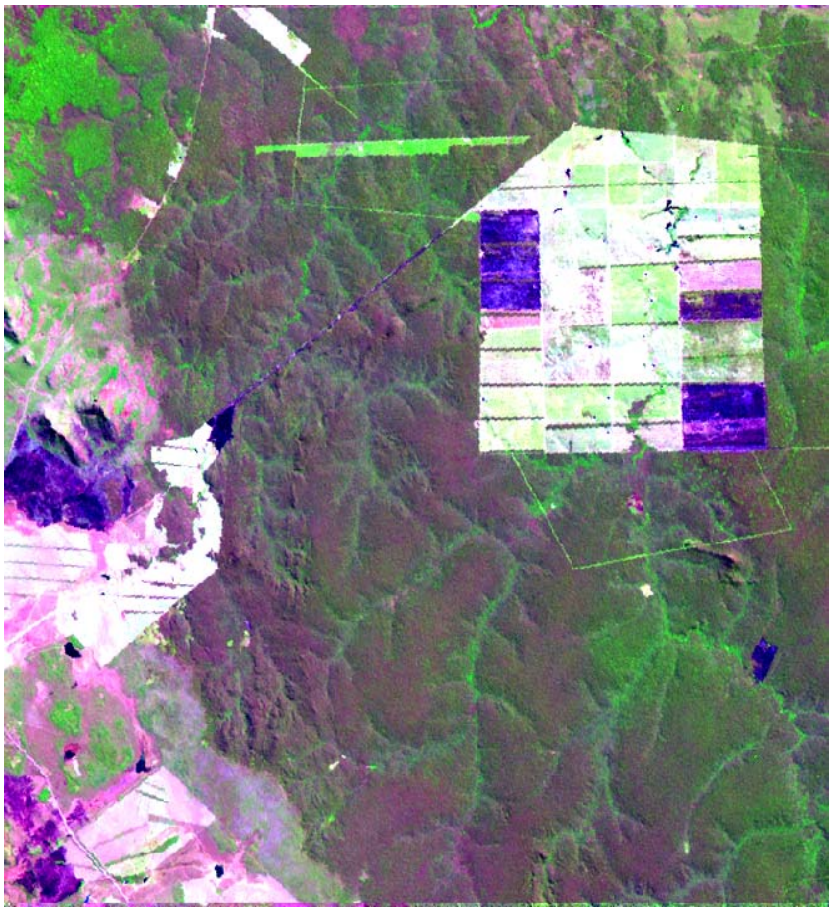
Subjective Tests – Can segmentation software provided us with results equal to that obtained by on screen digitising?

10km by 10 km Landsat subset 5,4,3

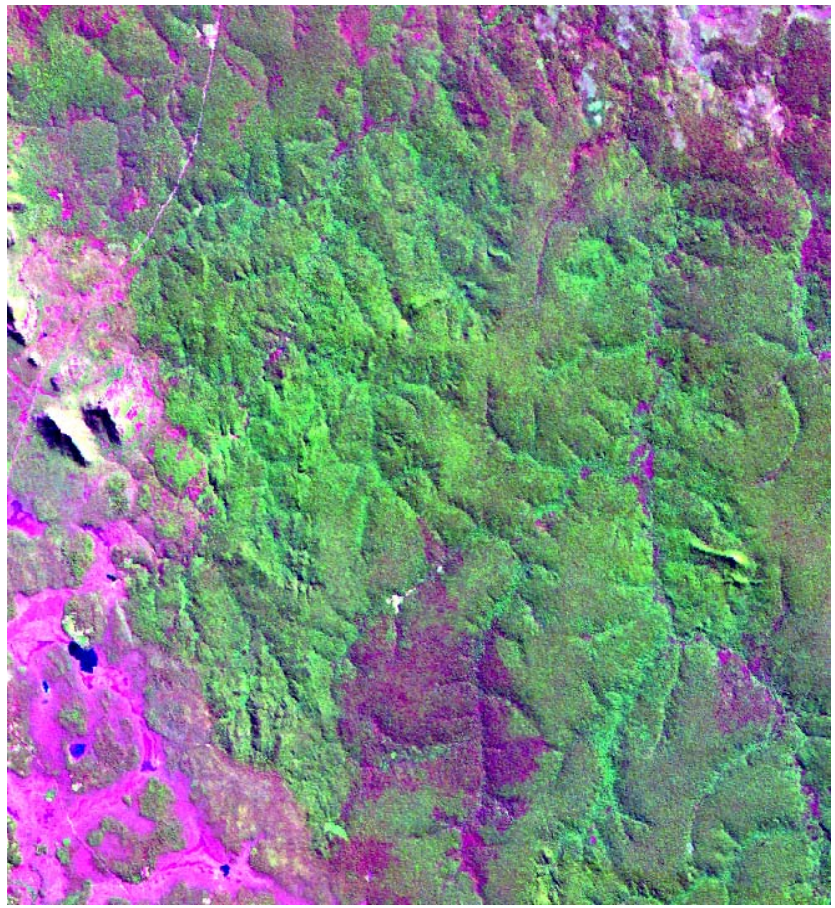
Digitised and eCognition classifications

PAIRED SEGMENTATION – WHAT MMU?

2000



1990

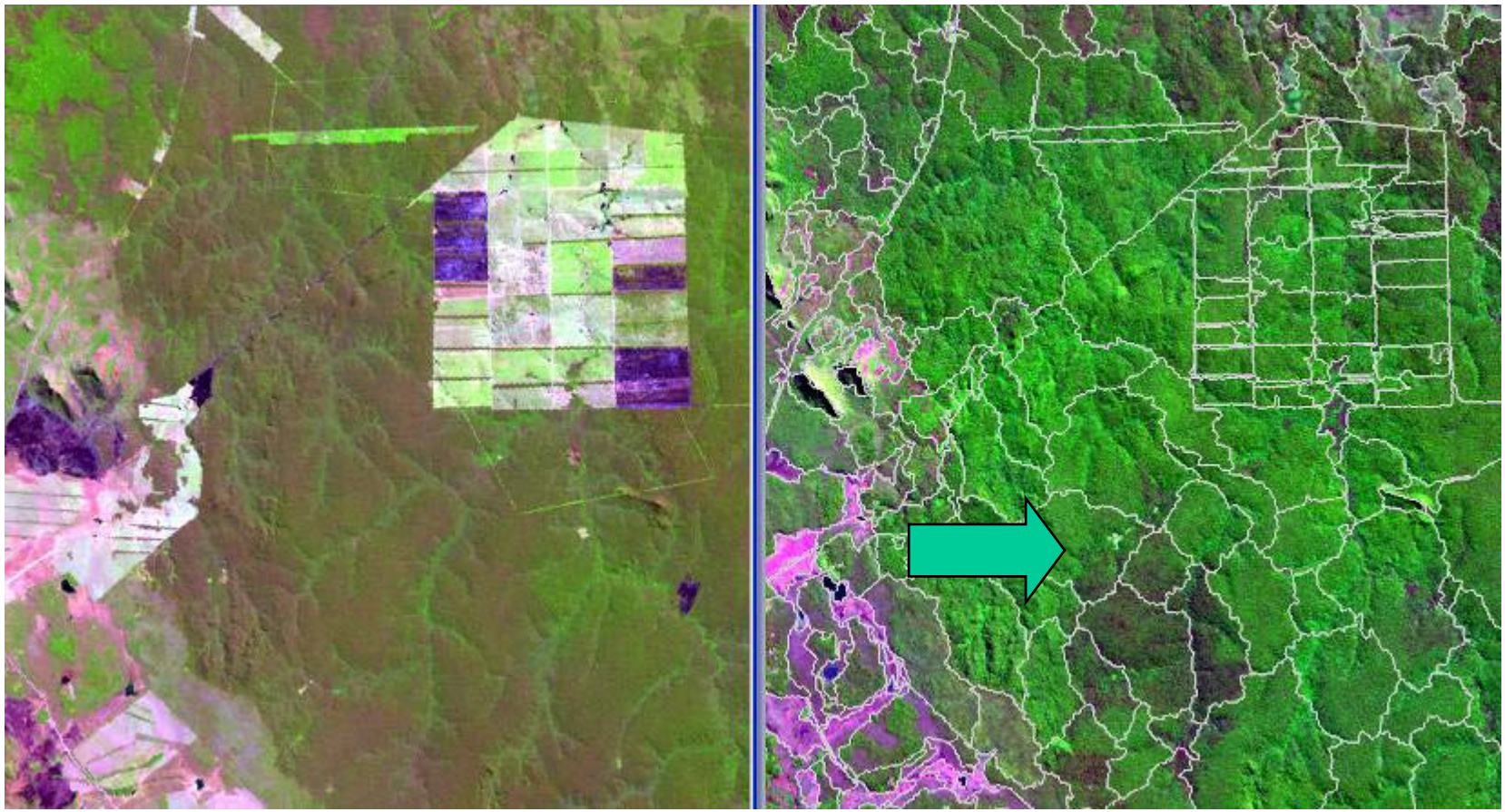


Site in NE Bolvia – Dry forest (Bosque Seco Chiquitano)

Mapping unit has implications for control

1500 polygons – minimum 0.5 ha average 26 ha

Too large and features are lost – here the burnt area



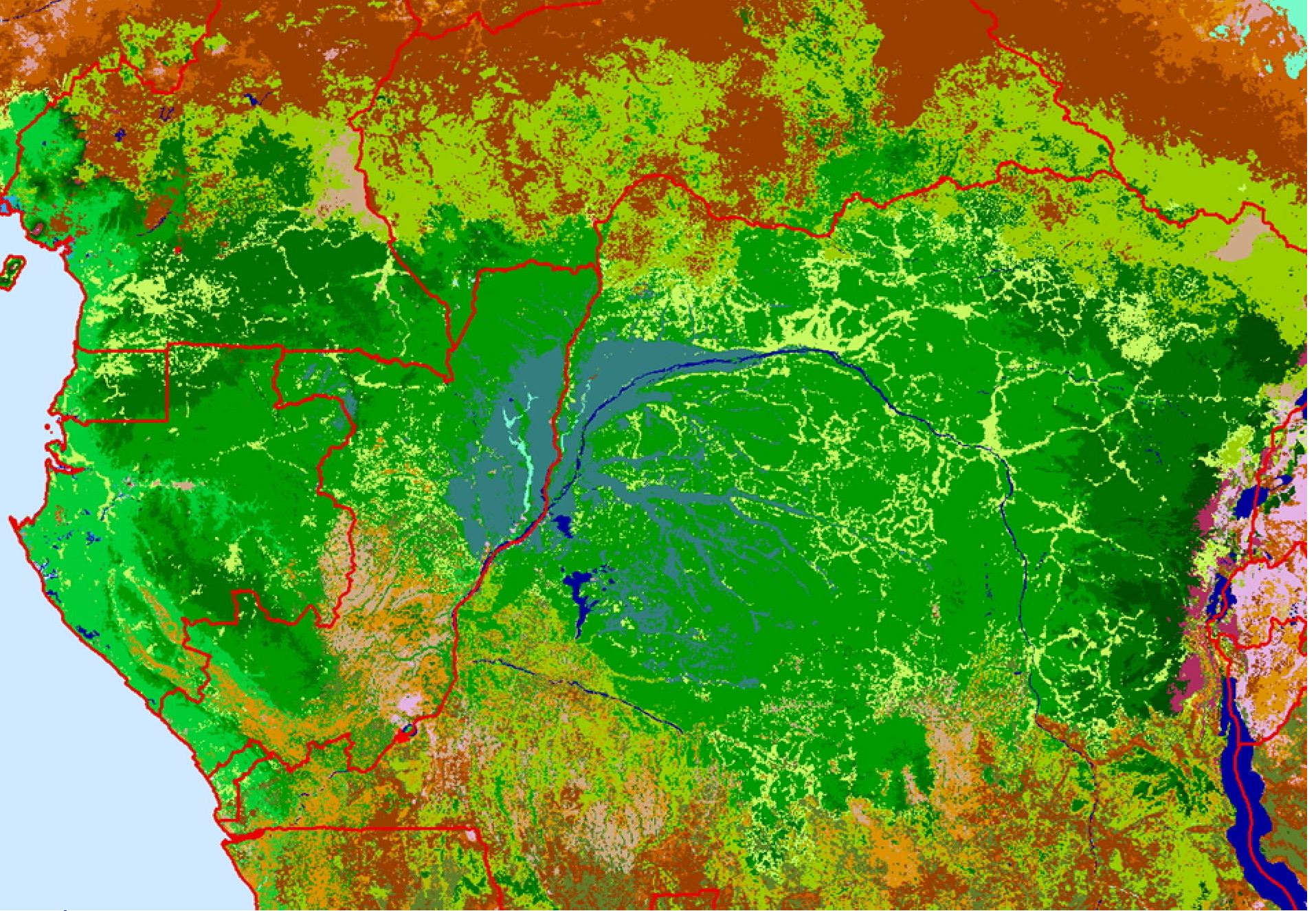
400 polygons – minimum 2 ha average 94 ha

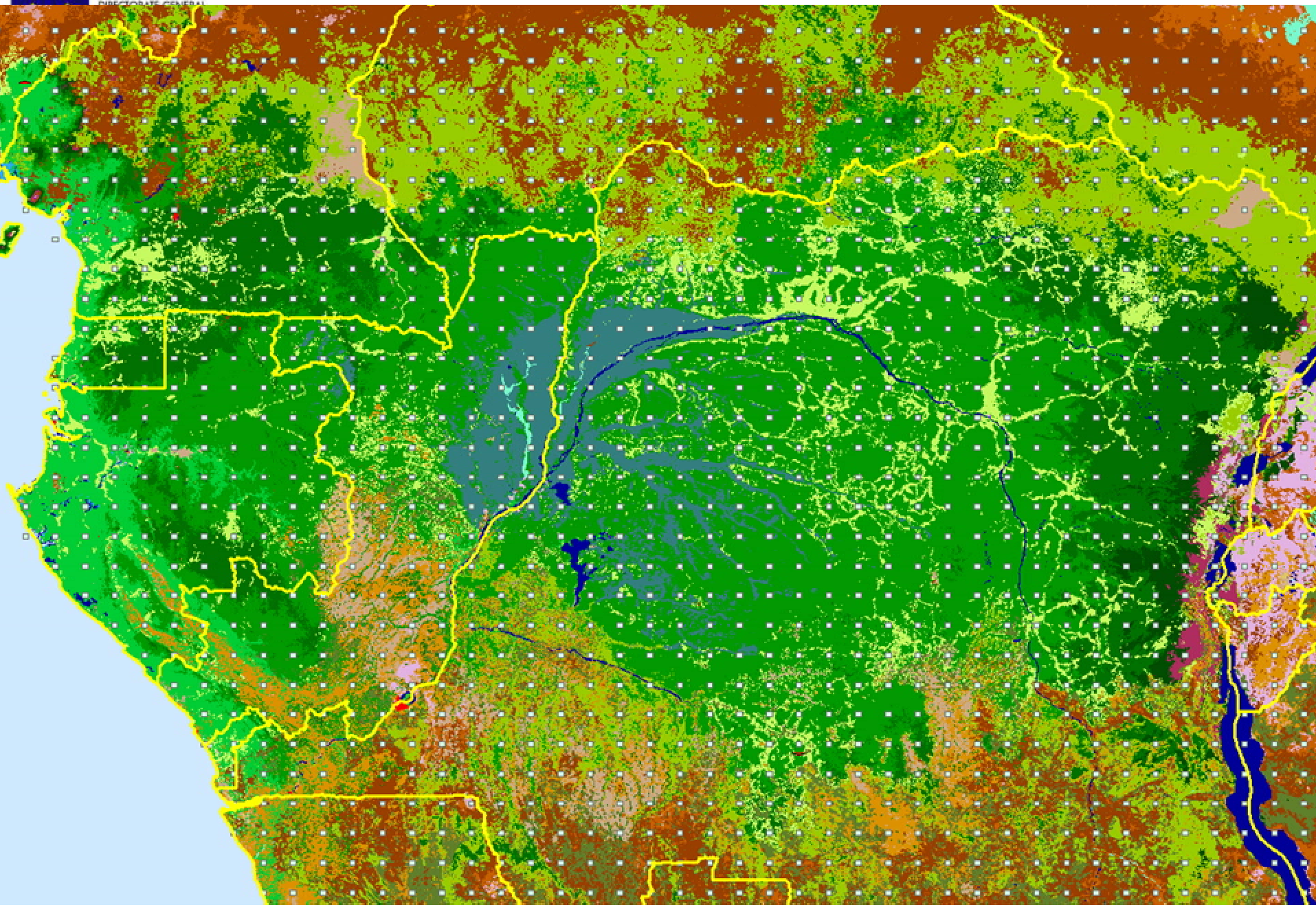
Methods Tests

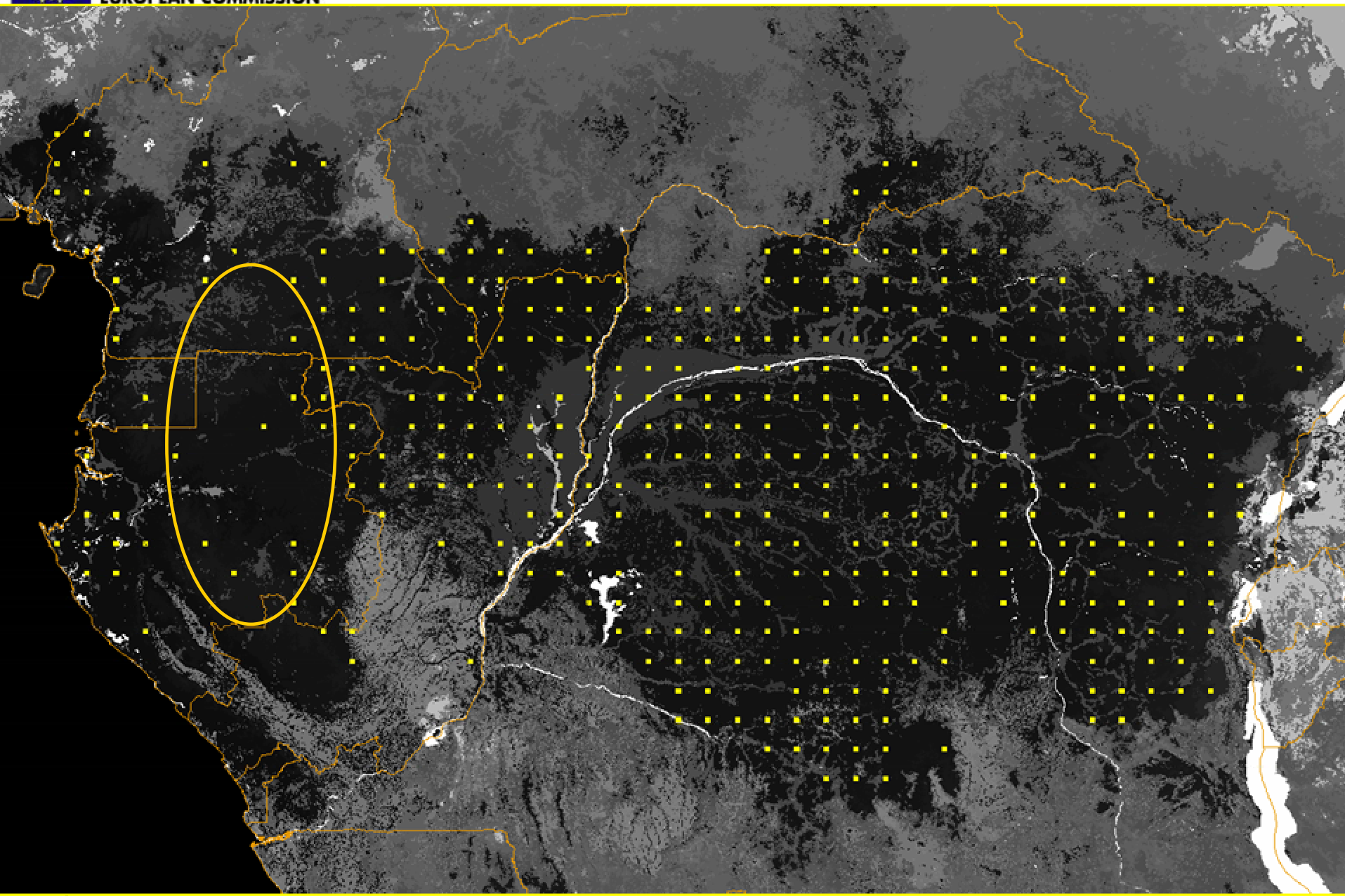
Congo Basin Test – Carried out with the University of Louvain-la-Neuve

-½ degree grid was used with 10km by 10km sample units

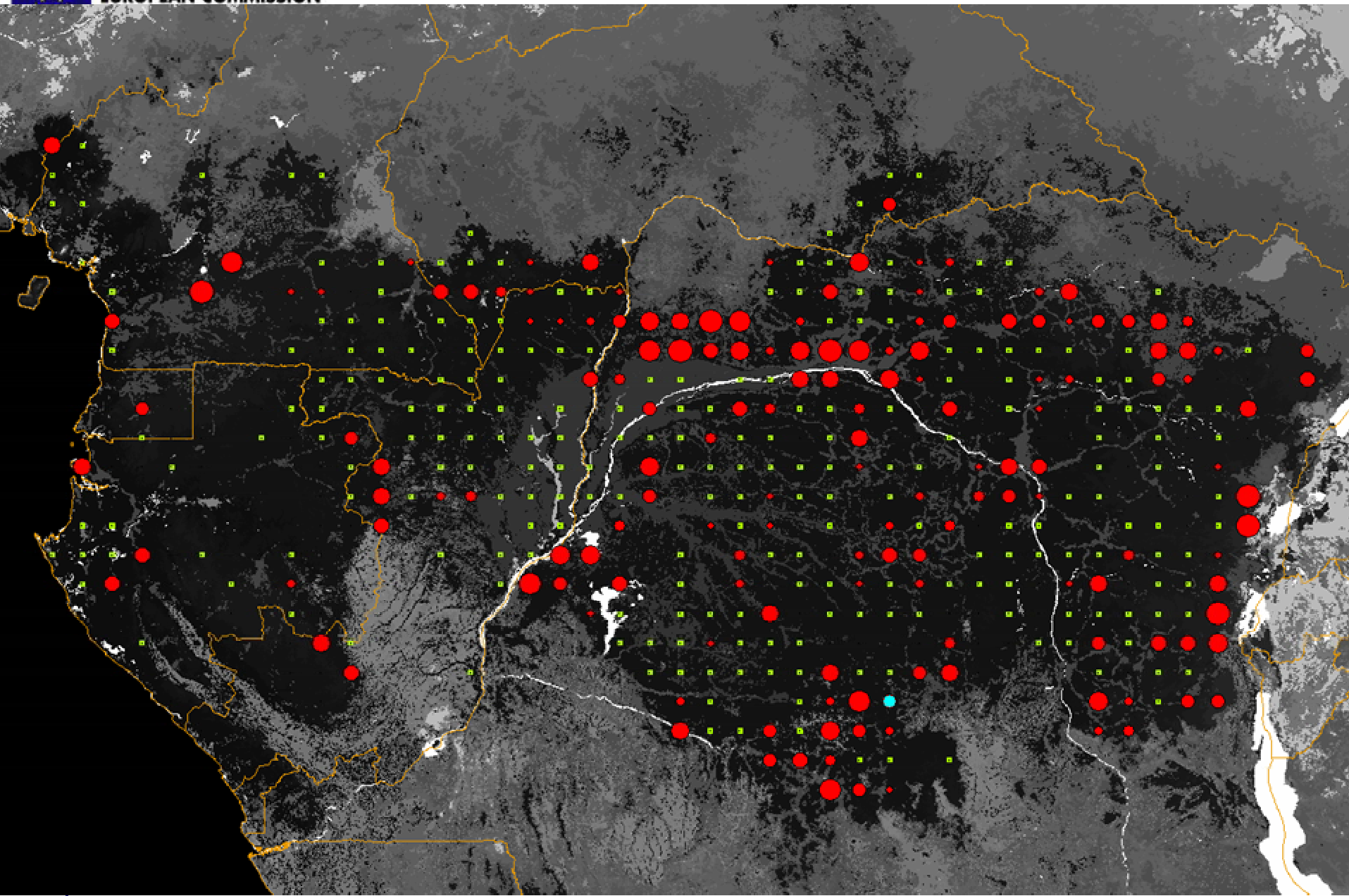
-Forest change calculated for 1990-2000







DATA AVAILABILITY



RED DOTS ARE THE SITES WITH CHANGE

Total deforestation (on 10 years)

	Central Africa Forest area = 180.4 Mons ha		
	n	average	C.I.
1 degree X 1 degree	101	2.20%	0.88%
	104	1.48%	0.74%
	98	1.94%	1.02%
	97	2.73%	1.22%
1/2 degree X 1/2 degree	**400**	**2.08%**	**0.48%**

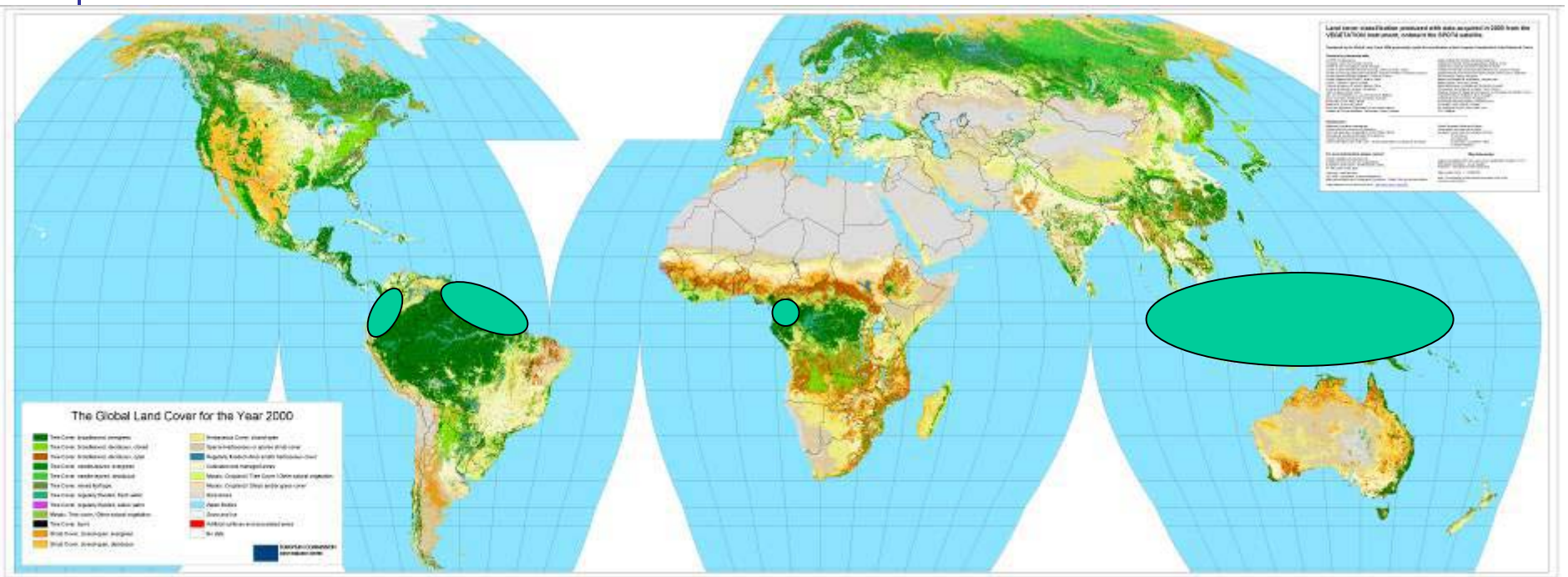
Using 10km by 10 km samples

More work is required on defining the level of aggregation at which the forest change statistics are valid (or acceptable).

The gives the opportunity to work with established regional inventories (e.g. PRODES) to assess the validity of the sampling scheme.

As a result of Congo Basin test we decided to move to 20km by 20 km test sites

Missing data points – Known problem areas



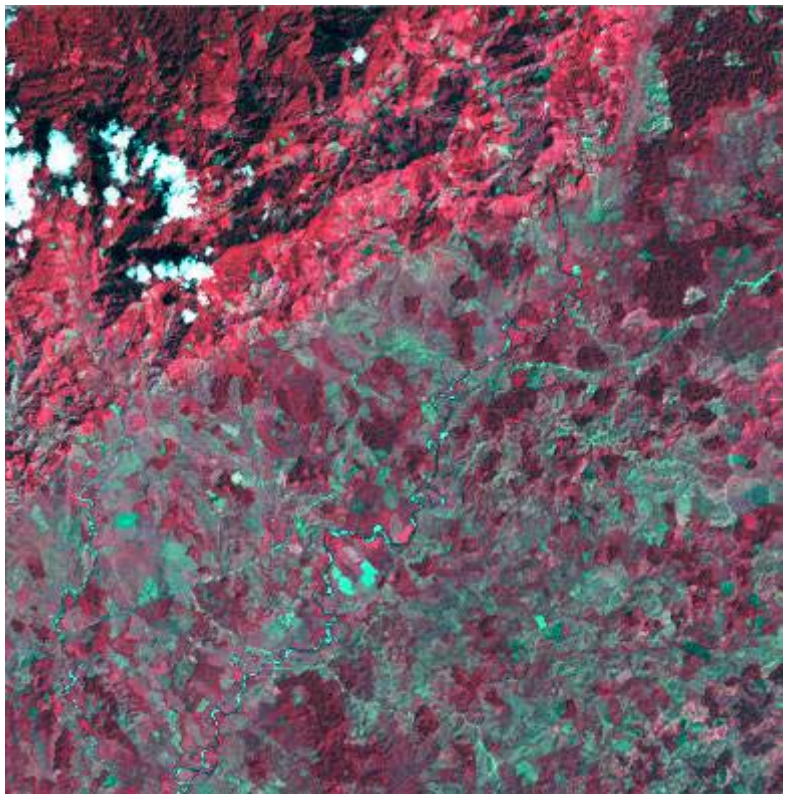
All insular SE Asia

Coastal zone of Congo Basin

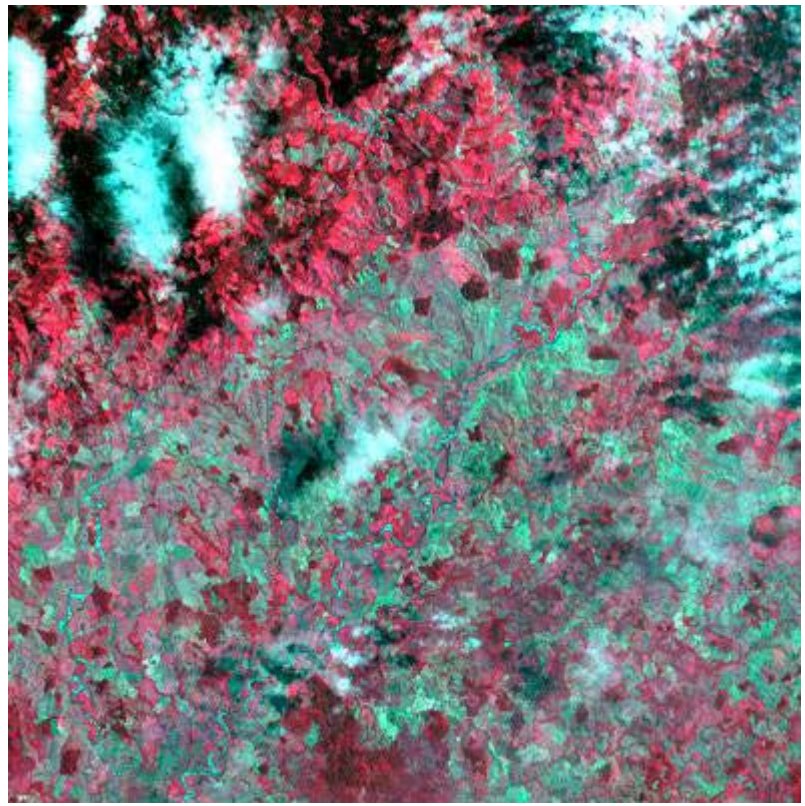
Guianas-Amazon-Braganza, Choco-Andes

Replacement imagery – Avoiding bias

1990



2000



Cloud is very often over the forested areas – using this scene (Llanos of Venezuela) would create a bias towards higher deforestation

Available data – for missing sites

Landsat SLC off products

CBERS

DMC (complete Amazon basin coverage 2006)

MODIS

ASTER – 500 images order

'Guestimates'

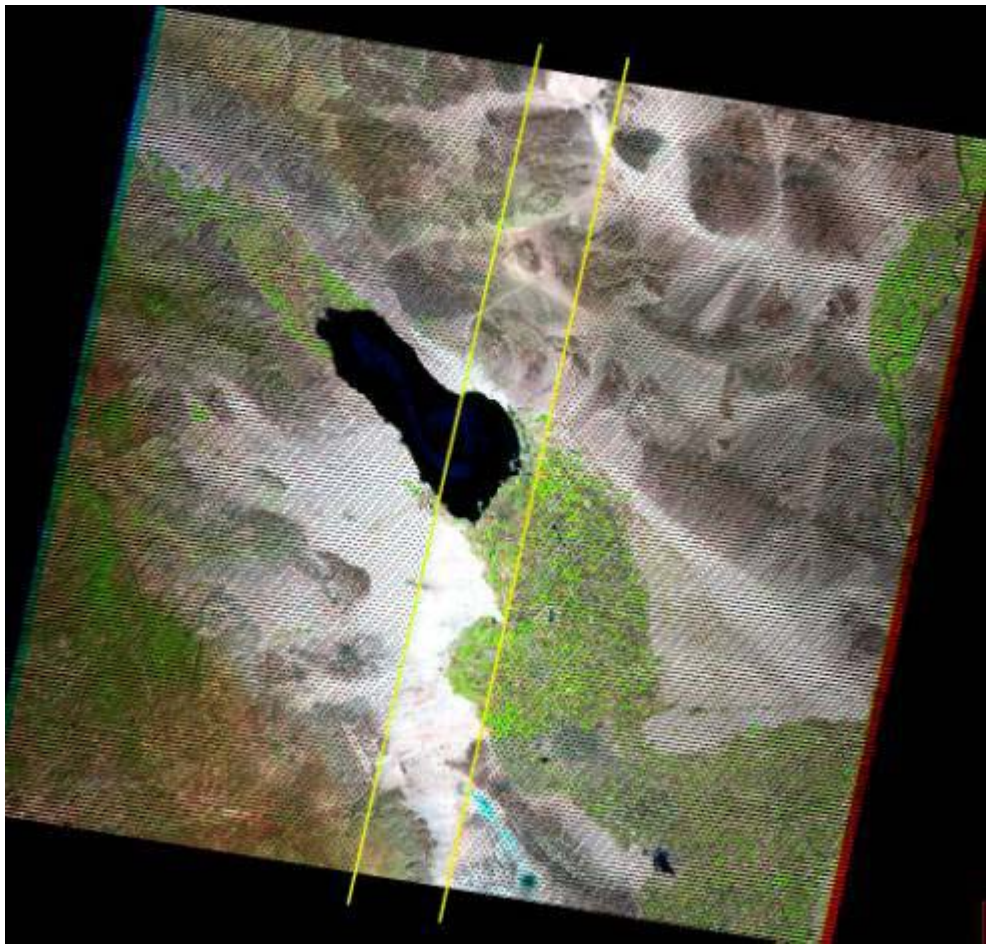
SPOT (IRD receiving station in Cayenne)

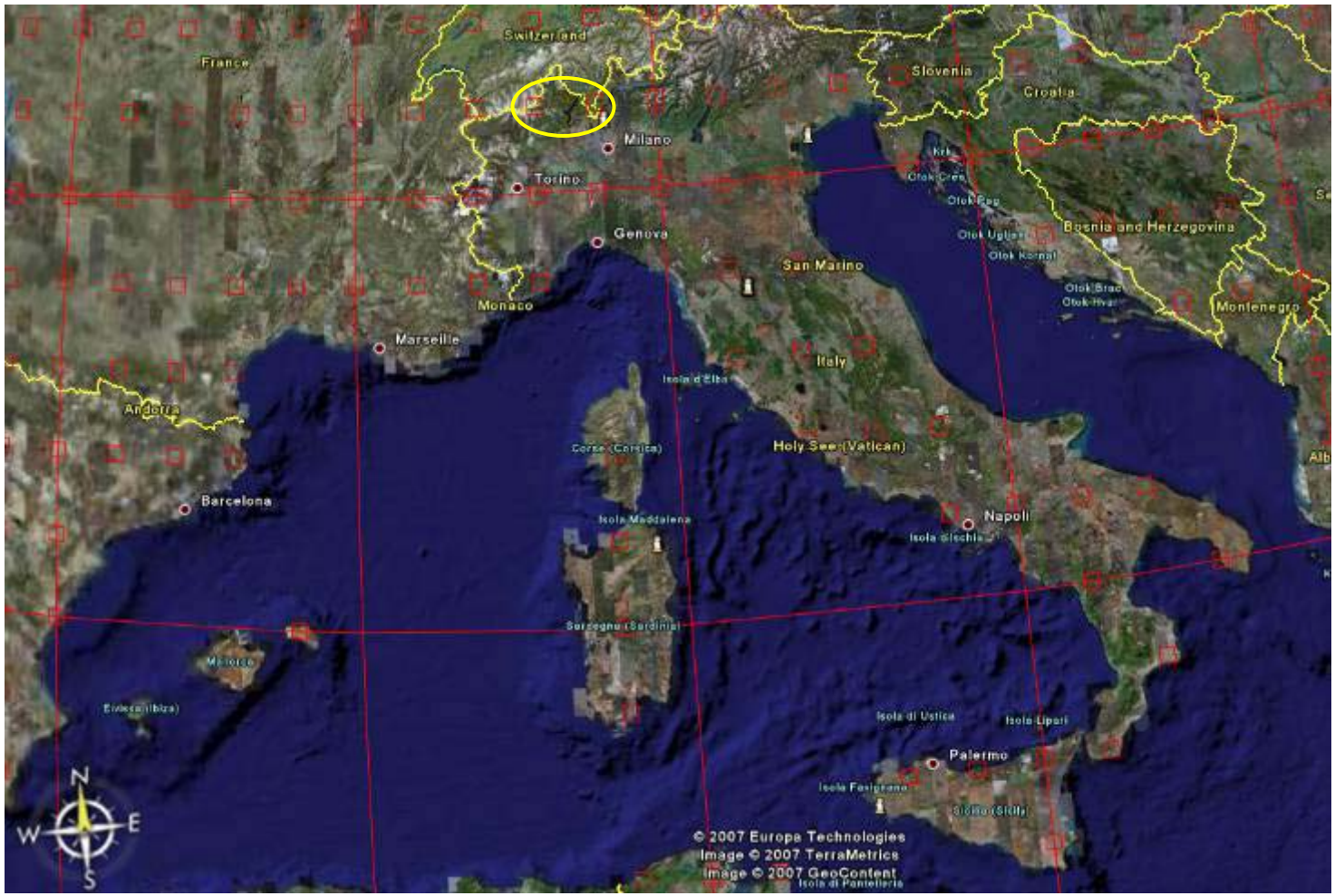
ALOS – PALSAR and AVNIR (50m) ...

Costs and processing overheads – new methods to develop

Available data – 2005/7

SLC-off products




France
Switzerland
Slovenia
Croatia
Milano
Torino
Genova
Bosnia and Herzegovina
San Marino
Monaco
Montenegro
Marseille
Italy
Andorra
Holy See (Vatican)
Barcelona
Napoli
Palermo
N
W
E
S
© 2007 Europa Technologies
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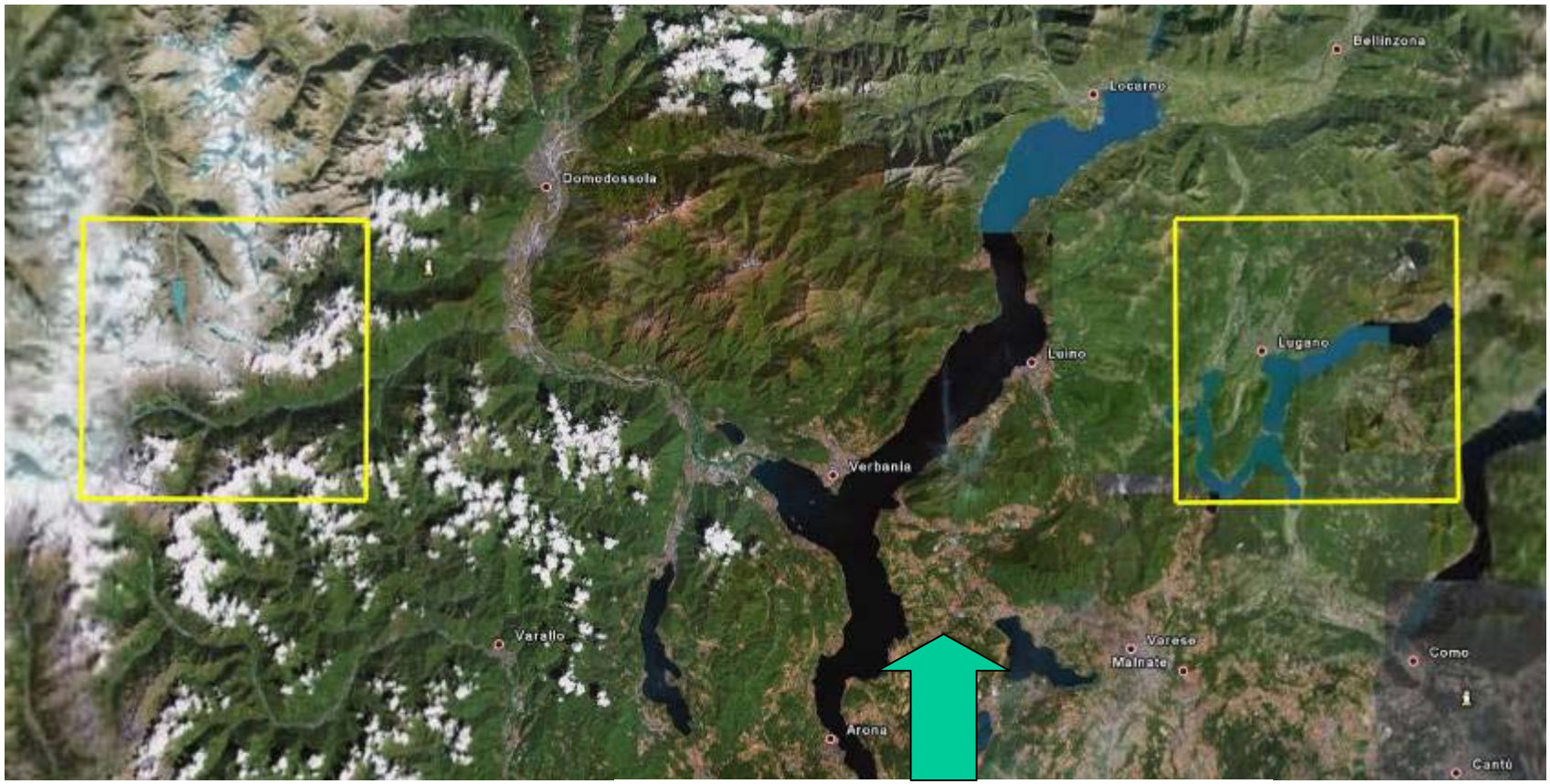
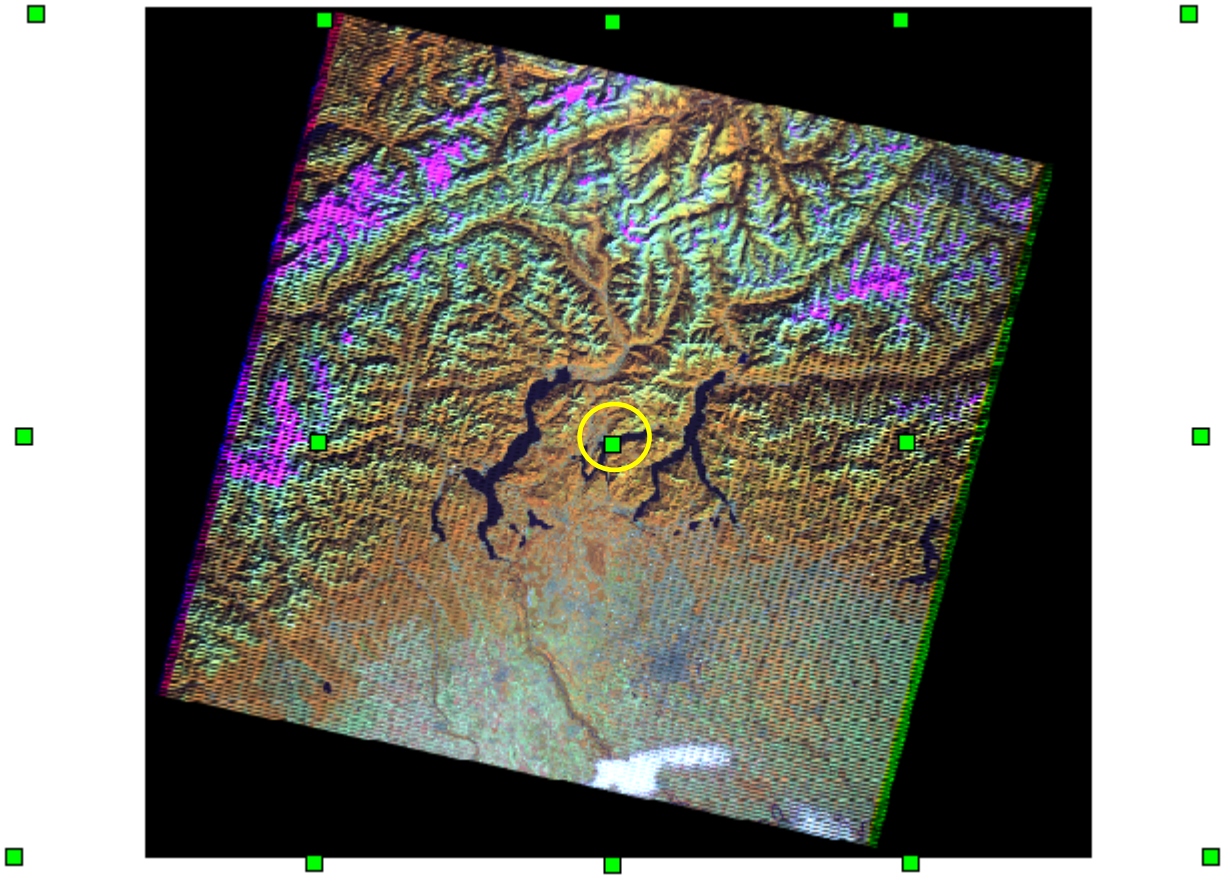


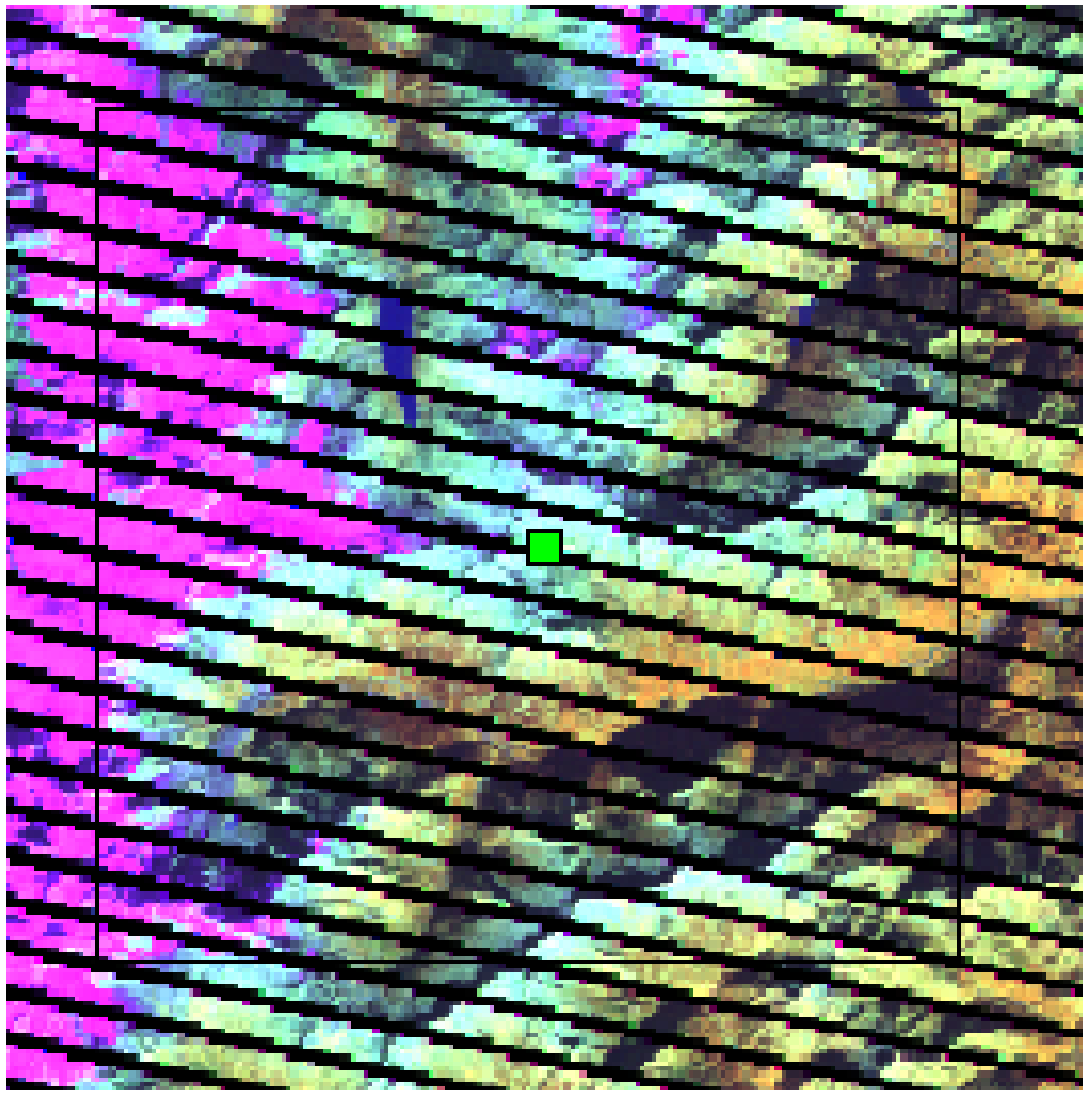
EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre

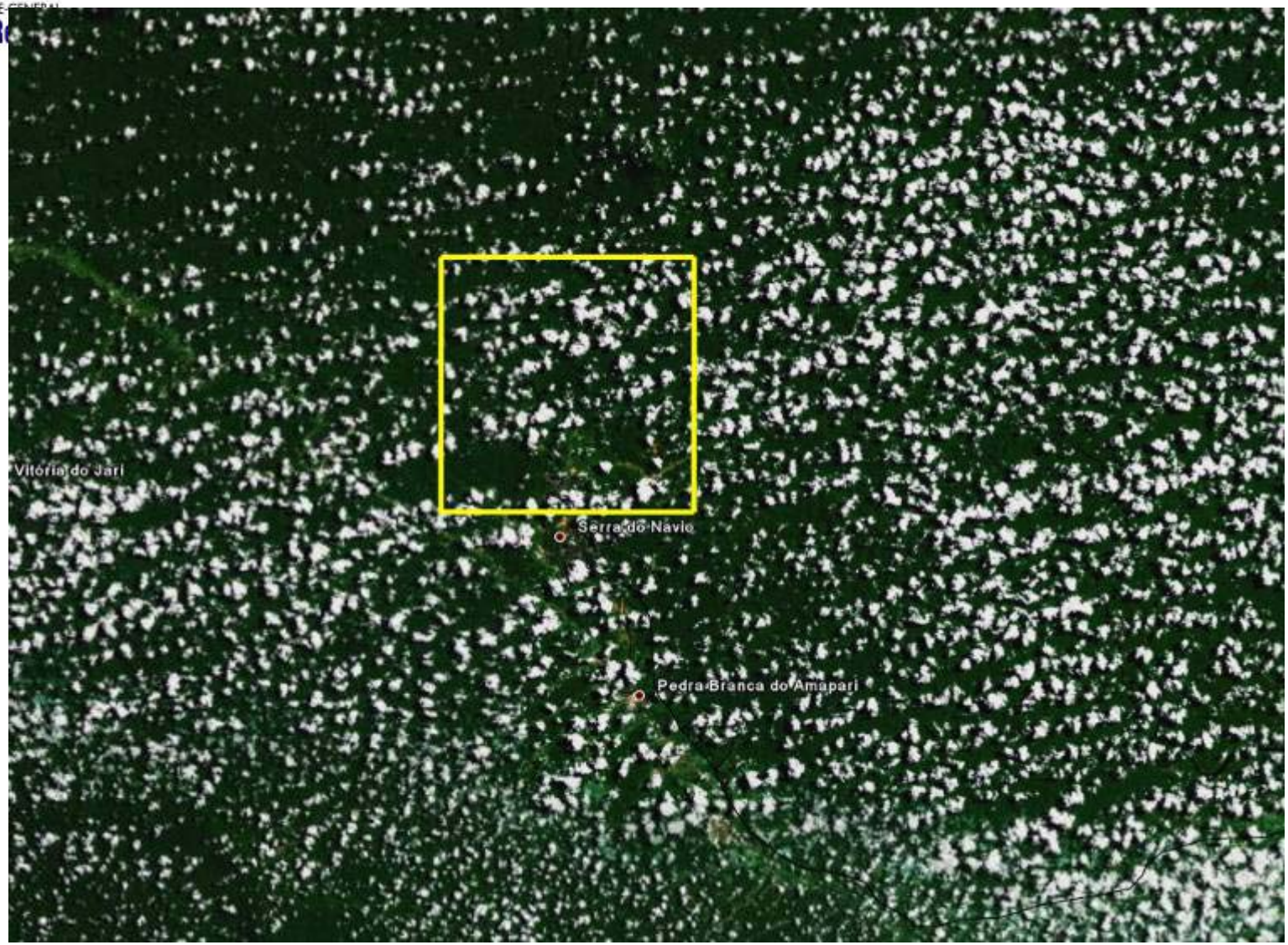
Available data – 2005/7



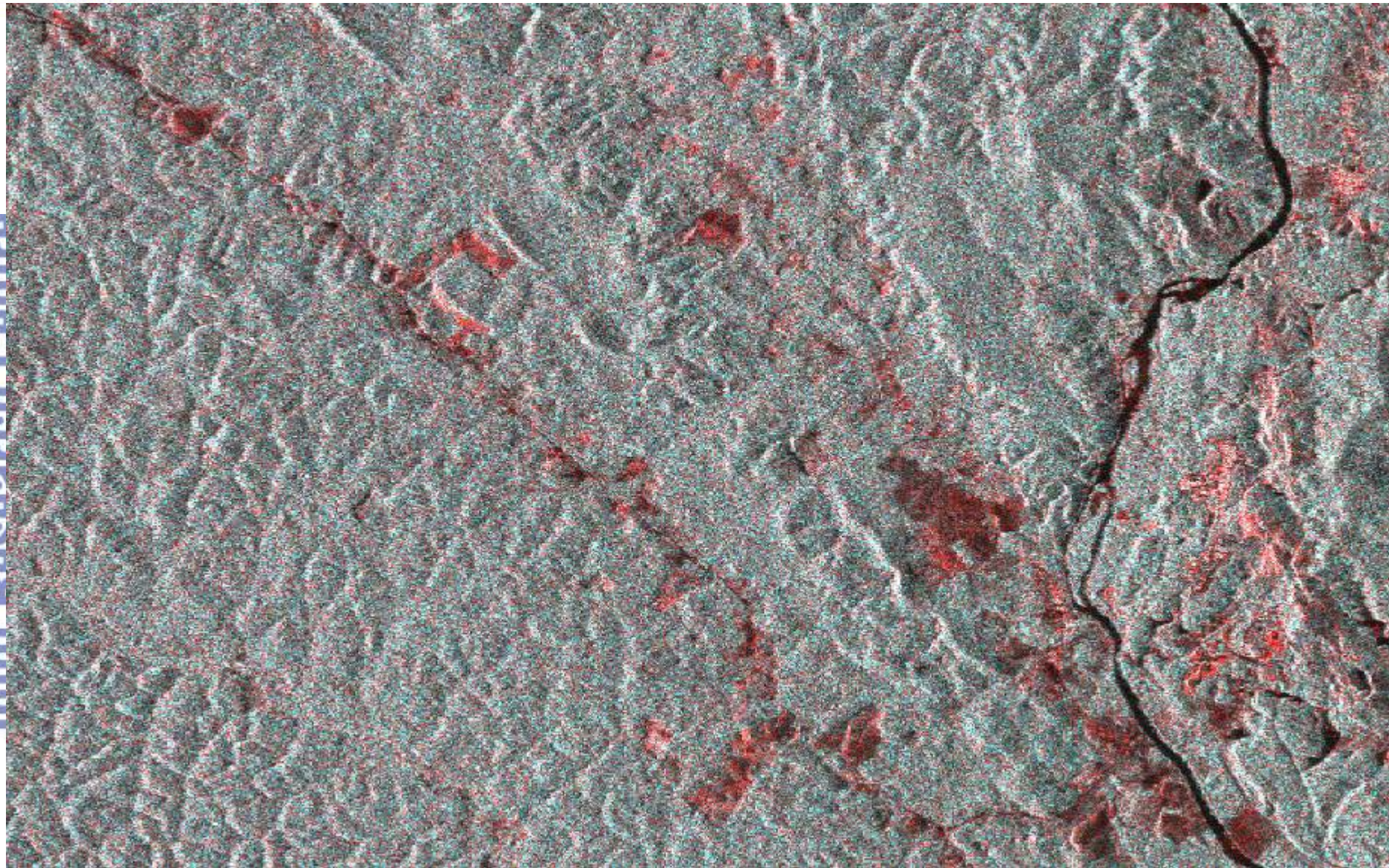
Nearest sample site to the JRC is Lugarno – 46N 9E

Sites off-nadir are difficult to exploit





Serrra do Navio – Amapa – 1N 52W



ALOS PALSAR 2007. Courtesy of JAXA/METI

Validation

At this scale validation is problematic

-Compare to established national databases – e.g. INPE PRODES

-Carry out a consistency test

10% sample re-assessed by independent experts for thematic label and spatial delineation

Current Status

Data for the 1990 and 2000 periods have been downloaded

Defined a sampling scheme for the tropics – at higher latitudes to be defined with partners

Defined our sample unit size (20km by 20km)

In the process of:

Defining the pre-processing

Testing different segmentation software

Testing an in-house spectral library for automatic class labeling

Identifying missing data points

Dead line is the end of this year to start processing 1990-2000

Conclusions

The Need

-To reduce uncertainty in the estimation of forest cover and forest cover change at continental to global levels from c. 1980-1990-2000-2005-2010

The Method

-The use of a sample of high spatial resolution satellite data with 20km by 20km sample sites

The challenges

-Ensuring that the sampling scheme is high enough to achieve acceptable results

-Developing robust methods that can be applied across different forest biomes

-Matching project requirements with technical capacities (legend)

Thank you for your attention

TREES results for the "Brazilian Amazon & Guianas" region

Comparison with Brazilian (INPE) estimates

Brazilian Amazon & Guyanas	JRC TREES	INPE-Amazonia + FAO-Guyanas
Forest cover in 1990 (10^6ha)	420 ±37	401
Annual deforestation 1990 – 1997 (10^6ha yr^{-1})	1.40 ±0.74	1.43

Outline

The Joint Research Centre of the European Commission

The EC and forest monitoring

The TREES project 1992-2013

Uncertainty in global forest monitoring

T