Role of satellite remote sensing data on supporting forest carbon tracking in Indonesia

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Background

- In July 2008, the President of Indonesia and the Prime Minister of Australia signed the Indonesia-Australia Forest Carbon Partnership (IAFCP). The objectives of the Partnership are:
  - Implementing incentive-based REDD+ demonstration activities.
  - Increasing Indonesia's capacity to measure greenhouse gas emissions related to forests.
  - Supporting national policy frameworks for REDD+.
- The Indonesia's National Carbon Accounting System (INCAS) program (2009-2014) is a key component of the IAFCP:
  - Remote sensing component – lead by LAPAN.
  - Biomass and carbon emissions modelling components – lead by the Ministry of Forestry.
  - Location of future MRV Institution – still to be decided.

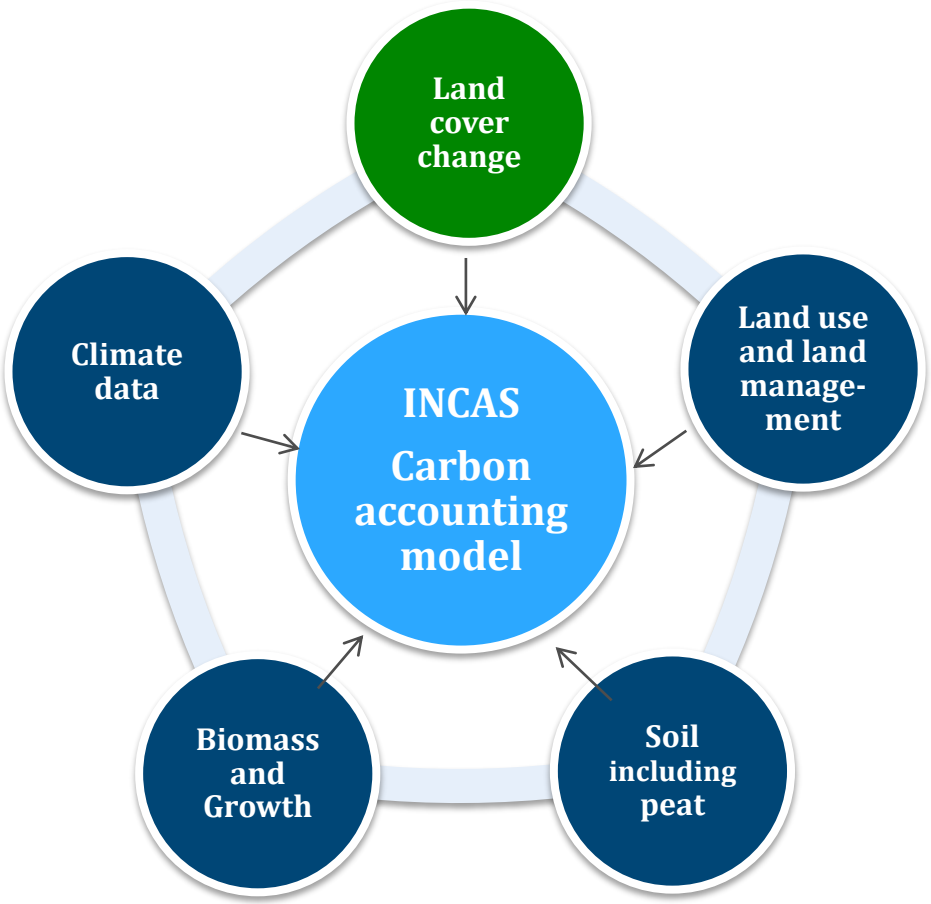
Indonesia-Australia
Forest Carbon Partnership

INCAS development

System design developed to enable:

- wall-to-wall coverage
- annual reporting of emissions
- coverage of all carbon pools and greenhouse gases
- reporting at fine scales
- scaling to allow nesting
- ability to test different land use and management scenarios
- spatial and temporal consistency

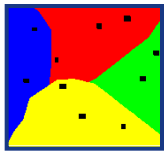
Key components of the INCAS



INCAS interim outputs

A Biomass Classification

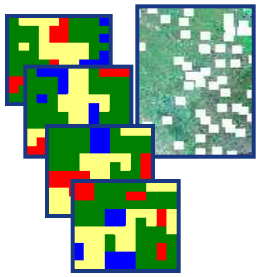
Classification of forests into groups (biomass classes) with common biomass characteristics (in undisturbed condition)



B Annual Land Cover Change

Annual time-series defining areas of:

- Deforestation (permanent loss of forest cover)
- Degradation (forest clearance and regeneration or partial removal)



E Carbon Accounting and Reporting Model (ICARM)

C Forest Disturbance Class Mapping

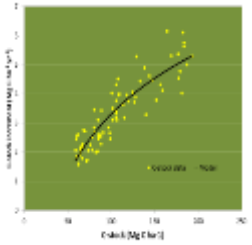
National map of forest disturbance classes at known date

- Minimal disturbance
- Moderate disturbance
- Heavy disturbance

D C-mass Estimation

C-mass estimates for each biomass class (stock, growth/loss rate):

- Aboveground biomass
- Belowground biomass
- Litter
- Debris
- Soil



Role of remote sensing data in INCAS

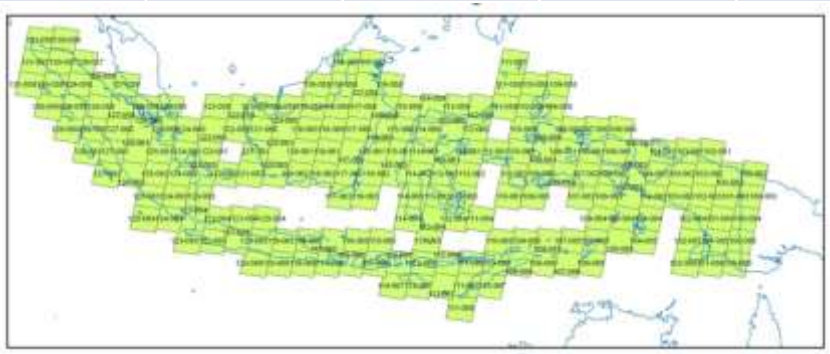
- **Goal:**
  - To process annual land cover imageries to produce accurate change products at 25m for Indonesia → implementation at national scale with first priority for years 2000-2009/2010 /2011 and second priority for years 1990-1999.
  - To increase capacity building activities to transfer data, methods and analysis tools to Gov. of Indonesia's institutions.
- **Strategy:**
  - Systematic data aquisition/time-series consistency is critical.
  - Landsat data is used as the primary data, because of its spatial resolution and "free" of charge.
  - Development and implementation to more automatic processes.

Landsat Data

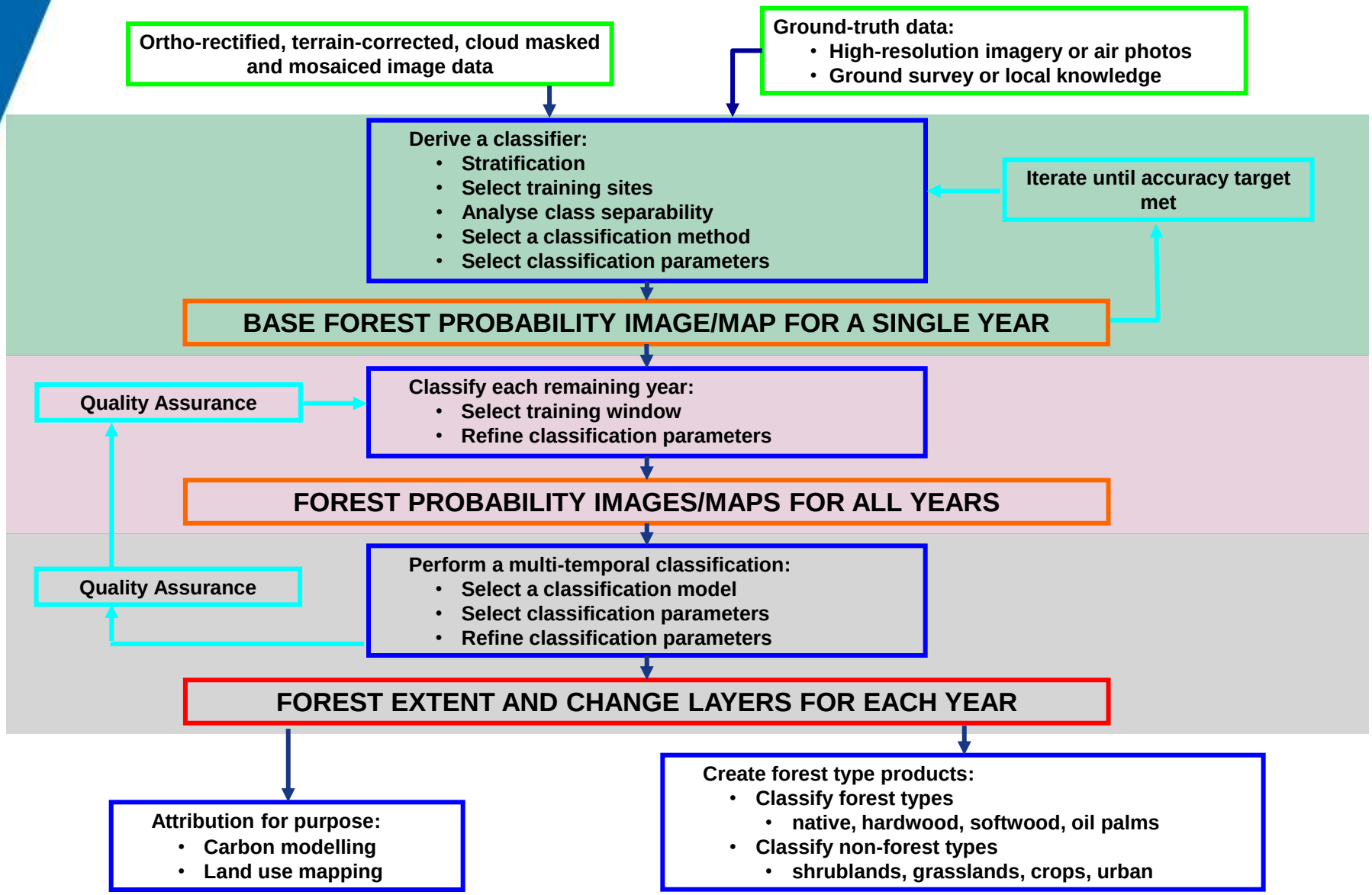
Year	Kalimantan (45 scenes)	Sumatera (52 scenes)	Papua (37 scenes)	Sulawesi (28 scenes)	Java (17 scenes)	Other islands (53 scenes)	TOTAL
2000	78	97	55	32	17	49	328
2001	101	103	116	62	28	62	472
2002	120	115	78	51	32	48	444
2003	53	55	68	47	19	48	290
2004	93	105	102	72	27	67	466
2005	119	108	93	66	35	64	485
2006	104	120	95	77	30	64	490
2007	89	84	84	58	28	54	397
2008	87	73	73	68	26	45	372
2009	141	91	104	69	24	61	490
TOTAL	985	951	868	602	266	562	4234

Source:

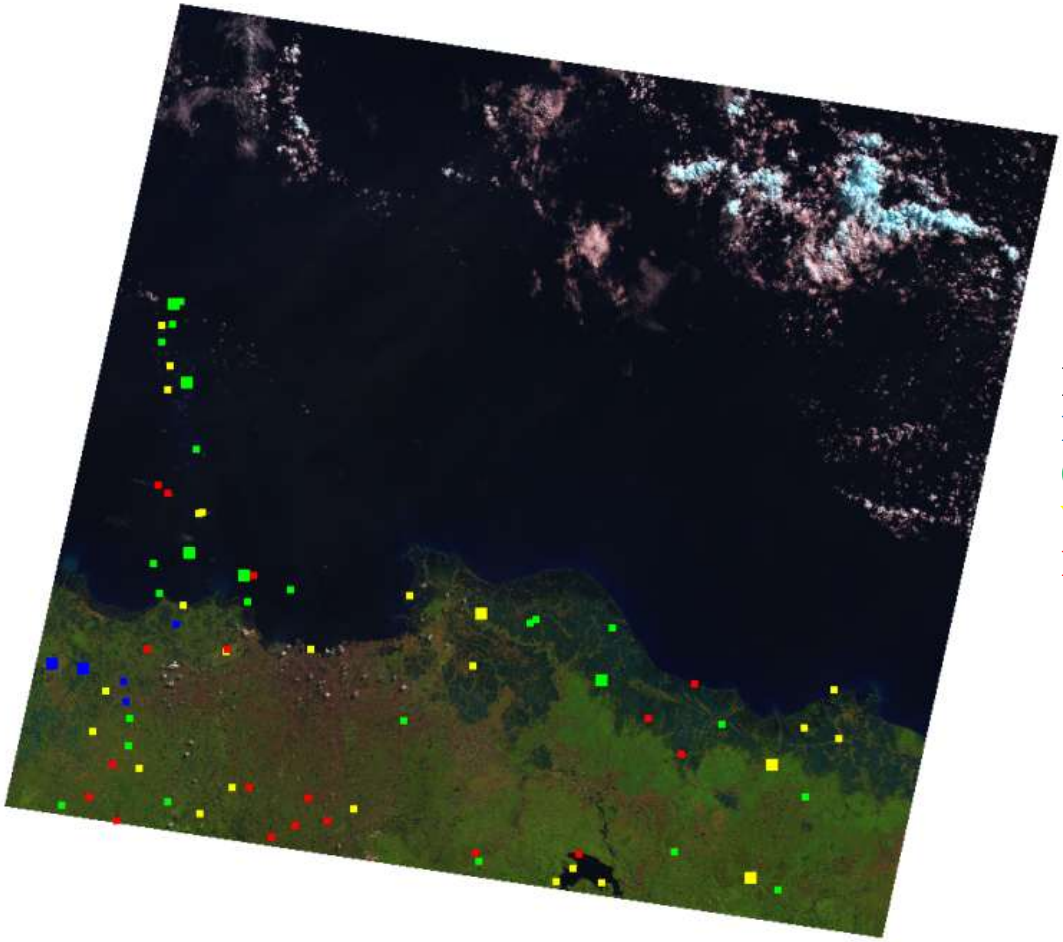
- Geosciences Australia (GA)
- GISTDA (Thailand)
- USGS (USA)
- LAPAN (Indonesia)



Annual forest cover and cover change processing stream *(adopted from CSIRO)*



Quality Assurance - Ortho-rectification



Error direction:

Blue : NE error direction
Green : SE error direction
Yellow : SW error directtion
Red : NW error direction

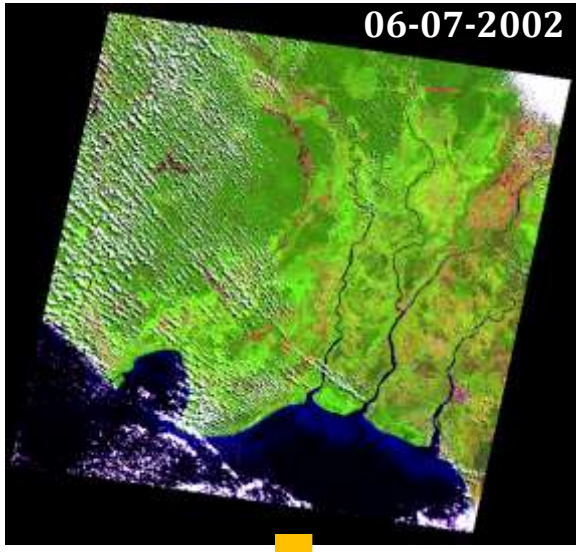
: < 1 pixel error
: 1-2 pixel error
: > 2 pixel error

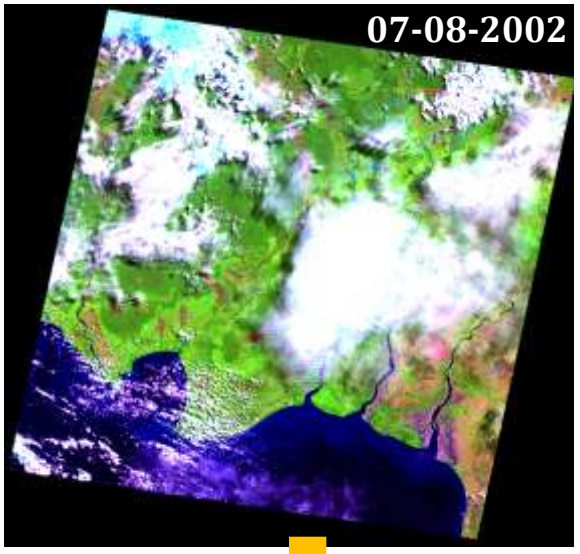
QA for ortho-rectification pass if :

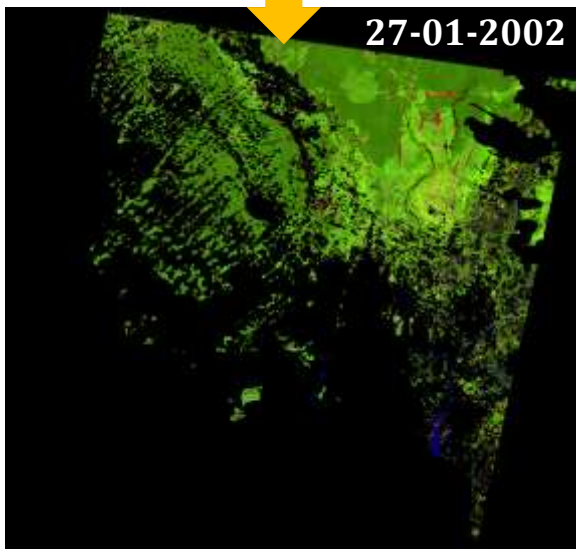
- RMS error < 1.2 pixel, and
- Visual inspection error < 1 pixel

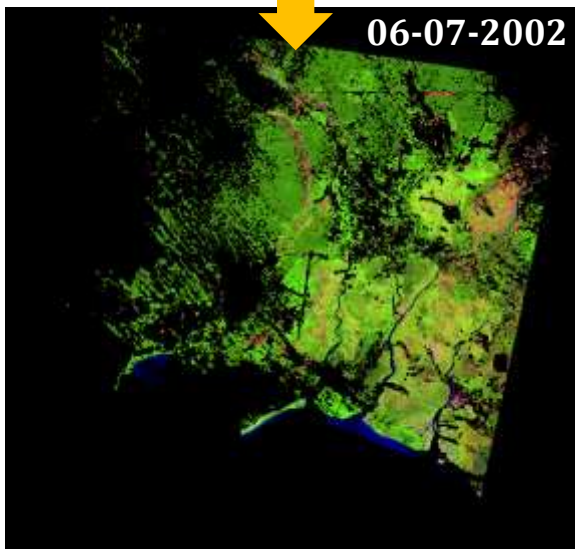
Cloud masking

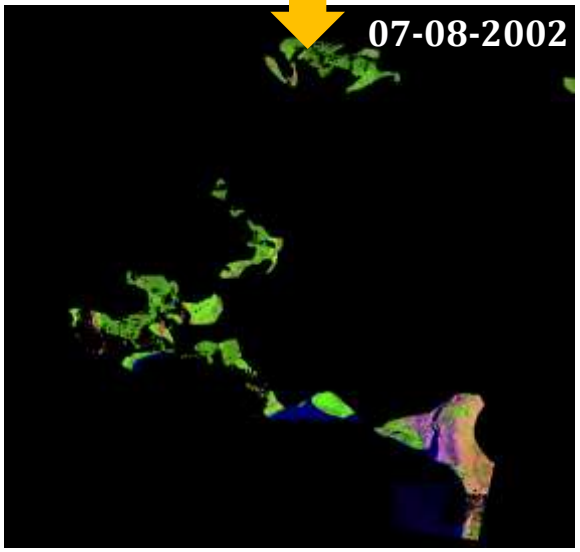
Terrain corrected scenes







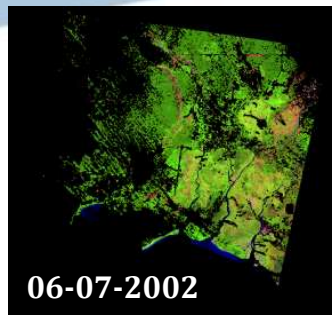


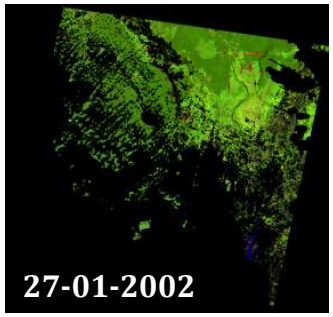


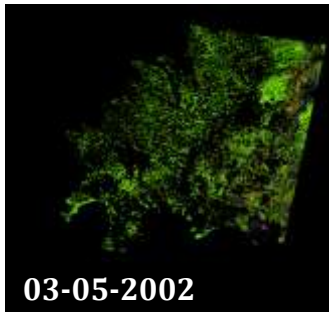
Cloud masked scenes

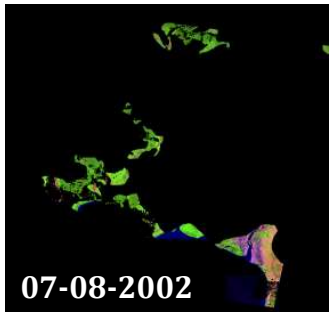
Mosaicing

Cloud masked scenes

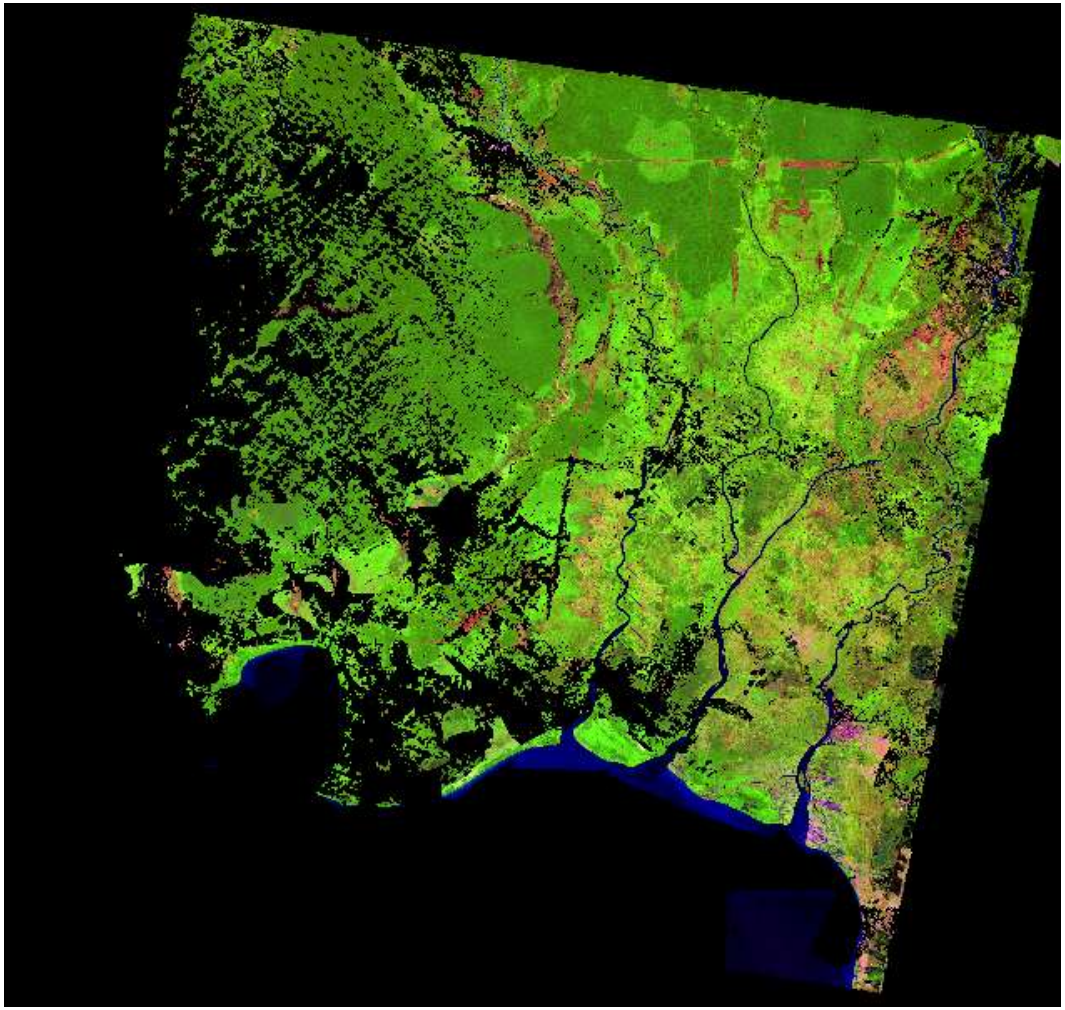








Cloud masked mosaic scene (2002)

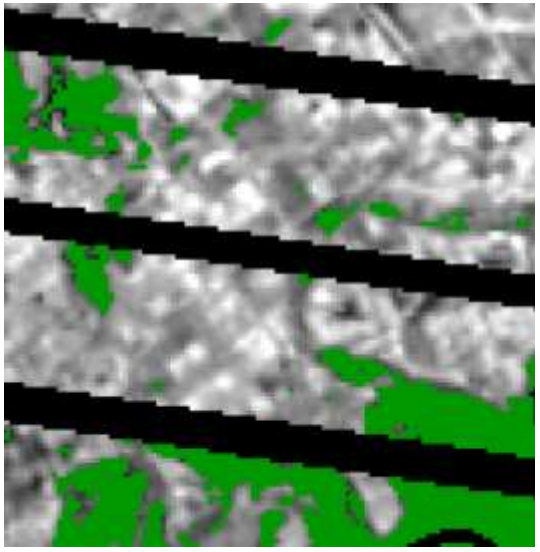


Base forest probability

Quickbird multi-spectral image: 22 August 2009

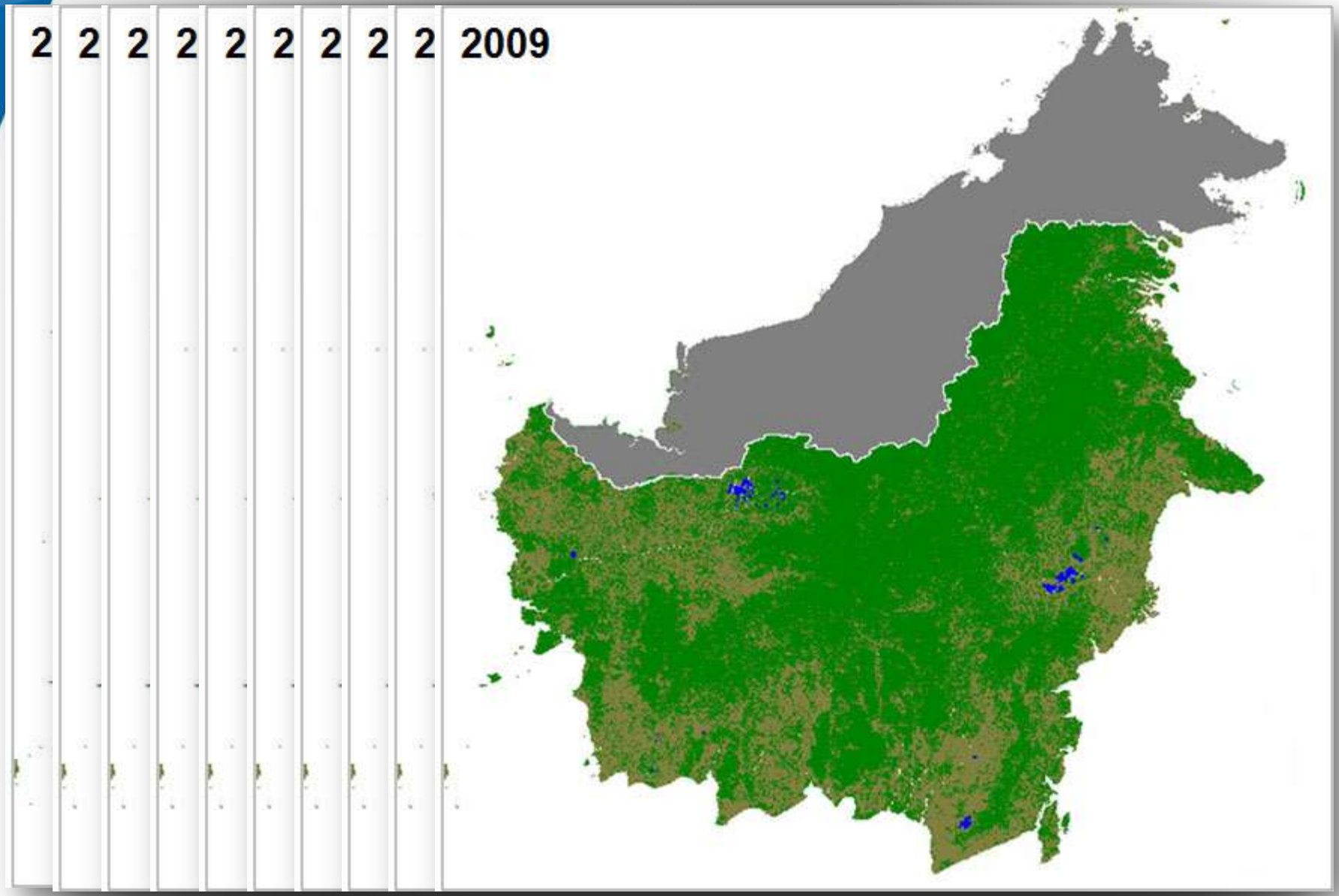
2008 Landsat TM image mosaic

Quickbird panchromatic image: 22 August 2009

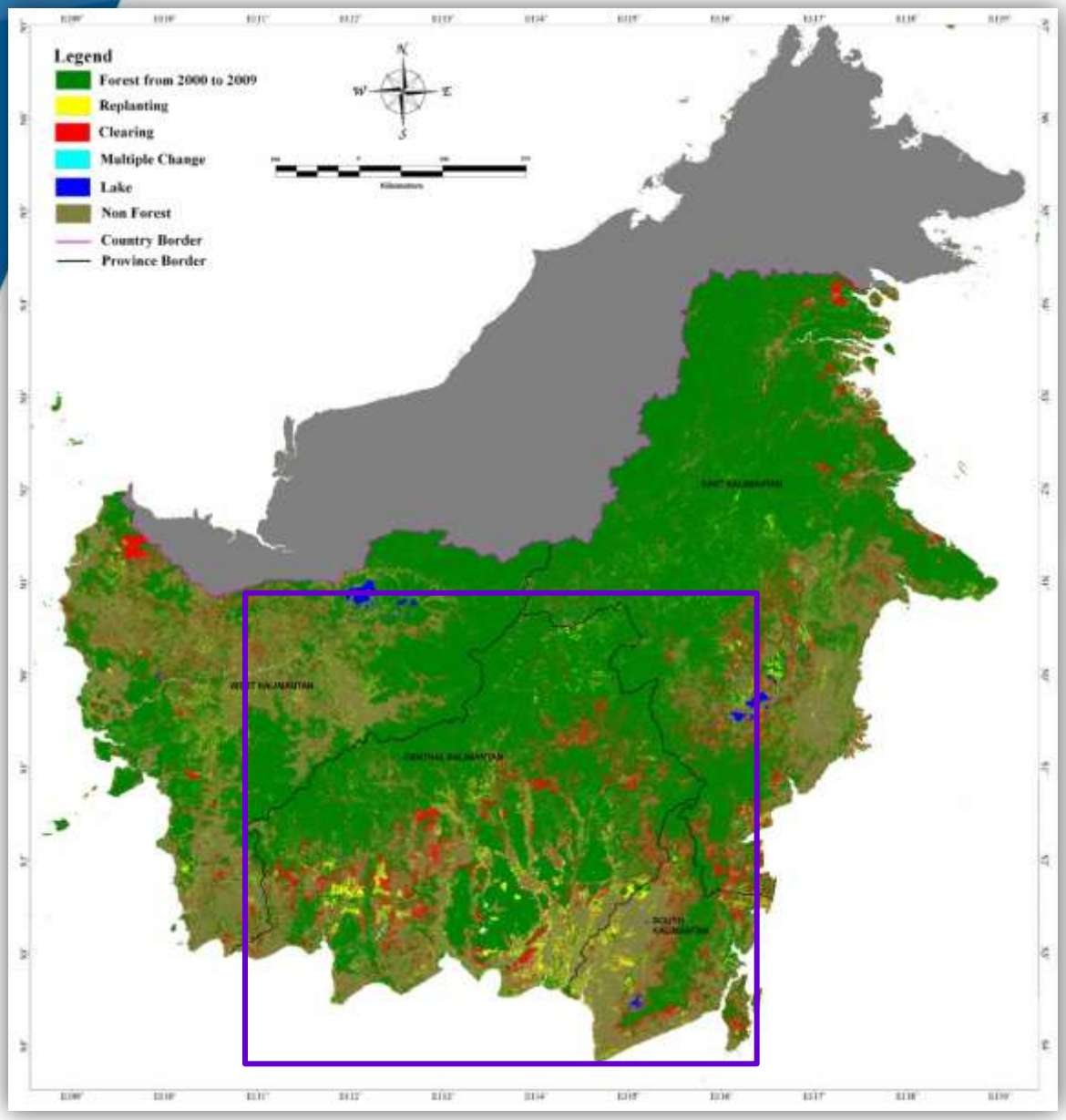


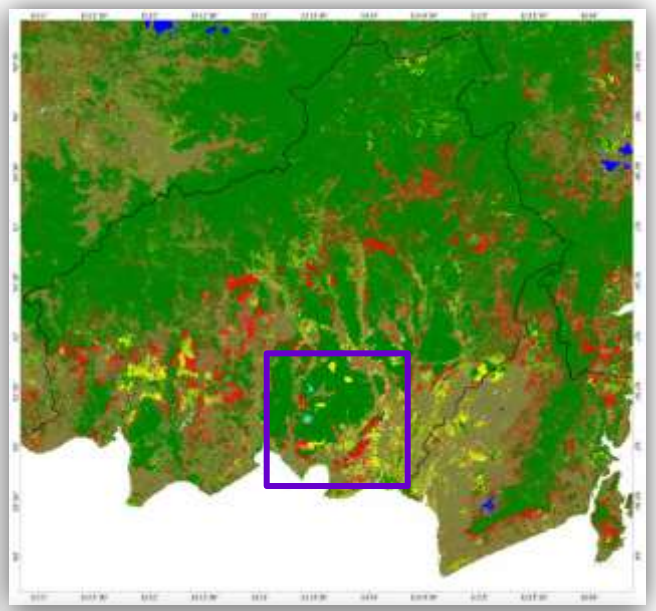
Forest classification (green) over Landsat image (grey)

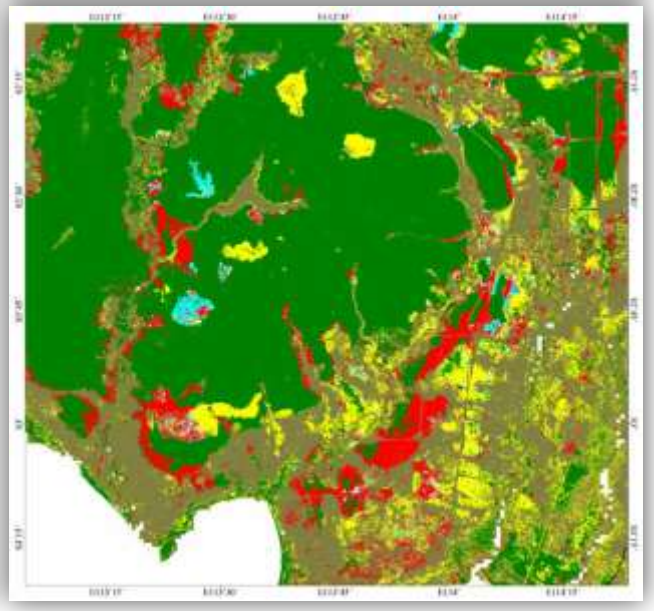
Annual Forest/Non-Forest Cover (Kalimantan, 2000-2009)



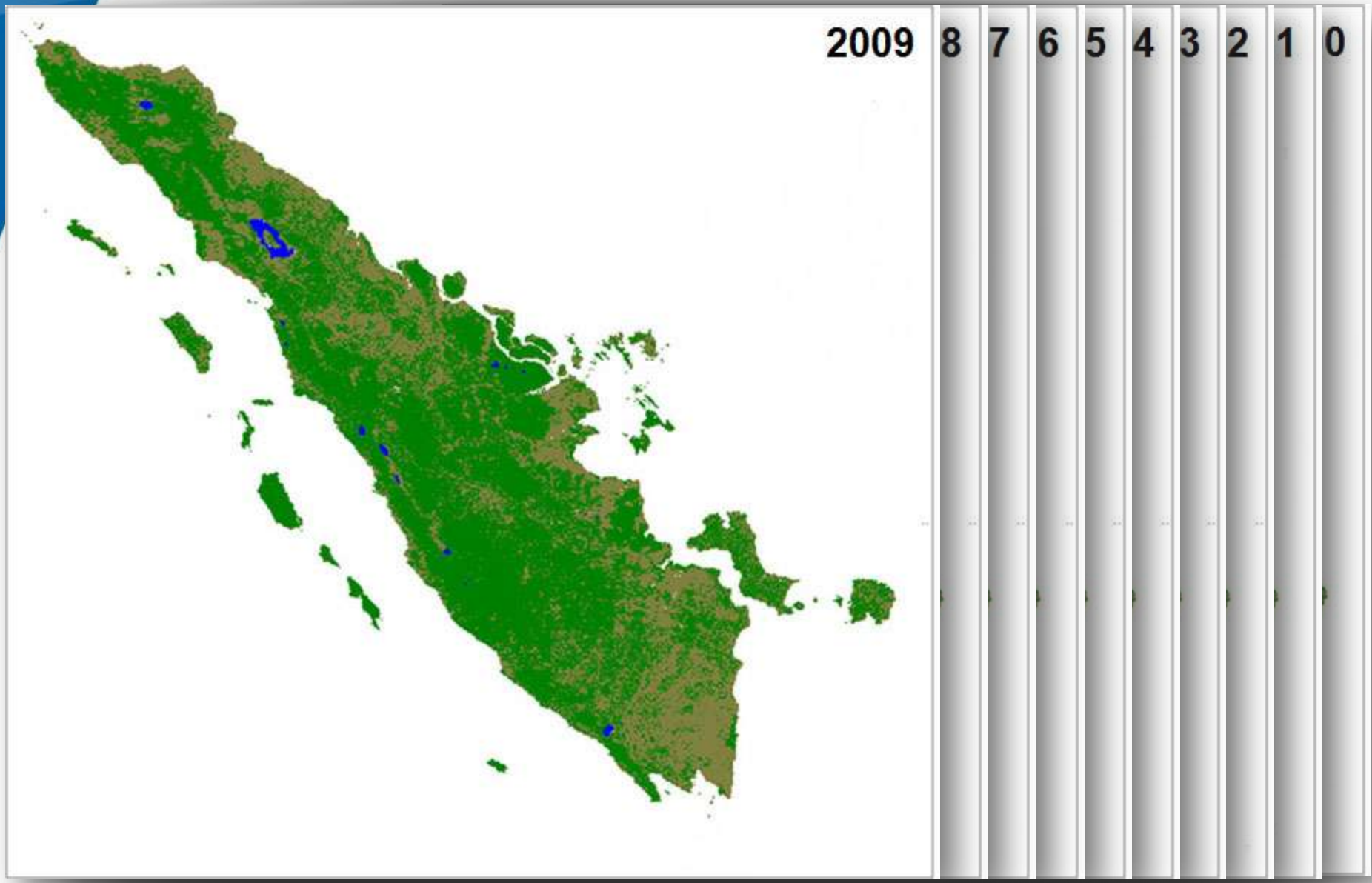
Forest cover loss and gain (Kalimantan, 2000-2009)



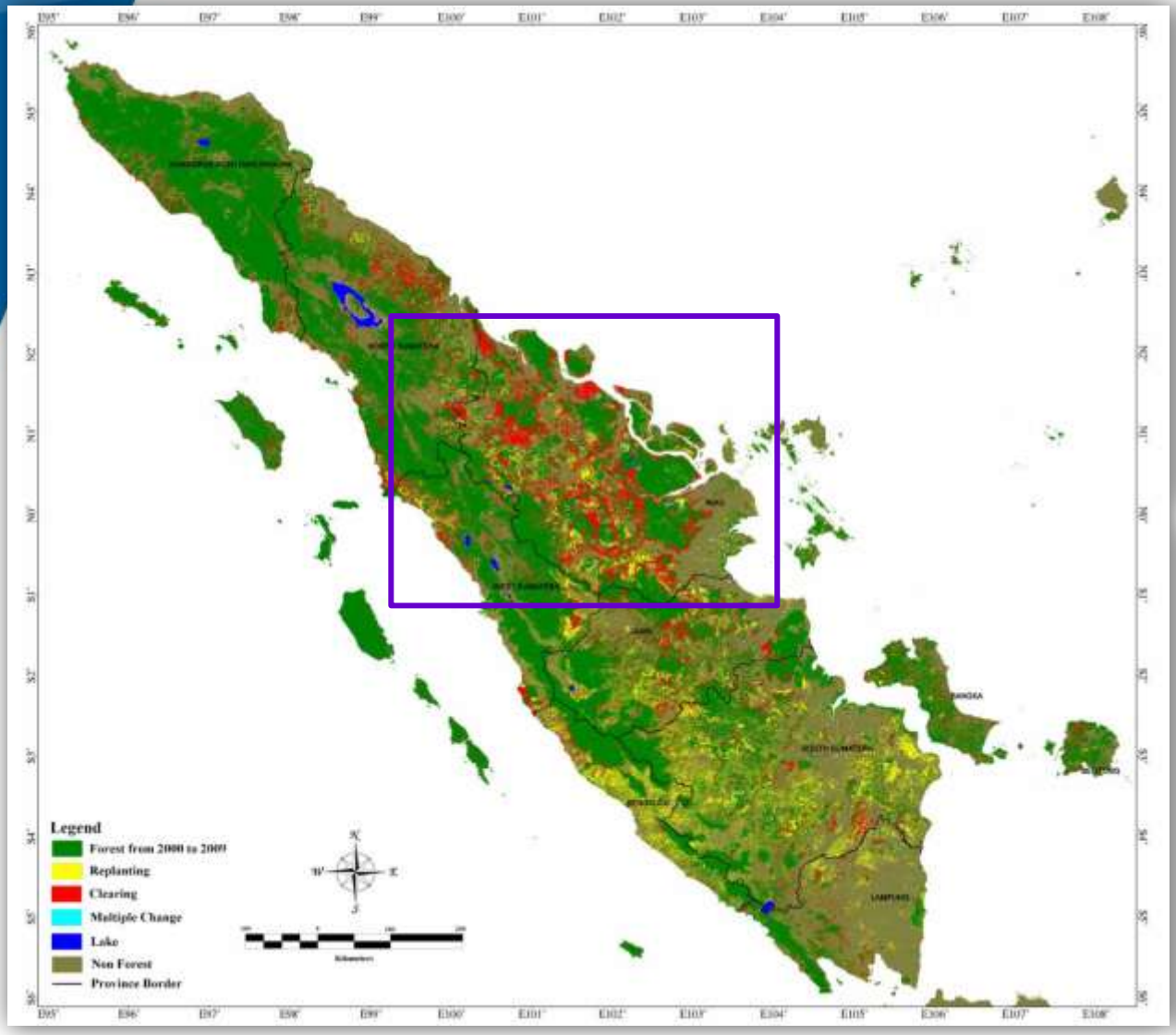


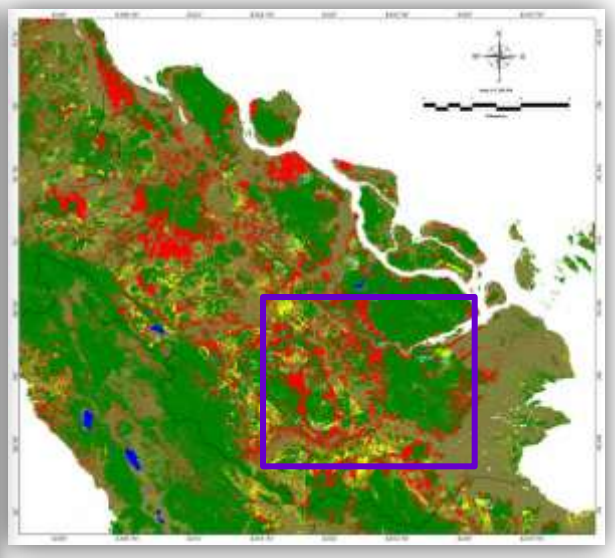


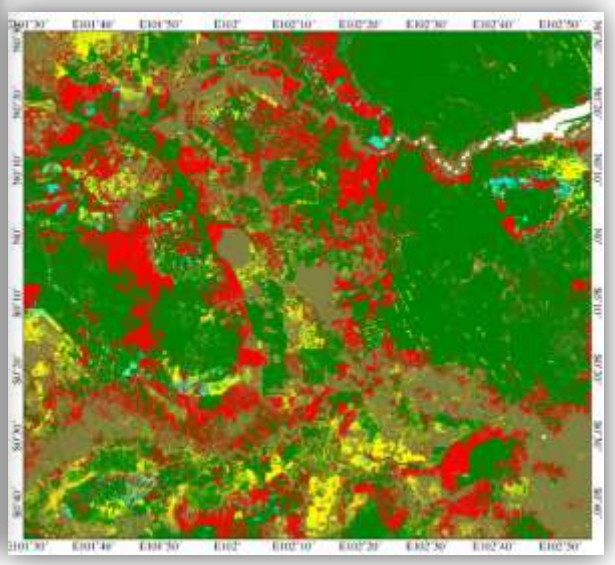
Annual Forest/Non-Forest Cover (Sumatera, 2000-2009)



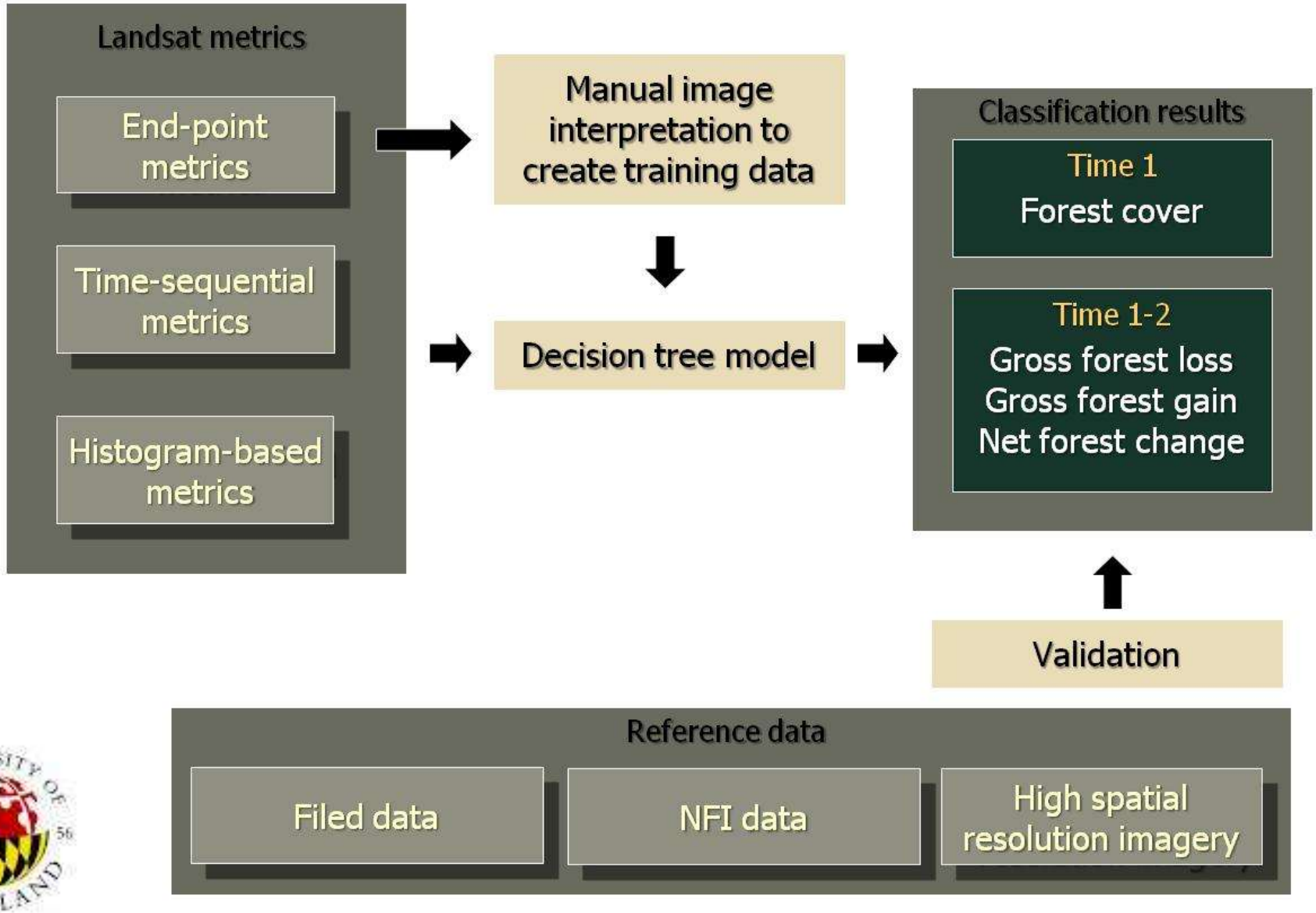
Forest cover loss and gain (Sumatera, 2000-2009)



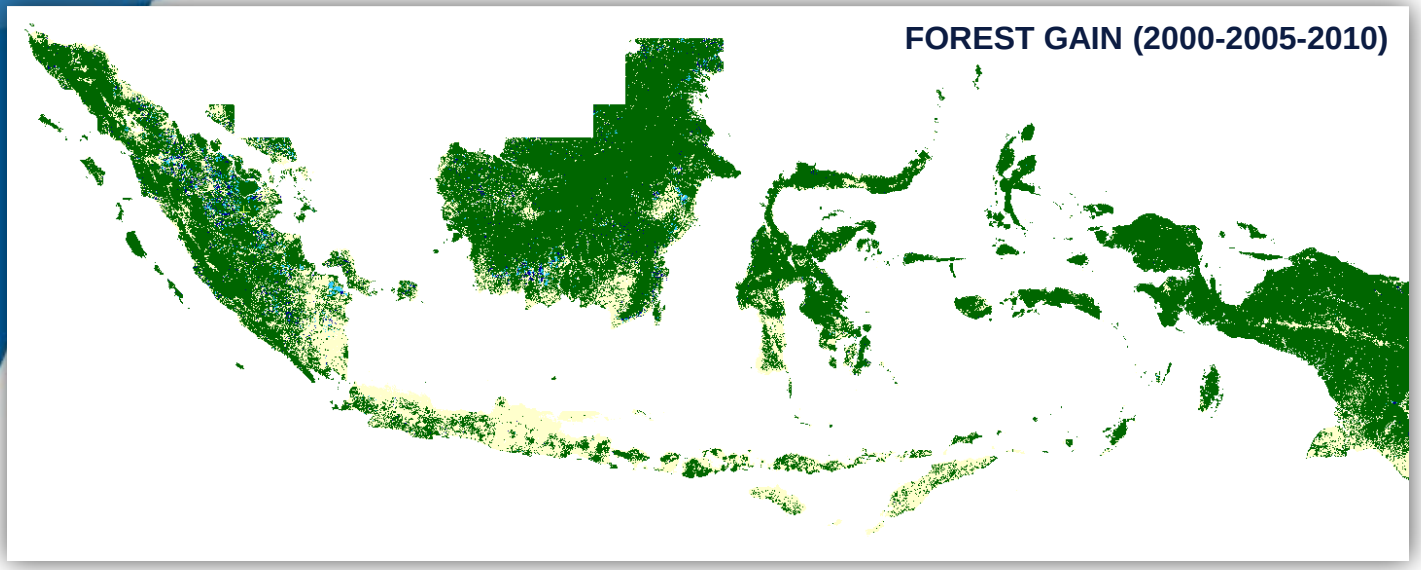




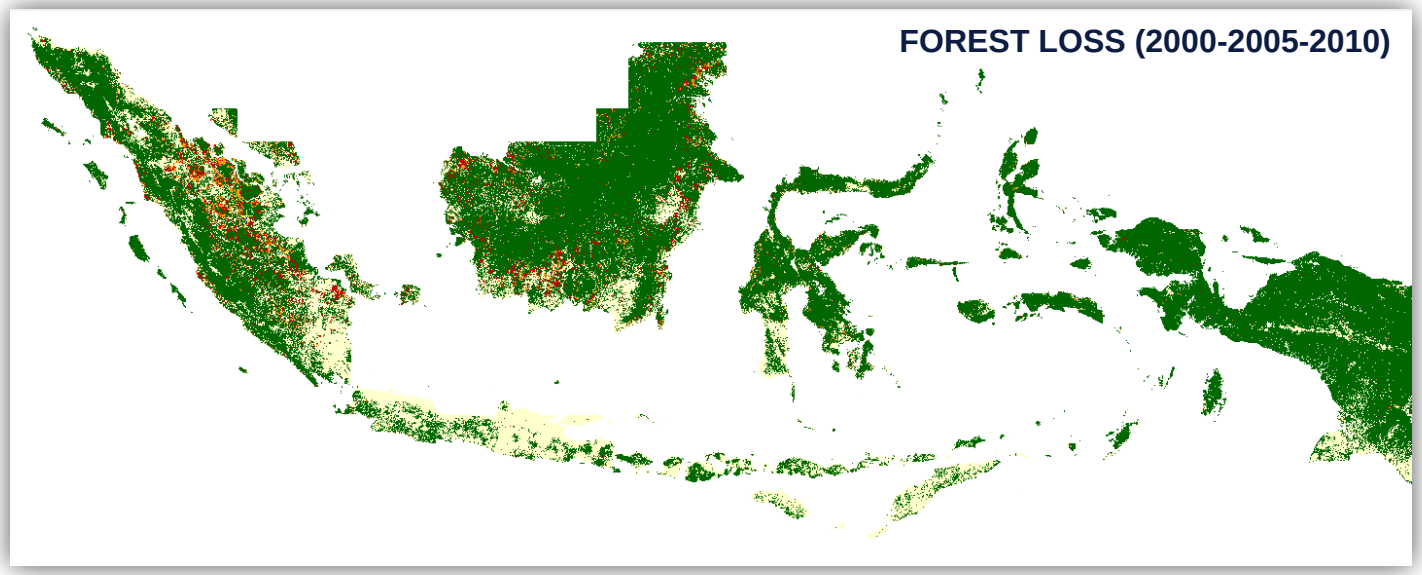
Classification and validation *(adopted from University of Maryland)*



Forest gain and loss (2000-2005-2010)

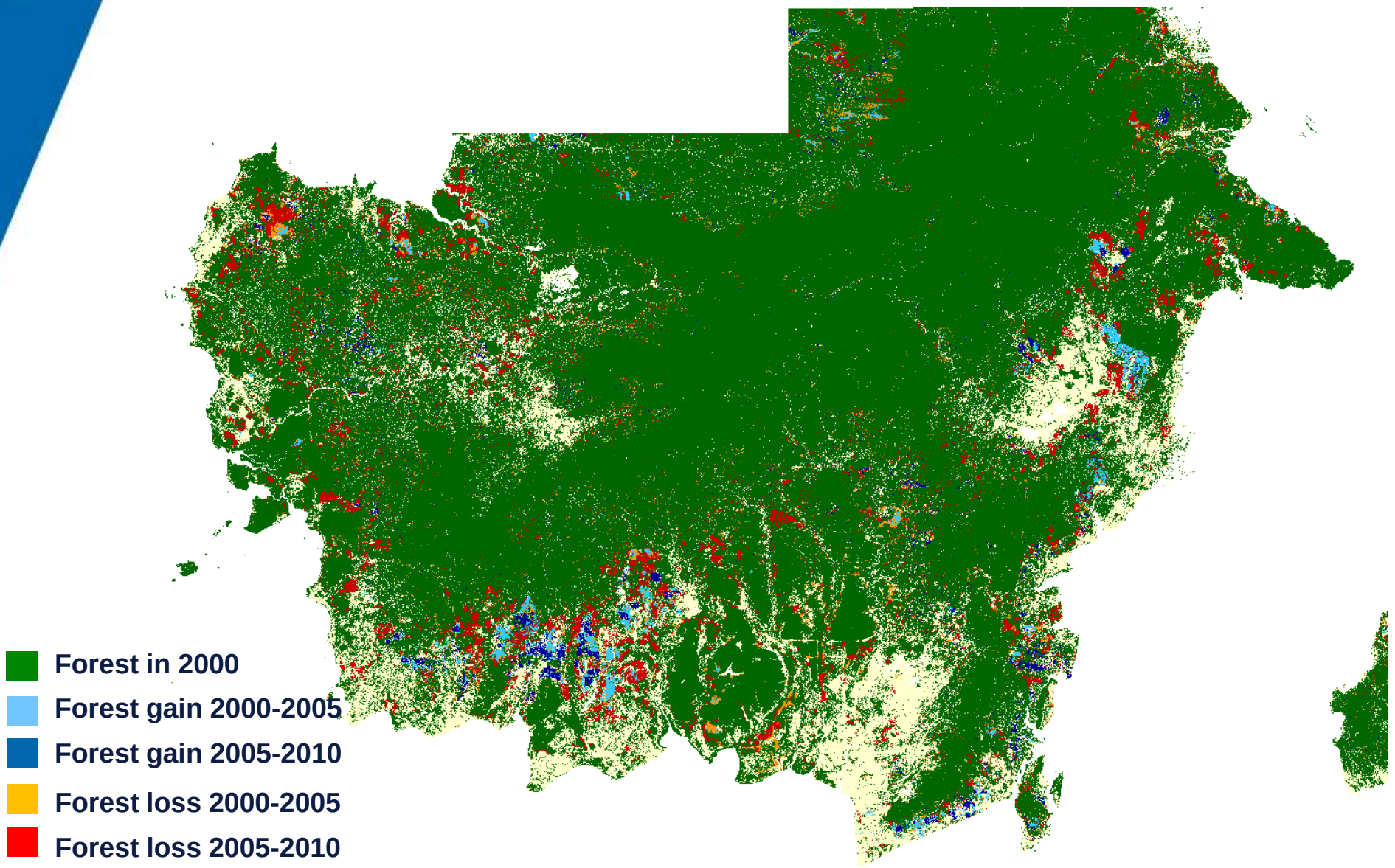


Forest in 2000
Forest gain 2000-2005
Forest gain 2005-2010



Forest in 2000
Forest loss 2000-2005
Forest loss 2005-2010

Forest gain and loss (Kalimantan, 2000-2005-2010)

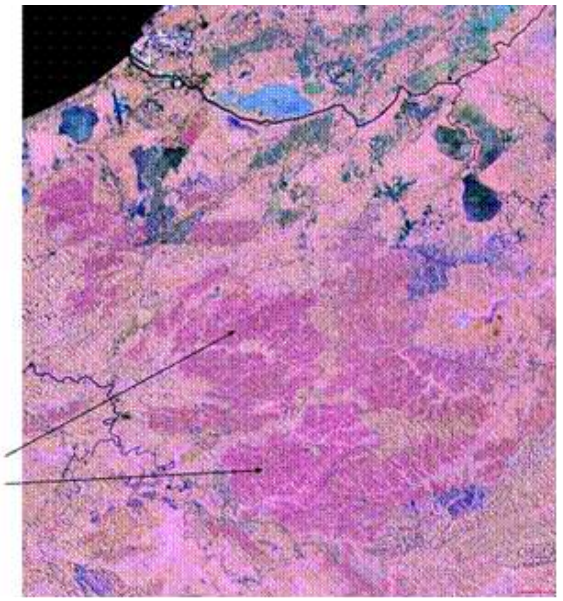


Land cover classification *(adopted from Wageningen University)*

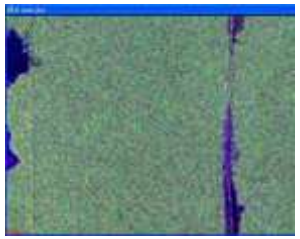
- L-band (ALOS Palsar HH and HV)/C-band (Radarsat-2 VV and VH) combination improves contrast between forest and Acacia plantation.
- Ground-truth data from the field survey has been used for radar legend development.

INDF mosaic
Radarsat-2 WB
Palsar FB
2009-2010
HH-HV-VV

Better visibility of Acacia plantations

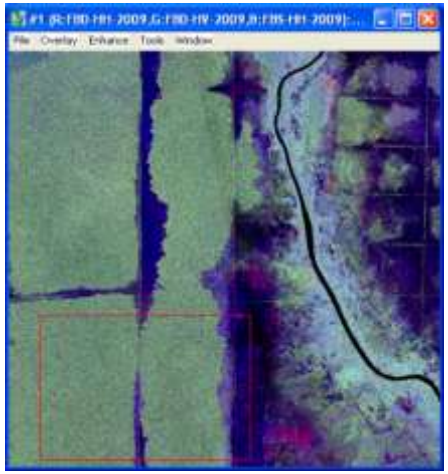


Land Cover Type
Peat swamp pole forest (15)



Zoom Area

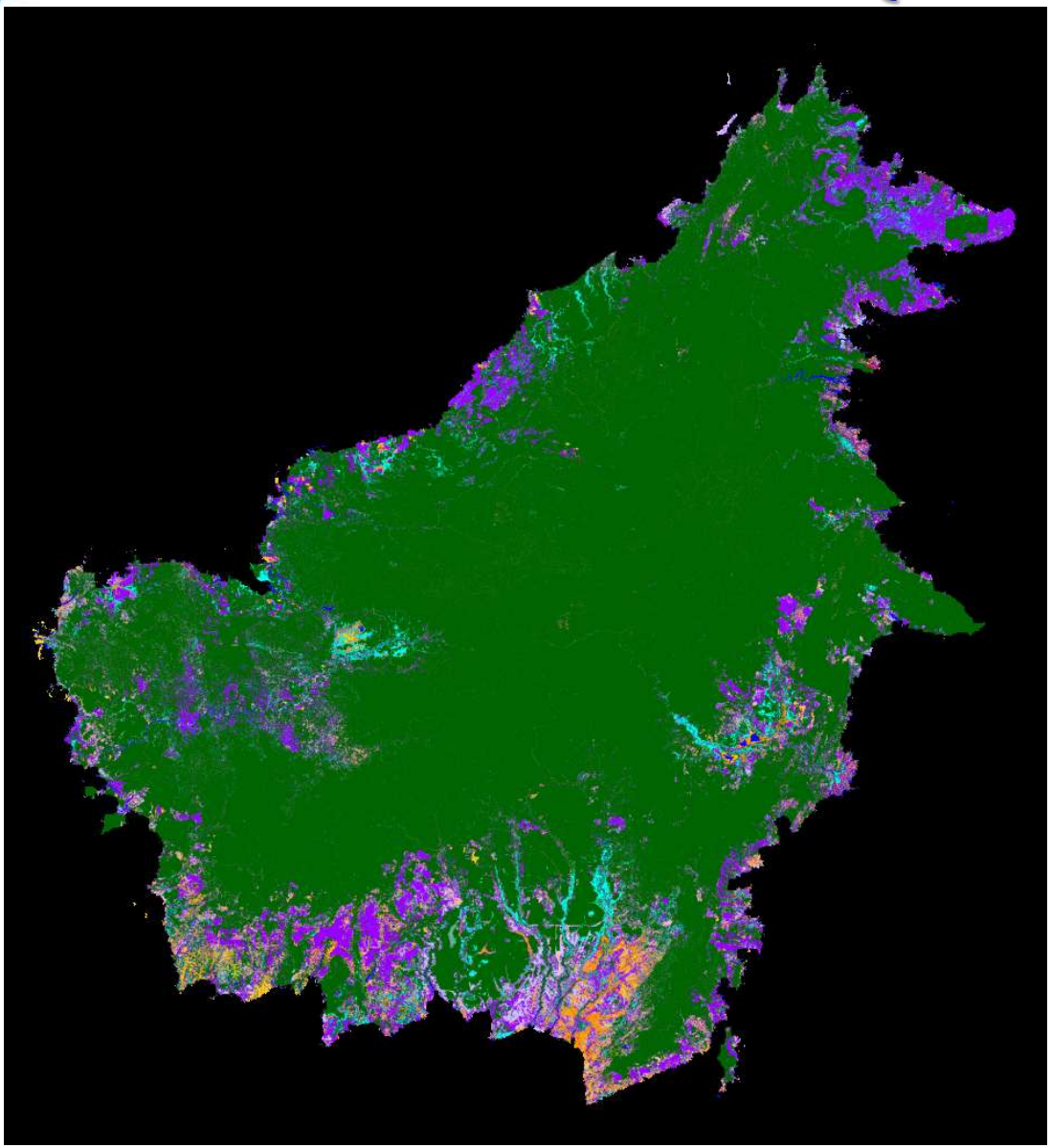
Palsar Classification



Ground Check

WAGENINGEN UNIVERSITY
ENVIRONMENTAL SCIENCES

Land cover classification (Kalimantan, 2009)



This example is a land cover map for Borneo of 2009, which is part of a consistent series of annual maps for the period 2007-2010. These maps are based on PALSAR data where, in this example, MODIS data are used to achieve a segregation of forest classes.

Closing remarks

- INCAS is developed to result in the spatial and temporal consistency of national forest carbon tracking.
- Different satellite remote sensing data *(i.e. Landsat and ALOS Palsar)* and methods *(i.e. CSIRO, Univerity of Maryland, and Wageningen University)* have been used to support INCAS forest cover/cover change analysis. There will be a workshop conducted for harmonizing the methods and products (around mid-Nov 2012).
- More data and methods are needed to improve the accuracy of the information of forest cover/cover change.

THANK YOU