

# **Monitoring of tropical forests using EO data:**

## **The TREES project of the JRC and**

## **Perspective of the REDD+ item of the UNFCCC**

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Joint Research Centre of the European Commission

# *Monitoring Forest Cover at Global Scale*

**The Joint Research Centre (JRC) approach  
&**

**The FAO Global Forest Resource Assessment 2010 Remote Sensing Survey**

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*FAO FRA 2010 RSS Staff: Adam Gerrand, Eric Lindquist, Mette Løyche-Wilkie*

## **To reduce uncertainties in global estimates of forest cover change and related carbon emissions with focus on the Tropics and boreal Eurasia**

- land cover change dynamics
- where forests are changing & by how much they are changing
- what are the resulting changes in carbon emissions

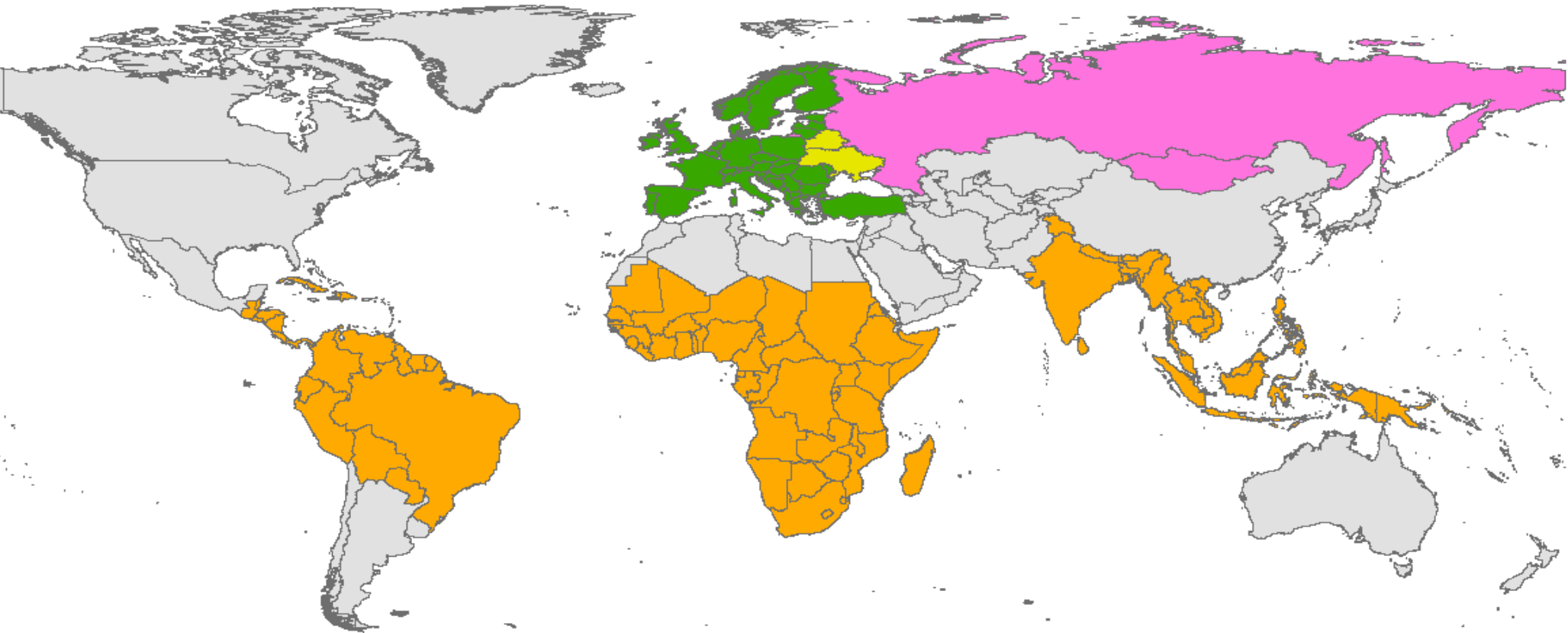
## **To provide information to EC services to support them in their definition of policies in the framework of multilateral environmental agreements**

- climate change negotiations (e.g. REDD issue)
- potential deforestation drivers (e.g. bio-fuels)
- FLEGT: support to EU-funded projects

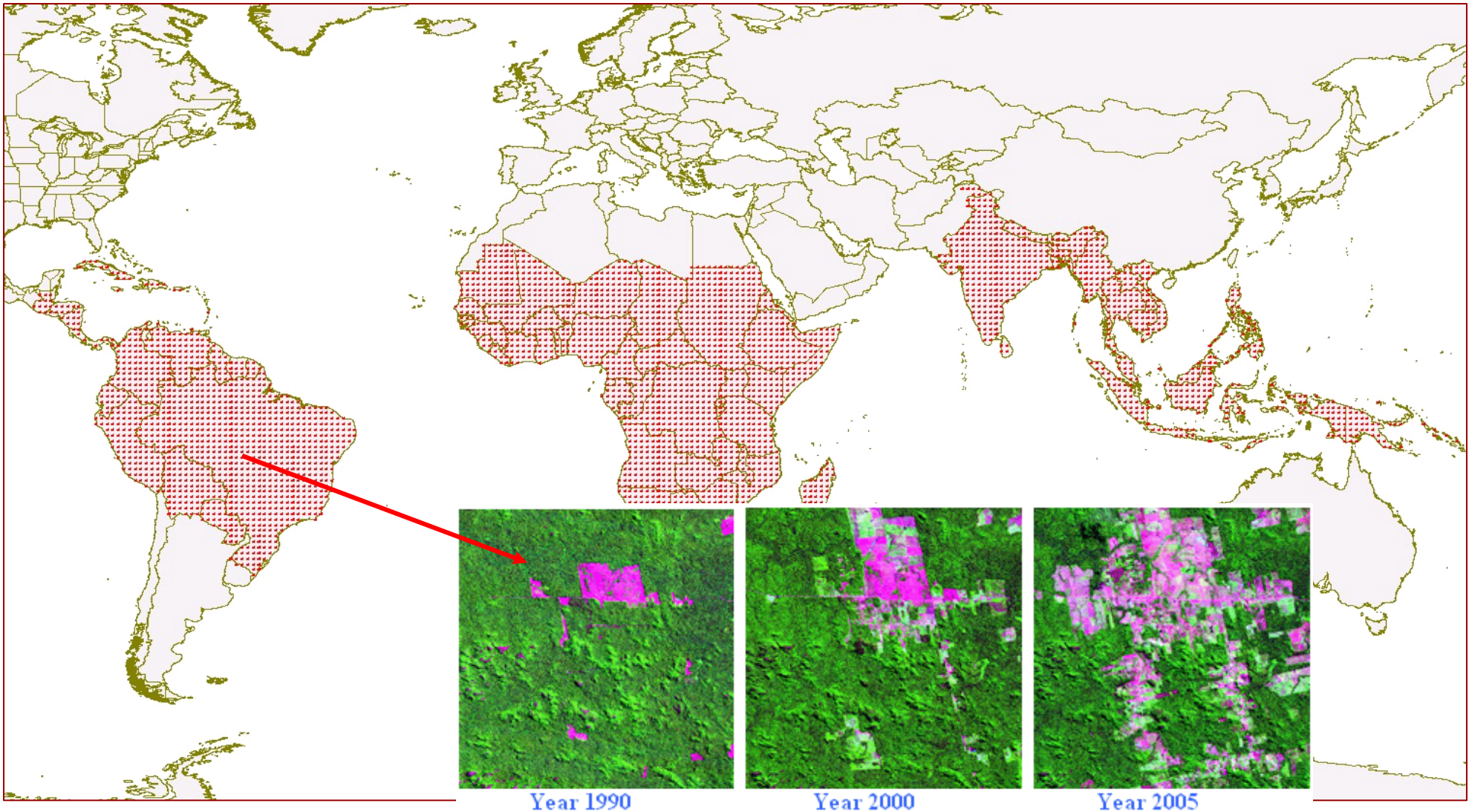
## **To contribute to capacity building in developing countries**

- technical support on concepts /methods of forest monitoring (REDD / FLEGT)

# JRC geographical and temporal focus



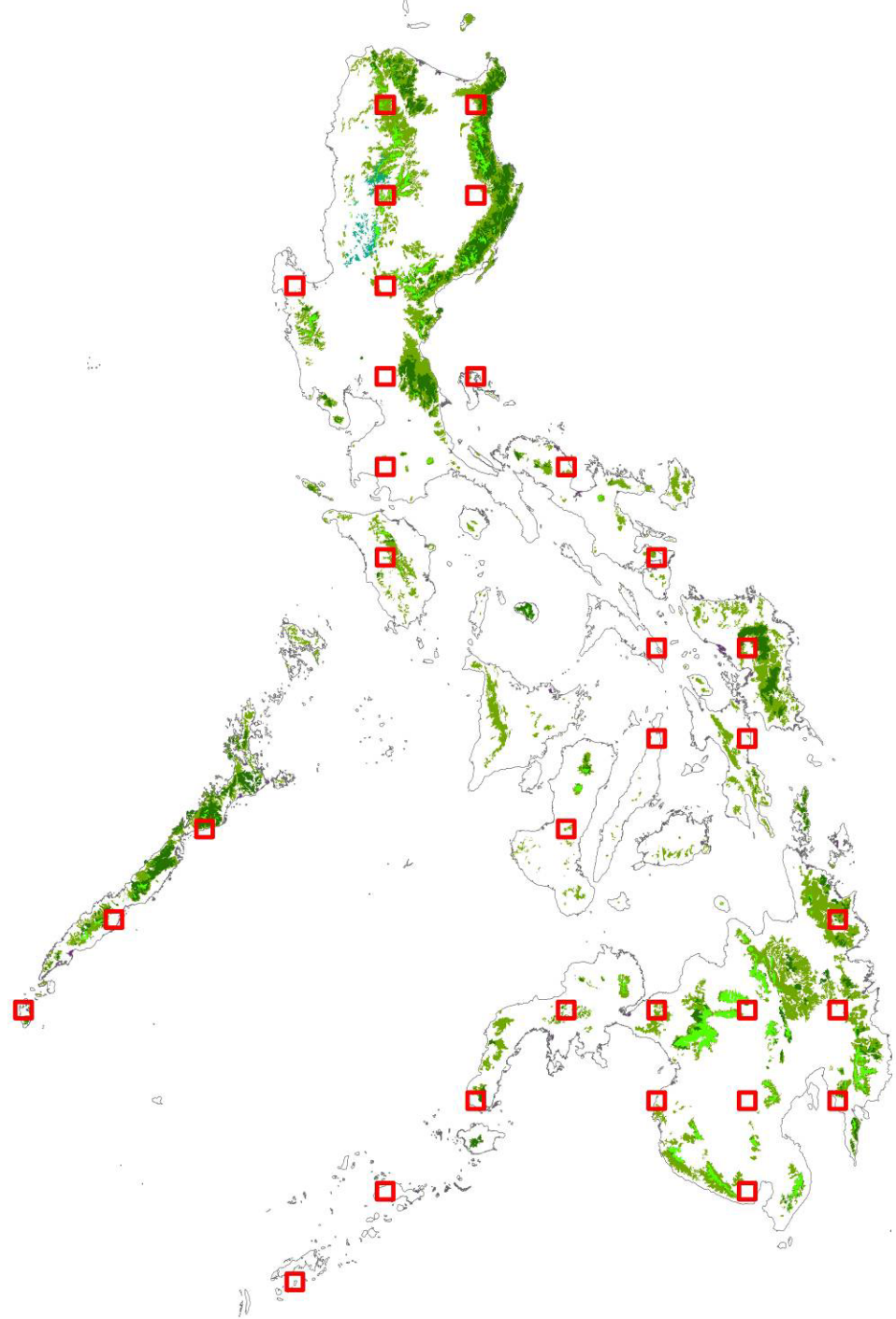
# Systematic grid over the Tropics



Analysis of a systematic sample of sites with 30 m resolution satellite data



Analysis of a systematic  
sample of sites  
20 km × 20 km size  
with Landsat-TM type imagery

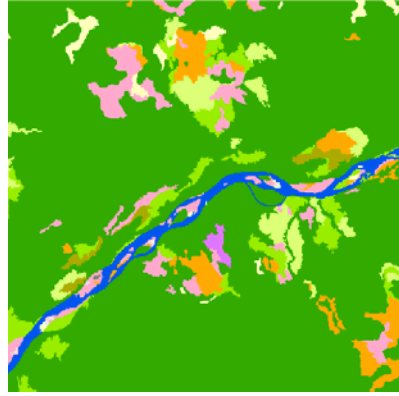


The methodology is based on the analysis of a systematic sample of sites for which Landsat-type satellite data are collected

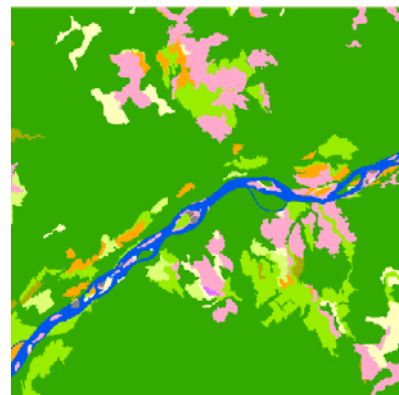
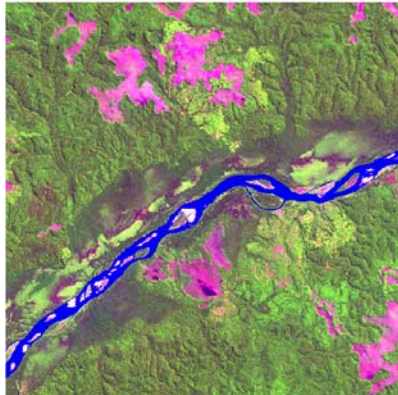
- 1. Data selection (for years 1990, 2000 and 2005)**
- 2. Pre-processing**
- 3. Automatic Segmentation**
- 4. Semi-automatic labelling of segments**
- 5. Regional validation**



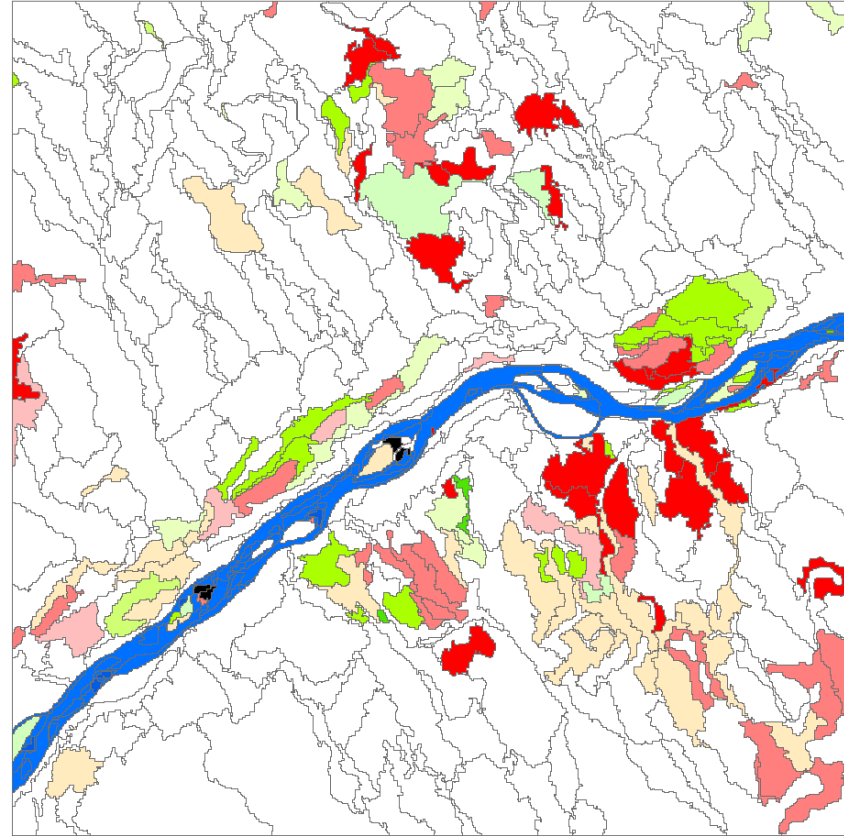
1990















2000










Change Map 1990-2000



-  Tree Cover
-  Tree Mosaic-High%
-  Tree Mosaic-Low%
-  Shrub Cover
-  Shrub Regrowth
-  Other Vegetation Cover

-  Bare/Artificial
-  Burnt
-  Water
-  Non-Tree Cover Mosaic
-  Clouds/Shadow
-  No Data

-  } LCC From Forest
-  } LCC From Forest
-  } LCC From Forest
-  } LCC To Forest
-  } LCC To Forest
-  } LCC To Forest
-  No change



# Regional validation workshops



**Dakar** (08-13 March 2010)

**West Africa**

**15 Experts from 14 countries**

**3 JRC support staff**



**Nairobi** (28 Sept.- 2 Oct 2009)

**East and Southern Africa**

**12 Experts from 10 countries**

**4 support staff including 3 JRC**



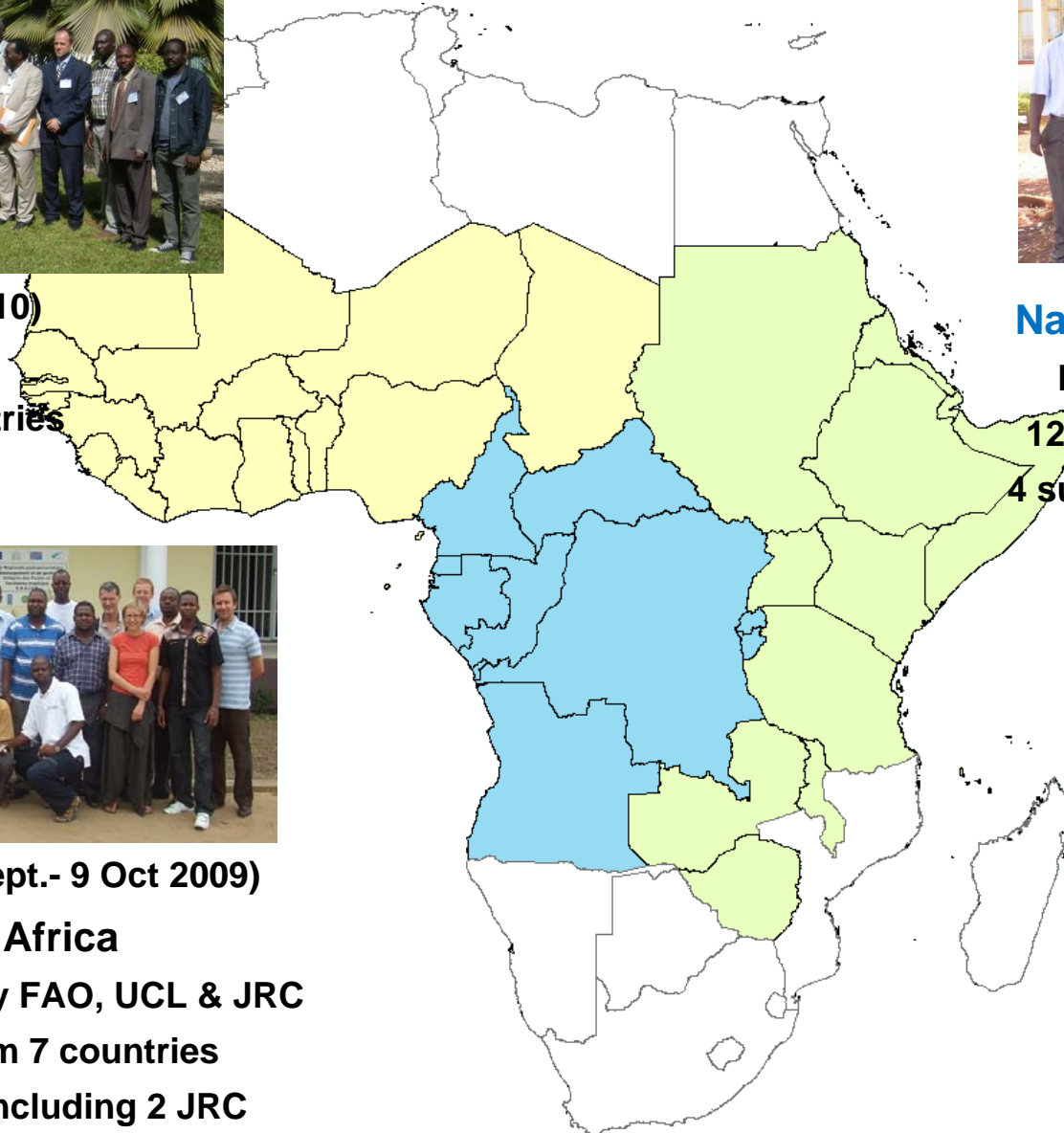
**Kinshasa** (28 Sept.- 9 Oct 2009)

**Central Africa**

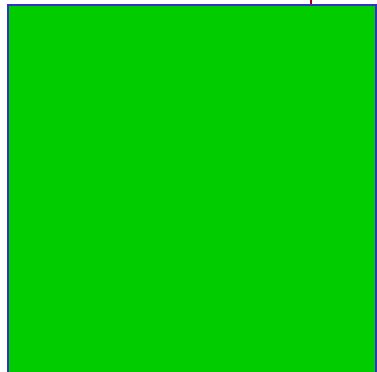
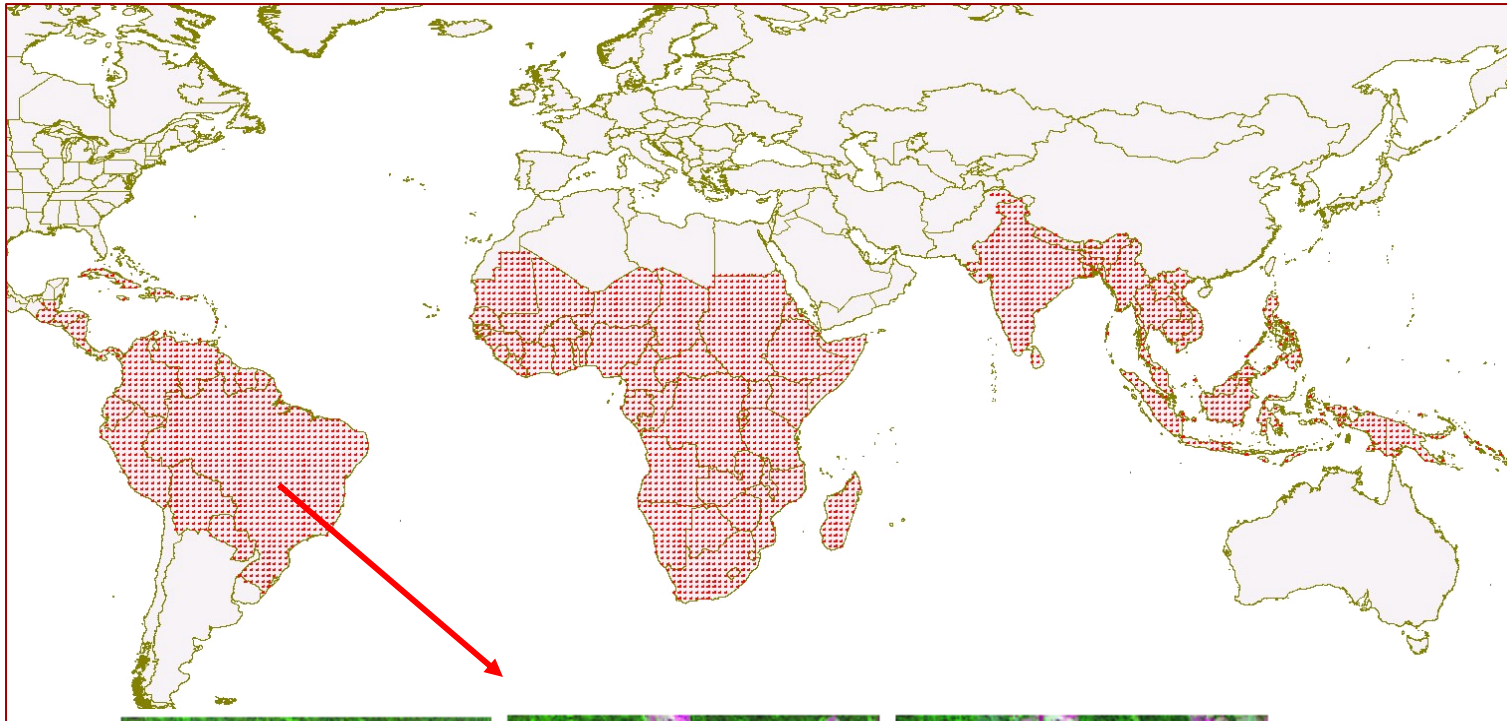
**Jointly organized by FAO, UCL & JRC**

**15 Experts from 7 countries**

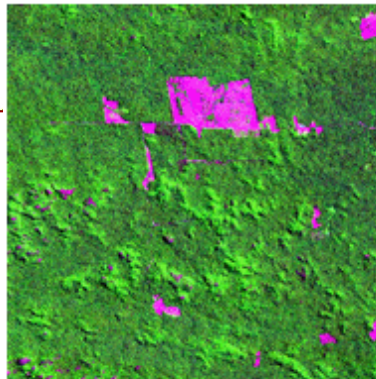
**6 support staff including 2 JRC**



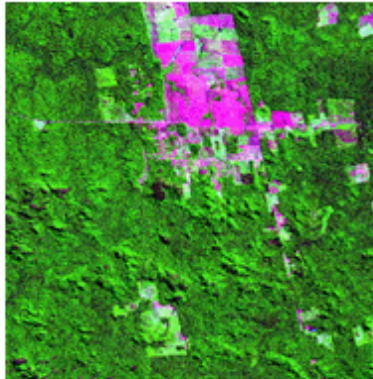
# Future developments: Year 2010



Mid 1970s



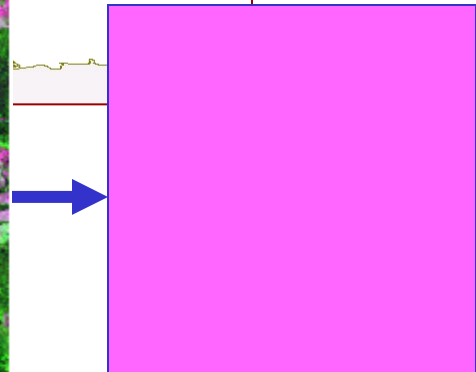
Year 1990



Year 2000



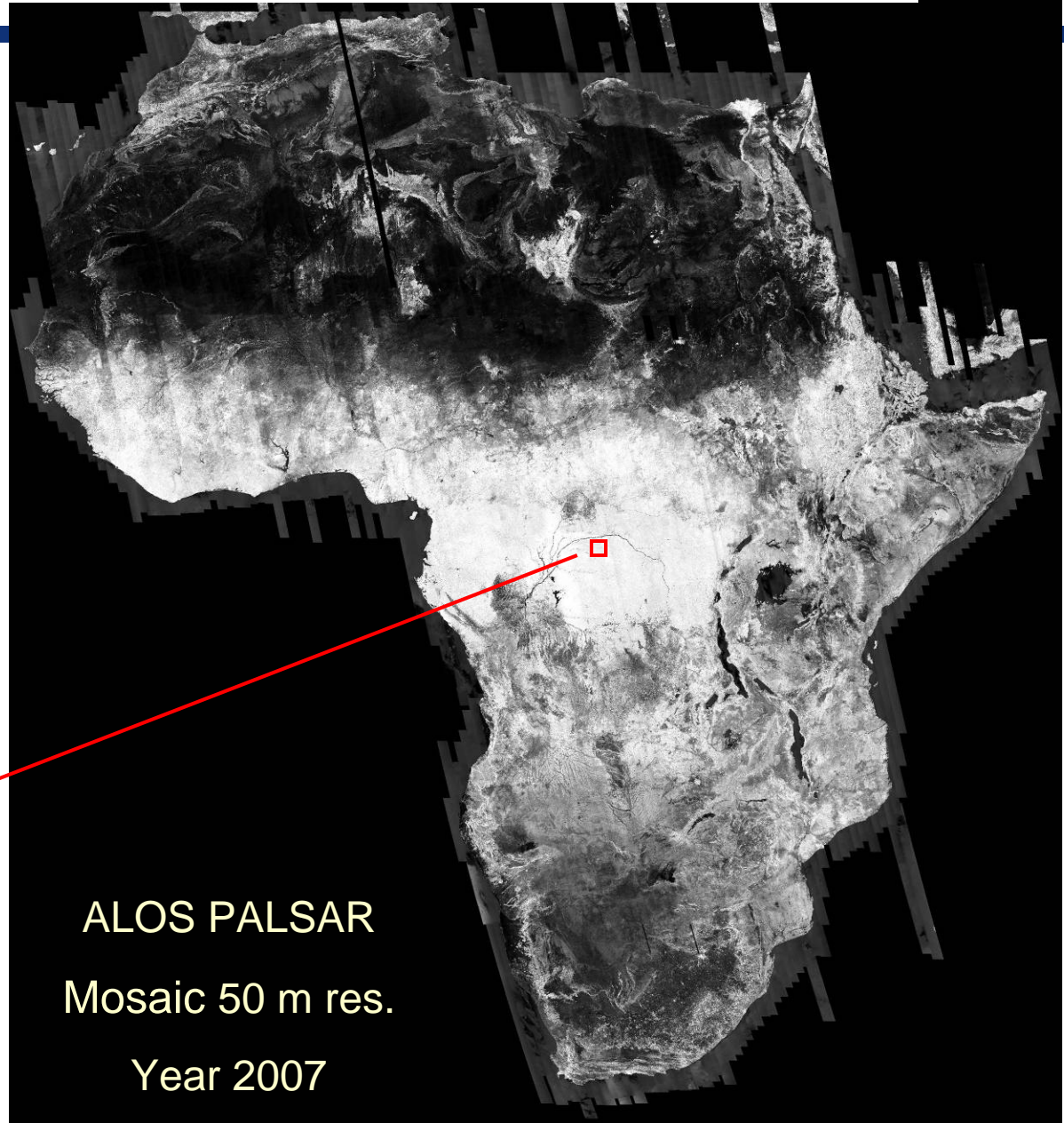
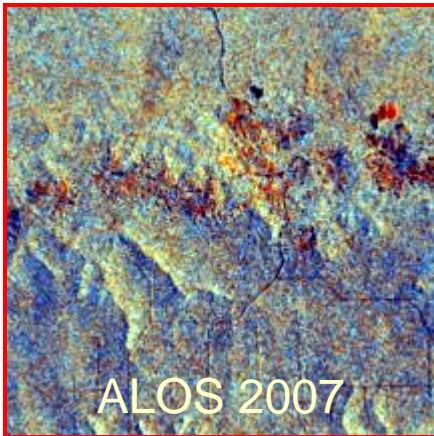
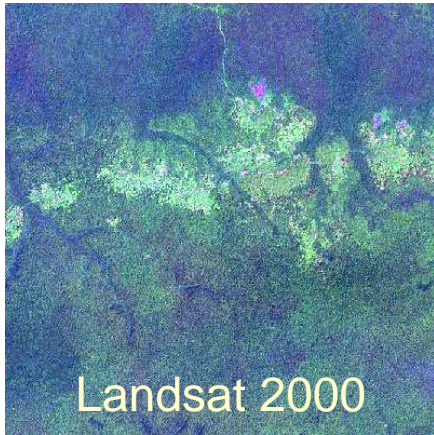
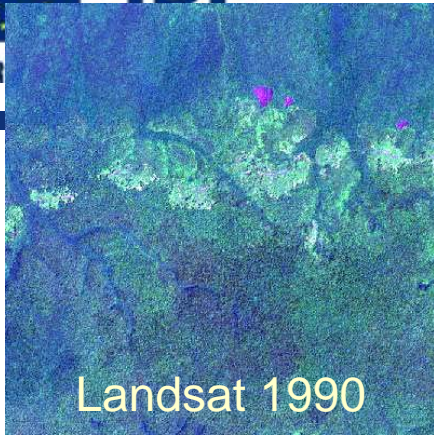
Year 2005



Year 2010 ?

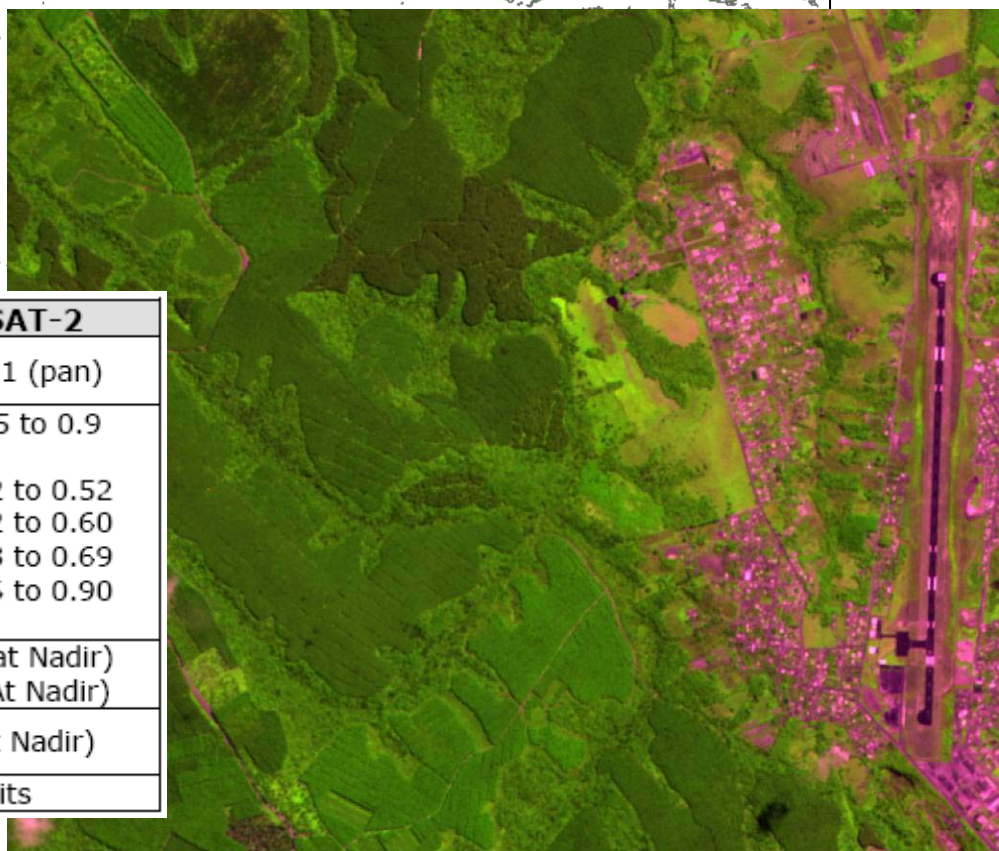
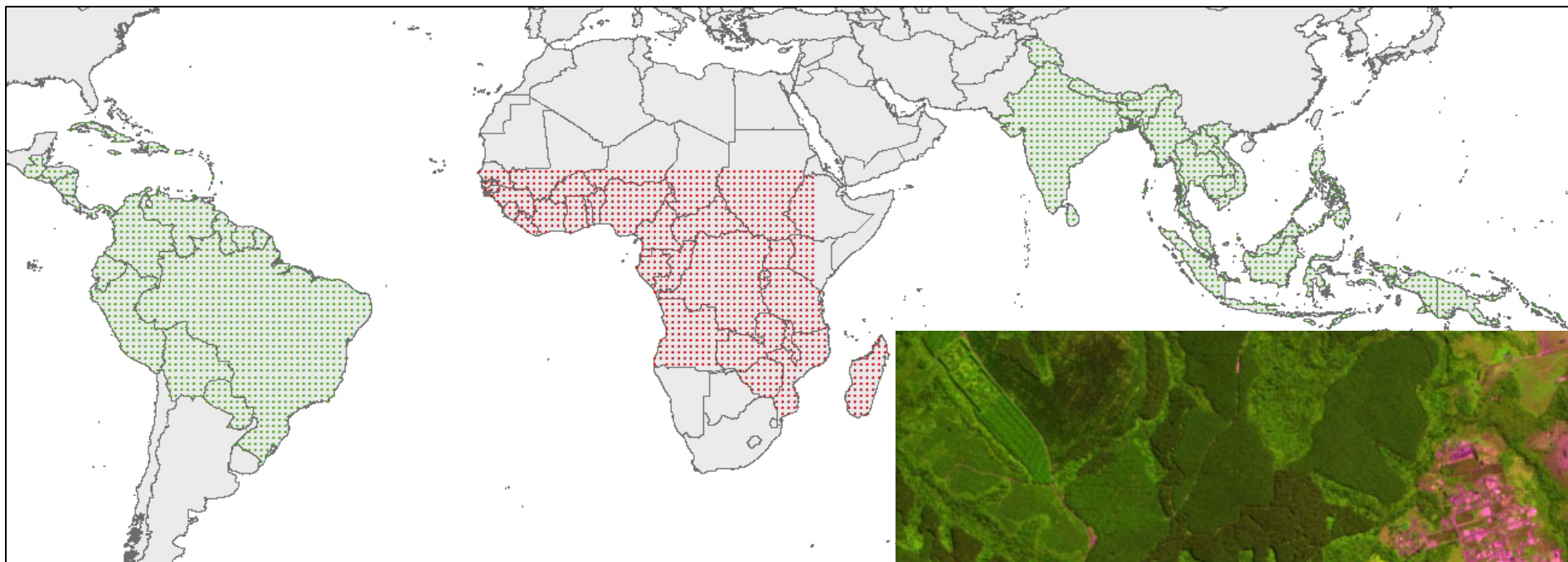


# Future developments: radar + Year 2010





# Future developments: Year 2010

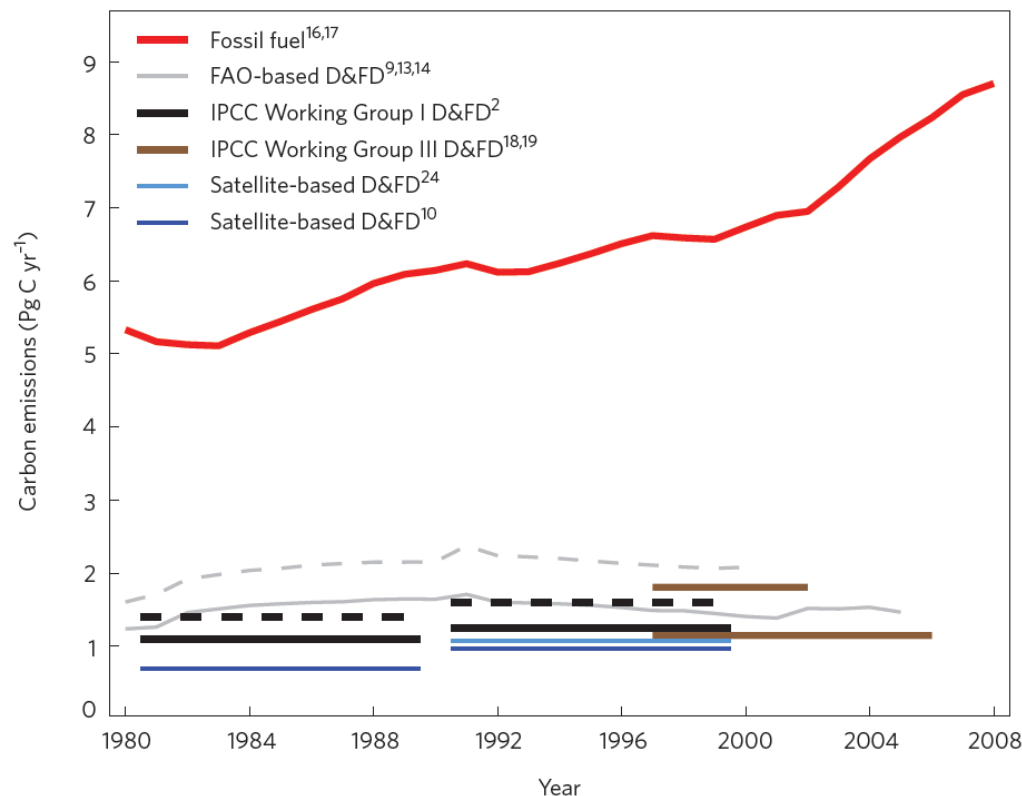


	DEIMOS-1	ALOS AVNIR-2	KOMPSAT-2
<b>Number of Bands</b>	3	4	4 (ms) + 1 (pan)
<b>Wavelength</b>			PanBand: 0.5 to 0.9
<b>Blue</b>		Band 1: 0.42 to 0.50	Band 1: 0.42 to 0.52
<b>Green</b>	Band 1: 0.52 to 0.60	Band 2: 0.52 to 0.60	Band 2: 0.52 to 0.60
<b>Red</b>	Band 3: 0.63 to 0.69	Band 3: 0.61 to 0.69	Band 3: 0.63 to 0.69
<b>VNIR</b>	Band 3: 0.77 to 0.90	Band 4: 0.76 to 0.89	Band 4: 0.76 to 0.90
<b>Spatial Resolution</b>	22m (at Nadir)	10m (at Nadir)	1m (Pan. at Nadir) 4m (MS. At Nadir)
<b>Swath Width</b>	660km (at Nadir)	70km (at Nadir)	15km (at Nadir)
<b>Bit Length</b>	8 bits	8 bits	10 bits

- **To produce regional trends in forest extent for all Tropics for period 1990 – 2005**
- **To acquire and analyse satellite data (with finer spatial resolution) from year 2010**
- **To contribute to REDD mechanism (through estimates of C emissions at tropical scale)**



# Contribution of emissions from deforestation and forest degradation



CO<sub>2</sub> emissions from deforestation and forest degradation: ~ 1.2 Pg C yr<sup>-1</sup>  
(12% [6–17%] of total anthropogenic CO<sub>2</sub> emissions)

Peat land emissions: ~ 0.30 Pg C yr<sup>-1</sup>

(Deforestation + peatland emissions = 15% [8–20%] of total CO<sub>2</sub> emissions)

Source: van der Werf et al, 2009 Nature 2:737-738



## The United Nations Climate Change Conference in Copenhagen, 7-19 December 2009

### Essential Background

### Documentation

### Meetings

Bonn Climate Change Talks April 2010

UNFCCC Calendar

Rio Conventions Calendar

Meetings Archive

#### COP 15 and CMP 5

Conference Programme

Conference Documents

Speeches

Side Events & Exhibits

Logistics

Media

Virtual Participation in COP 15

International Calls for Action

Barcelona Climate Change Talks 2009

Bangkok Climate Change Talks 2009

Bonn Climate Change Talks August 2009

Bonn Climate Change Talks June 2009

Bonn Climate Change Talks March 2009

Poznań Climate Change Conference, COP 14

Accra Climate Change Talks 2008

Bonn Climate Change Talks 2008

Bangkok Climate Change Talks 2008

COP 13, CMP 3, SB 27 & AWG 4

Vienna Climate Change Talks 2007

SB 26 & AWG 3

Dialogue

COP 12, COP/CMP 2, SB 25 & AWG 2

SB 24 & AWG

COP 11, COP/CMP 1 & SB 23

SB 22

The United Nations Climate Change Conference, Copenhagen 2009, was hosted by the Government of Denmark. It was comprised of the following sessions:

- Fifteenth session of the Conference of the Parties (COP 15)
- Fifth session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP 5)
- Thirty-first session of the Subsidiary Body for Implementation (SBI 31)
- Thirty-first session of the Subsidiary Body for Scientific and Technological Advice (SBSTA 31)
- Tenth session of the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP 10)
- Eighth session of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA 8)

The Conference was an exceptional event that attracted unprecedented participation and resulted in:

- Attendance by 120 Heads of State and Government, raising climate discussions to a new level. [More](#)
- Record numbers of participants including 10,500 delegates, 13,500 observers, and coverage by more than 3,000 media representatives
- Intensive negotiations characterized by over 1,000 official, informal and group meetings among Parties. Observers discussed climate change in more than 400 meetings and media attended over 300 press conferences.
- A vibrant programme of over 200 [side events](#).
- Over 220 exhibits from Parties, UN, IGOs and civil society
- A total of 23 decisions adopted by the COP and the CMP

Governments engaged at the highest political level, and the outcome of that engagement was reflected in the Copenhagen Accord. While much attention has focused on the Accord, the Conference in Copenhagen also made good progress in a number of areas including improvements to the clean development mechanism, amending Annex I to the Convention to add Malta, guidance on REDD+, and draft decisions on adaptation, technology, and capacity-building. However, the Bali Roadmap negotiations could not be concluded and negotiations will continue in 2010.

### COP 15 and CMP 5 reports

Report of the Conference of the Parties on its fifteenth session. Part One: Proceedings  
[FCCC/CP/2009/11](#)

Report of the Conference of the Parties on its fifteenth session. Part Two: Action taken by the Conference of the Parties  
[FCCC/CP/2009/11/Add.1](#)

Report of the Conference of the Parties serving as the meeting of the Parties on its fifth session. Part One: Proceedings  
[FCCC/KP/CMP/2009/21](#)

Report of the Conference of the Parties serving as the meeting of the Parties on its fifth session. Part Two: Action taken by the Conference of the Parties serving as the meeting of the Parties  
[FCCC/KP/CMP/2009/21/Add.1](#)

### Danish host country website



### Side events at COP 15 / CMP 5

[Side events/exhibits archive](#)

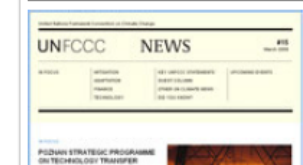
Select COP 15 and CMP 5 from the dropdown menu to display events

### ENB | Newsletter | Community Tools



#### ENB Coverage COP 15

The Earth Negotiations Bulletin (ENB) – a balanced, timely and independent reporting service covers the UN Climate Change Conference, each day, in print and electronic formats.



#### UNFCCC Newsletter



Download the iPhone

app – ‘COP 15 Navigator’ – [free of charge here](#)

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## Copenhagen Accord (Decision 2/CP.15)

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The Heads of State, Heads of Government, Ministers, and other heads of the following delegations present at the United Nations Climate Change Conference 2009 in Copenhagen: [List of Parties]

...

- 6. We recognize the crucial role of reducing emission from deforestation and forest degradation and the need to enhance removals of greenhouse gas emission by forests and agree on the need to provide positive incentives to such actions through the immediate establishment of a mechanism including REDD-plus, to enable the mobilization of financial resources from developed countries.**

# Copenhagen Accord

8. Scaled up, new and additional, predictable and adequate funding as well as improved access shall be provided to developing countries, in accordance with the relevant provisions of the Convention, to enable and support enhanced action on mitigation, including **substantial finance to reduce emissions from deforestation and forest degradation (REDD-plus)**, adaptation, technology development and transfer and capacity-building, for enhanced implementation of the Convention. The collective commitment by developed countries is to provide new and additional resources, including forestry and investments through international institutions, approaching USD 30 billion for the period 2010 - 2012 with balanced allocation between adaptation and mitigation. ... In the context of meaningful mitigation actions and transparency on implementation, **developed countries commit to a goal of mobilizing jointly USD 100 billion dollars a year by 2020 to address the needs of developing countries.** .. New multilateral funding for adaptation will be delivered through effective and efficient fund arrangements, with a governance structure providing for equal representation of developed and developing countries. A significant portion of such funding should flow through the Copenhagen Green Climate Fund.

## Decision 4/CP.15

### **Methodological guidance for activities relating to reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries**

*The Conference of the Parties,*

*Recalling* decisions 1/CP.13 and 2/CP.13,

*Acknowledging* the importance of reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries,

*Noting* the progress made by the Subsidiary Body for Scientific and Technological Advice in its programme of work on methodological issues related to a range of policy approaches and positive incentives,

*Also noting* the range of ongoing activities and cooperative efforts being undertaken by Parties and international organizations, in accordance with decision 2/CP.13, paragraphs 1, 2, 3 and 5,



## Decision 4/CP.15 on “REDD-plus”

1. *Requests* developing country Parties, on the basis of work conducted on the methodological issues set out in decision 2/CP.13, paragraphs 7 and 11, to take the following guidance into account for activities relating to decision 2/CP.13, and without prejudging any further relevant decisions of the Conference of the Parties, in particular those relating to measurement and reporting:
  - (a) To identify drivers of deforestation and forest degradation resulting in emissions and also the means to address these;
  - (b) To identify activities within the country that result in reduced emissions and increased removals, and stabilization of forest carbon stocks;
  - (c) To use the most recent Intergovernmental Panel on Climate Change guidance and guidelines, as adopted or encouraged by the Conference of the Parties, as appropriate, as a basis for estimating anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;

## COP-15 Decision on REDD+

- (d) To establish, according to national circumstances and capabilities, robust and transparent national forest<sup>1</sup> monitoring systems and, if appropriate, sub-national systems as part of national monitoring systems that:
- (i) Use a combination of remote sensing and ground-based forest carbon inventory approaches for estimating, as appropriate, anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;
  - (ii) Provide estimates that are transparent, consistent, as far as possible accurate, and that reduce uncertainties, taking into account national capabilities and capacities;
  - (iii) Are transparent and their results are available and suitable for review as agreed by the Conference of the Parties;

2. *Recognizes* that further work may need to be undertaken by the Intergovernmental Panel on Climate Change, in accordance with any relevant decisions by the Conference of the Parties;

3. *Encourages*, as appropriate, the development of guidance for effective engagement of indigenous peoples and local communities in monitoring and reporting;

4. *Encourages* all Parties in a position to do so to support and strengthen the capacities of developing countries to collect and access, analyse and interpret data, in order to develop estimates;

5. *Invites* Parties in a position to do so and relevant international organizations to enhance capacity-building in relation to using the guidance and guidelines referred in to paragraph 1 (c) above, taking into account the work of the Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention;

## COP-15 Decision on REDD+

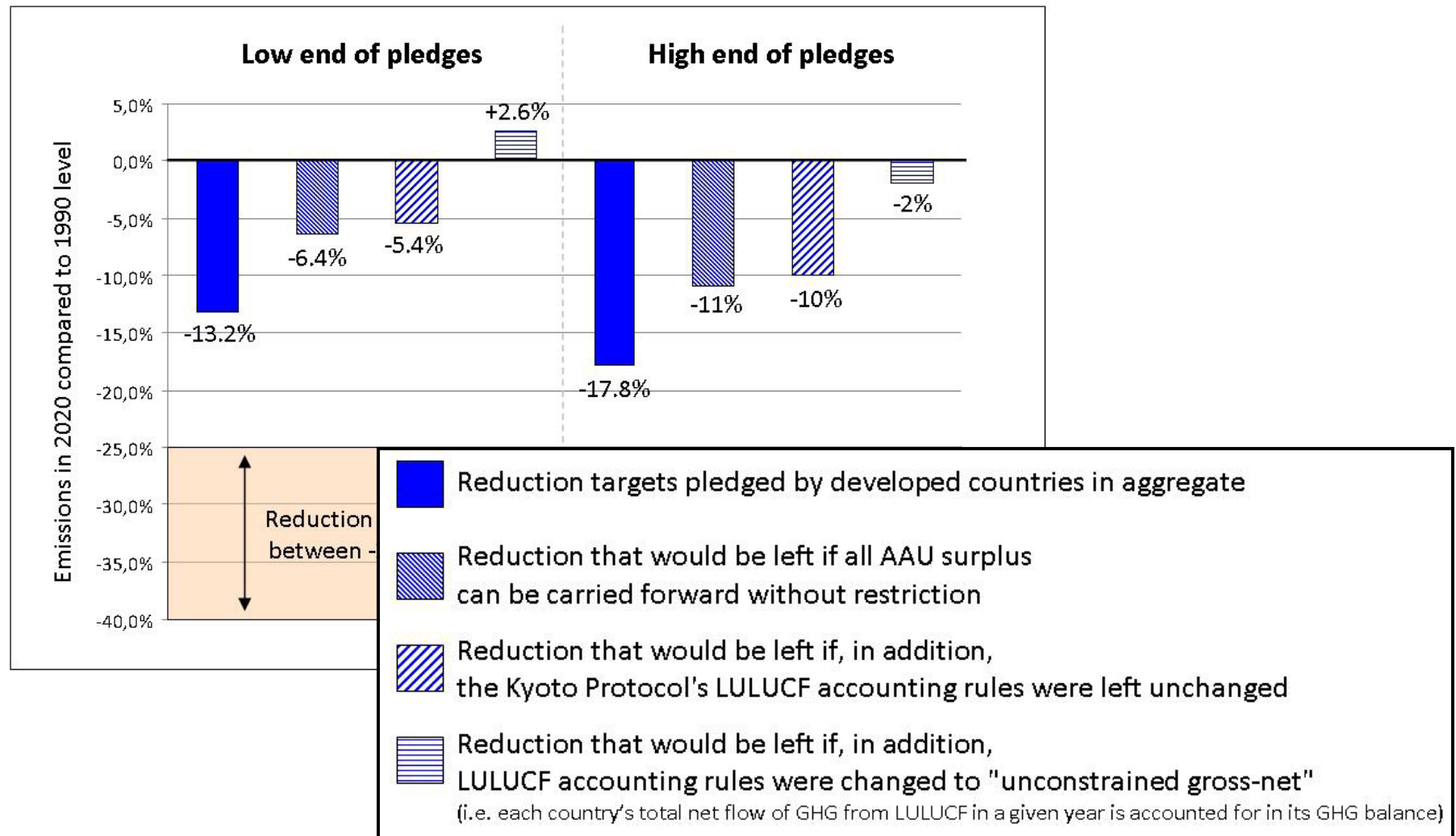
6. *Requests* the secretariat, subject to availability of supplementary funding, to enhance coordination of the activities referred to in paragraph 5 above, in the context of existing initiatives;

7. *Recognizes* that developing country Parties in establishing forest reference emission levels and forest reference levels should do so transparently taking into account historic data, and adjust for national circumstances, in accordance with relevant decisions of the Conference of the Parties;

8. *Invites* Parties to share lessons learned and experiences gained in the application of the guidance referred to in paragraph 1 above and the annex to decision 2/CP.13 through the web platform on the UNFCCC website;

9. *Urges* relevant international organizations, non-governmental organizations and stakeholders to integrate and coordinate their efforts in order to avoid duplication and enhance synergy with regard to activities relating to decision 2/CP.13.

# Impact of KP's weaknesses (AAU surplus & LULUCF accounting rules) on developed countries' reduction pledges in 2020



Source: EC Communication SEC(2010) 261 "International climate policy post-Copenhagen: Acting now to reinvigorate global action on climate change"



# IPCC Methodologies for Forests

Nalin SRIVASTAVA

Task Force on National Greenhouse Gas Inventories

*IPCC Expert Meeting on National Forest GHG Inventories - a Stock Taking* Yokohama, Japan

23-25 February, 2010

ipcc

INTERGOVERNMENTAL PANEL ON climate change

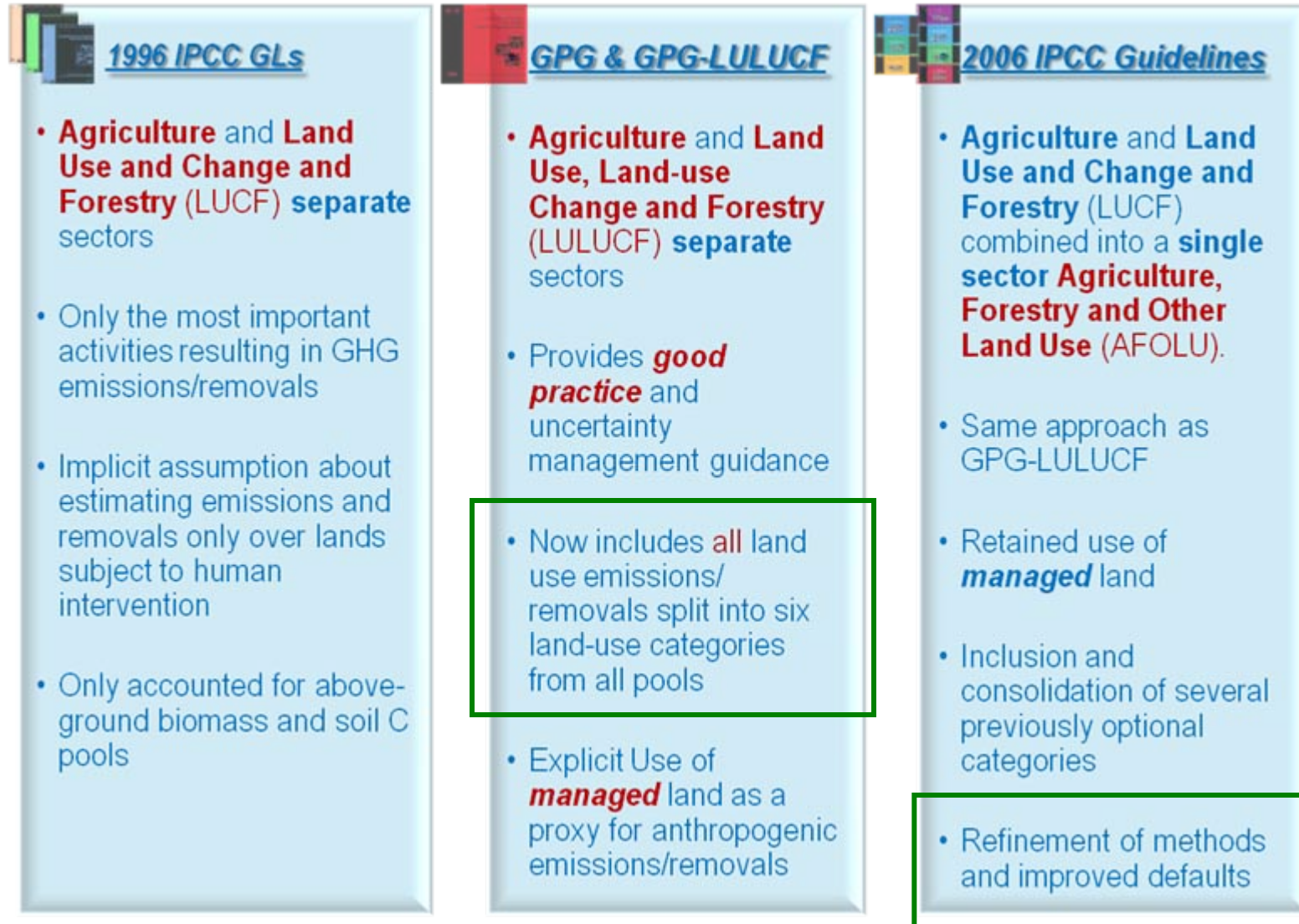


# IPCC Guidelines for National Greenhouse Gas Inventories

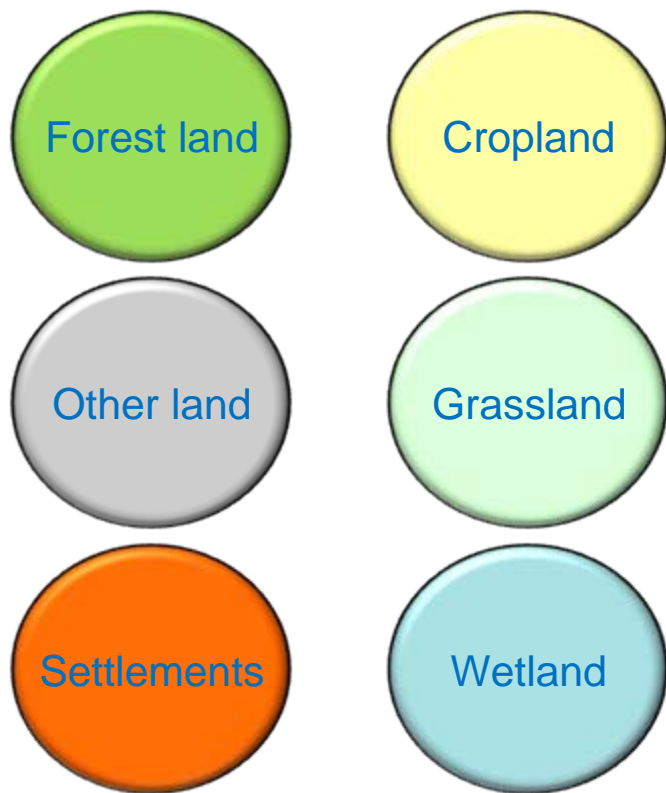
- Revised 1996 Guidelines -Land-Use Change and Forestry (LUCF)
- 2000 Good Practice Guidance and Uncertainty Management (GPG2000)
- 2003 Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF)
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories



# Evolution of IPCC Guidance on agriculture and land-use

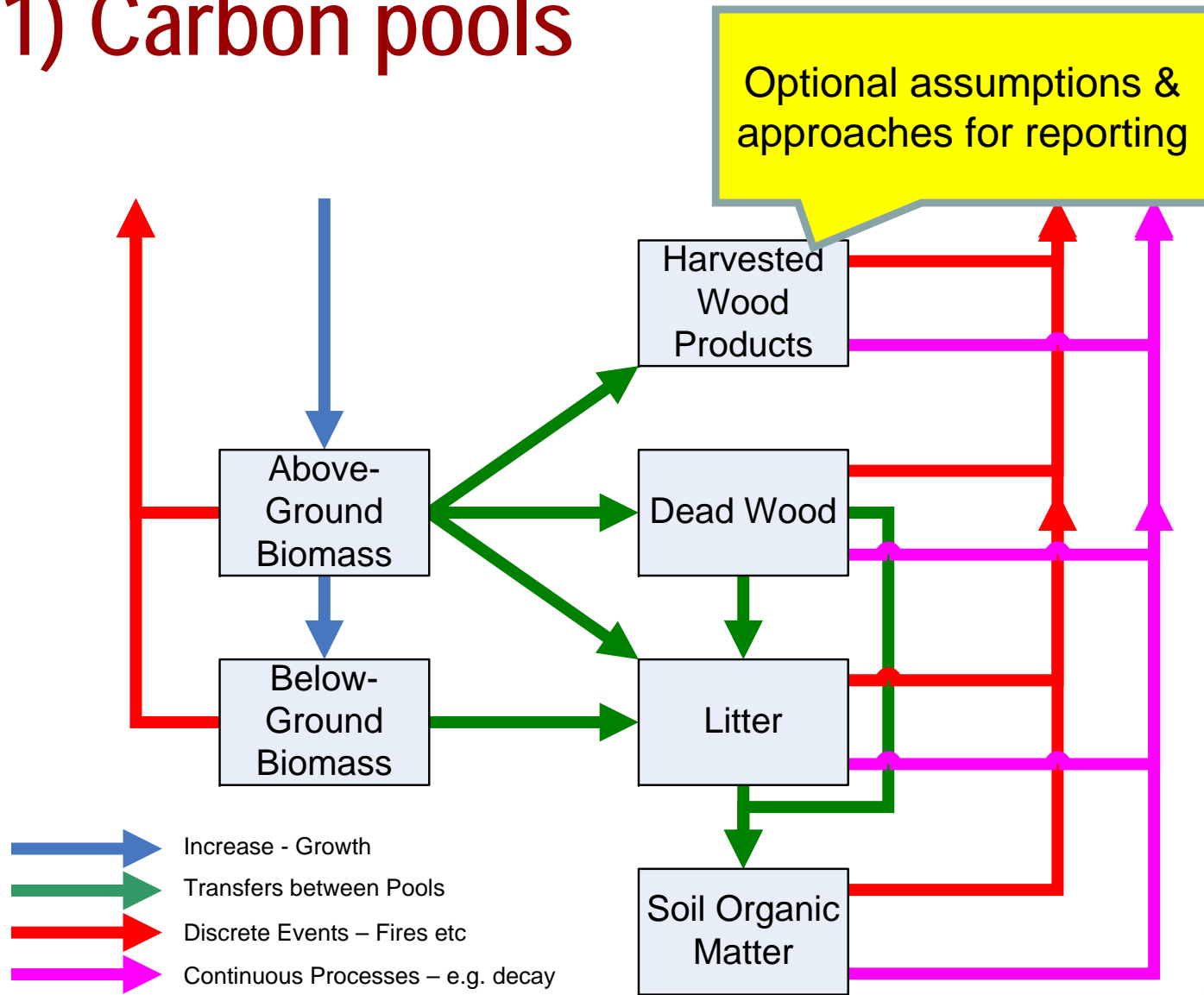


# Six Land Use Categories



- Reported Under Forests:
  - Degradation & Forest Management
    - Forest lands remaining Forest Lands
  - Afforestation & Reforestation
    - (Cropland/Grassland/Settlements etc.) converted to Forest Lands
- Reported under non-forest lands:
  - De-forestation
    - Forest Lands converted to (Cropland/Grassland/Settlements etc.)
- What is forest degradation?
  - TFI Special Report
  - Alternate definitions of degradation
    - criteria such as long term reduction of canopy cover, supply of benefits, C stocks
    - decided that no definition can be effectively operationalised

# 5 (+ 1) Carbon pools





# General methods for the estimation of emissions and removals of CO<sub>2</sub> and non-CO<sub>2</sub> for the LULUCF sector in the GPG 2003

## 3.1.4 General Methods

Chapter 3 uses the same basic methodological approaches as in the *IPCC Guidelines*. As stated in the *IPCC Guidelines*:

*The fundamental basis for the methodology rests upon two linked themes: i) the flux of CO<sub>2</sub> to or from the atmosphere is assumed to be equal to changes in carbon stocks in existing biomass and soils, and ii) changes in carbon stocks can be estimated by first establishing rates of change in land use and the practice used to bring about the change (e.g., burning, clear-cutting, selective cut, etc.). Second, simple assumptions or data are applied about their impact on carbon stocks and the biological response to a given land use.*

### EQUATION 3.1.1

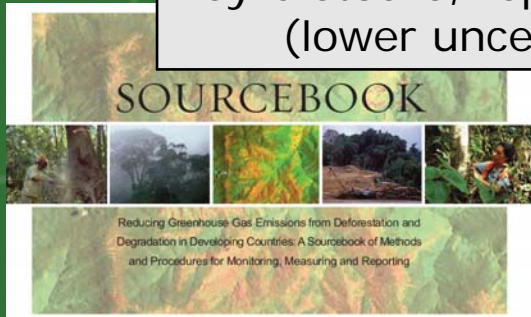
**ANNUAL CARBON STOCK CHANGE IN A GIVEN POOL AS A FUNCTION OF GAINS AND LOSSES**

$$\Delta C = \sum_{ijk} [A_{ijk} \bullet (C_I - C_L)_{ijk}]$$

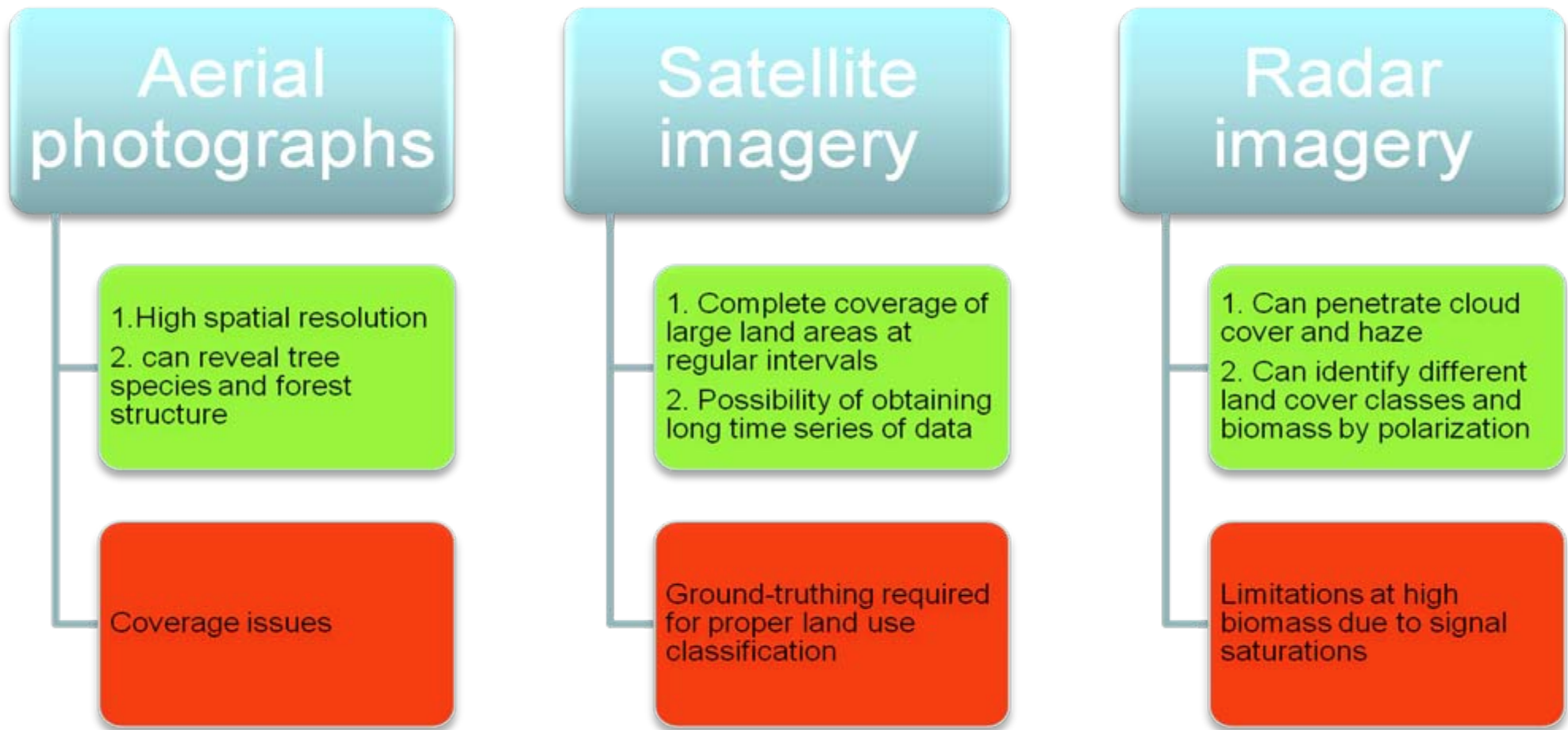
# Approaches for activity data and Tiers for emission factors

A summary of which approach can be used for the activity data and which Tier for the emission factors for estimating emissions & removals of CO<sub>2</sub>.

Tiers for emission factors: Change in C stocks	Approach for activity data: Area change
<b>1. Simple first order Approach:</b> IPCC default values (large uncertainties)	<b>1. Non-spatial country statistics (e.g. FAO) — generally gives net change in forest area</b>
<b>2. A more accurate Approach:</b> Country specific data for key factors (relatively smaller uncertainties)	<b>2. Based on maps, surveys, and other national statistical data</b>
<b>3. Higher order methods:</b> Detailed modeling and/or inventory of key C stocks, repeated measurements (lower uncertainties)	<b>3. Spatially specific data from interpretation of remote sensing data</b>



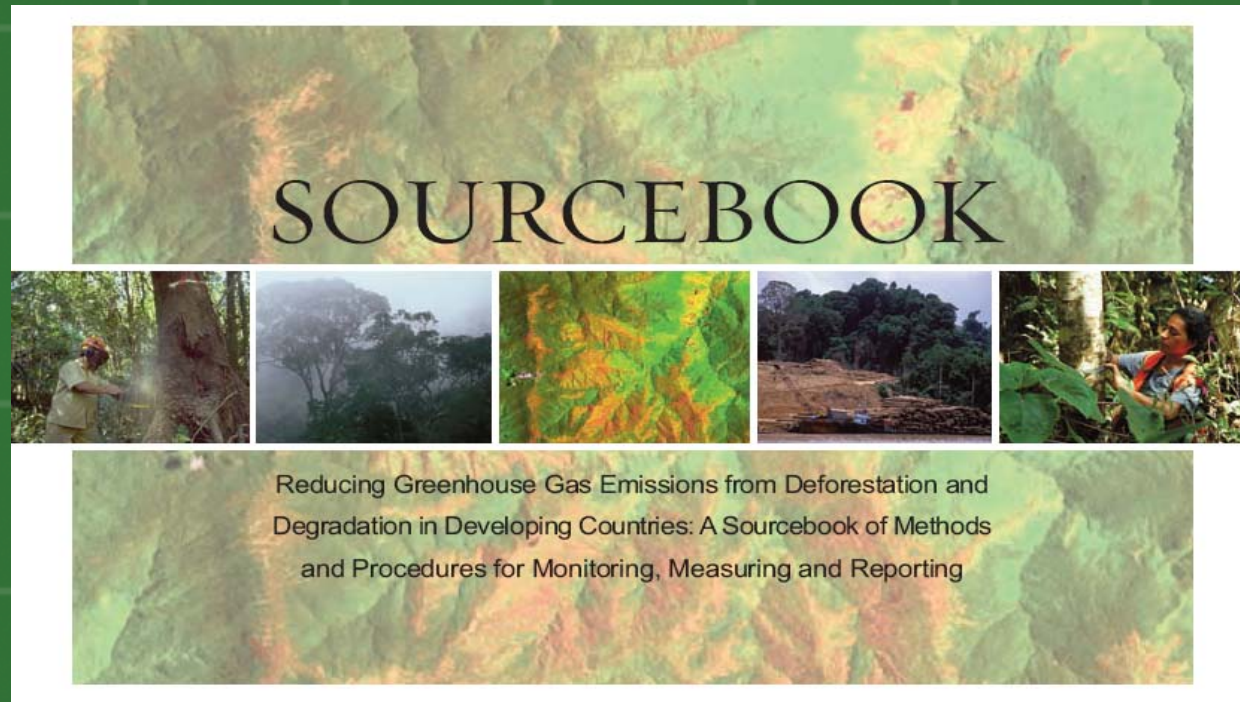
# Remote Sensing systems in 2006 IPCC Guidelines





# GOFC-GOLD Sourcebook v 3 presented in Copenhagen

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<http://www.gofc-gold.uni-jena.de/redd>

[http://www.grs.wur.nl/UK/Workshops/GOFC\\_GOLD/](http://www.grs.wur.nl/UK/Workshops/GOFC_GOLD/)



# Remote sensing support for carbon estimation

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- Direct biomass mapping remains a challenge
- Existing capabilities:
  - Satellite observation may help to map some specific forest types (i.e. mangroves, plantations etc.)
  - Deforestation/degradation mapping to guide field surveys – focus on area of most change
  - Targeted remote surveys to support carbon accounting:
    - *Very high resolution satellite data of air-photo quality to assist field surveys*
    - *Some sensitivity of data LIDAR and RADAR systems*
    - *Integration of in-situ and satellite data for large scale biomass mapping*
    - *Direct estimation of emissions from fire radiative power*

# Conclusions on REDD+

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- ✓ The future REDD+ mechanism will require the use of a combination of remote sensing and ground-based forest carbon inventory approaches for estimating anthropogenic GHG emissions by sources and removals by sinks, forest carbon stocks and forest area changes
- ✓ The current IPCC guidelines provide some limited guidance on the use of different data sources including remote sensing, ground based inventories and their combination
- ✓ Further scientific and technical work is needed to collect and access, analyse and interpret data, in order to develop more accurate estimates at national level.