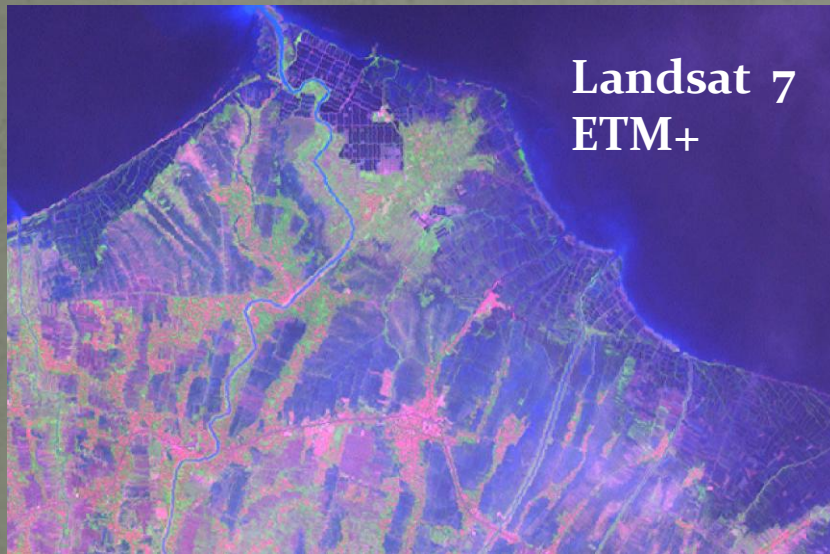


# Developing land cover products in Monsoon Asia through integration of Landsat (GLS2005) and L-band PALSAR imagery: --- An Update



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NASA LCLUC Science Team Meeting  
April 20-24, 2010, Maryland

## Acknowledgement ----- A network of international collaboration

USA: University of Oklahoma  
Huiyong Sang, Jingjing Wang, Chandrashekhara Biradar  
Applied Geosolutions, Inc.  
Williams Salas, Nathan Torbick

Thailand: Asian Institute of Technology  
Manzul Hazarika, Nalin enevirathne

Indonesia: Institute of Technology Bandung  
Ketut Wilkantika,

China: Institute of Geography and Natural Resources  
Jiyuan Liu  
Jiangxi Normal University  
Ying Liu, Peng Li, and Yonglin Zhao

India Indian Institute of Technology  
Mukunda Behera, Saurabh Gogai

Bangladesh Khulna University  
Shamim Mahabubul Haque, Zillur Rahman



# **Major topics of the presentation**

- 1. The scope of the project**
- 2. Description of the data used in this project**
- 3. Field surveys for ground truth data collection**
- 4. Algorithm and workflow for data processing**
- 5. Samples of sub-country results of land cover classification**
- 6. Transition to continental-scale automated mapping**

# Scientific background

- More than half of the world's population live in monsoon Asia.
- Land use and land cover change occurs extensively and dynamically because of demands for food, water, fibre, bioenergy, and human settlement.
- Intensification of agriculture through multiple cropping, irrigation, fertilizer application.



## **Project Objectives**

**(1). Develop prototypes of land cover products for monsoon Asia, using algorithms and procedures that integrate Landsat and PALSAR ScanSAR images;**

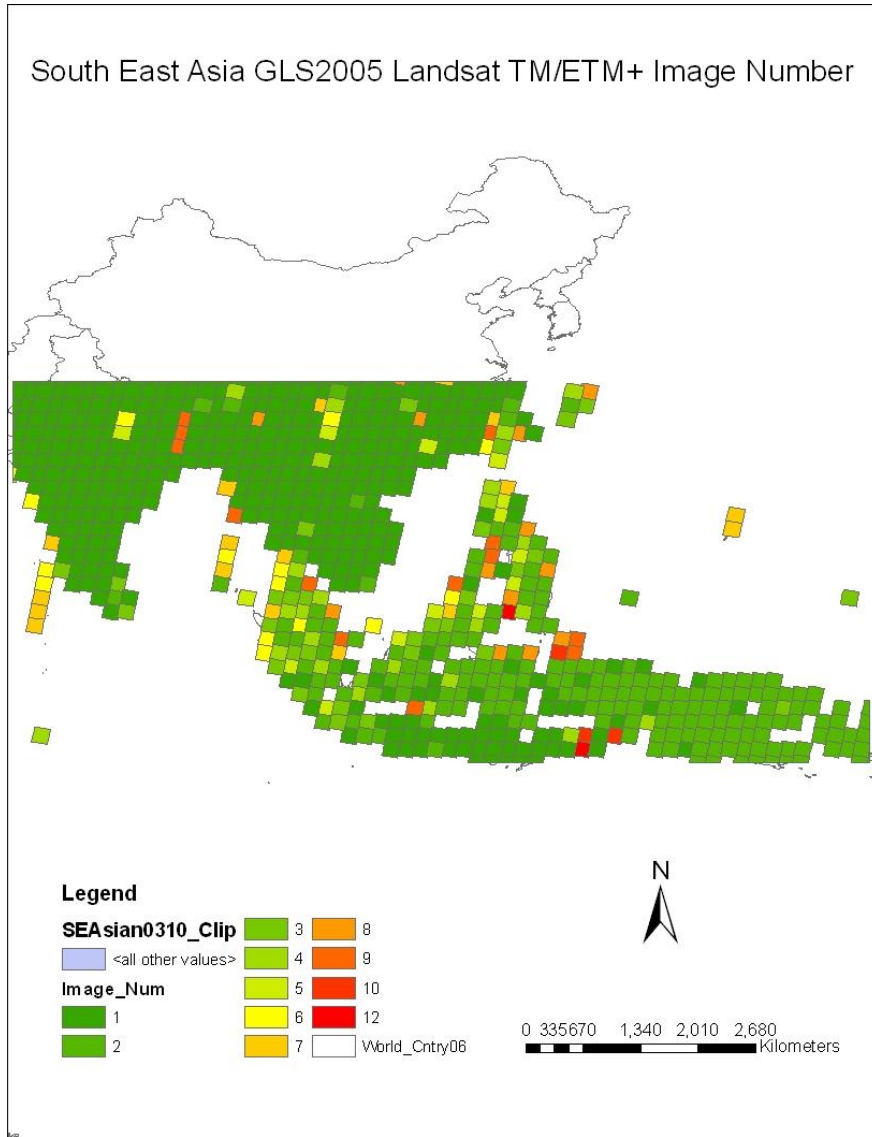
**(2). Evaluate the resultant land cover data products using field data, available regional geospatial datasets, and a large sample of high-resolution images (e.g., IKONOS, PALSAR data); refine the mapping algorithms as needed;**

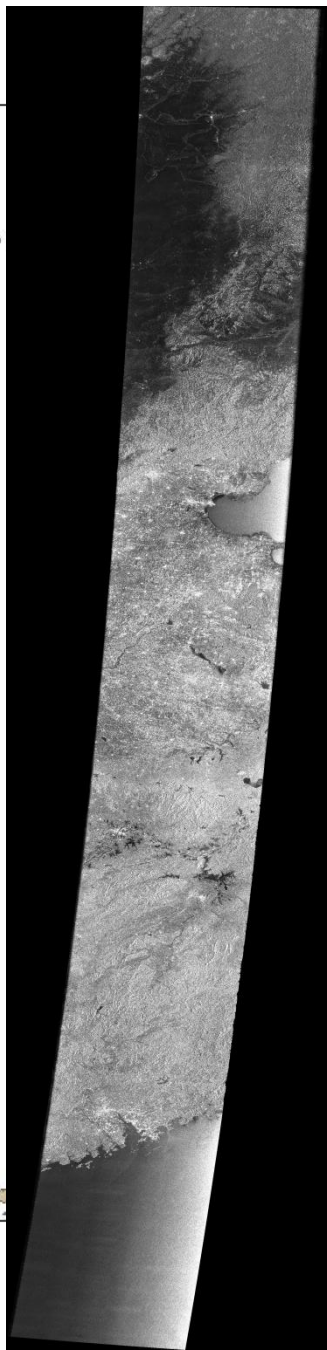
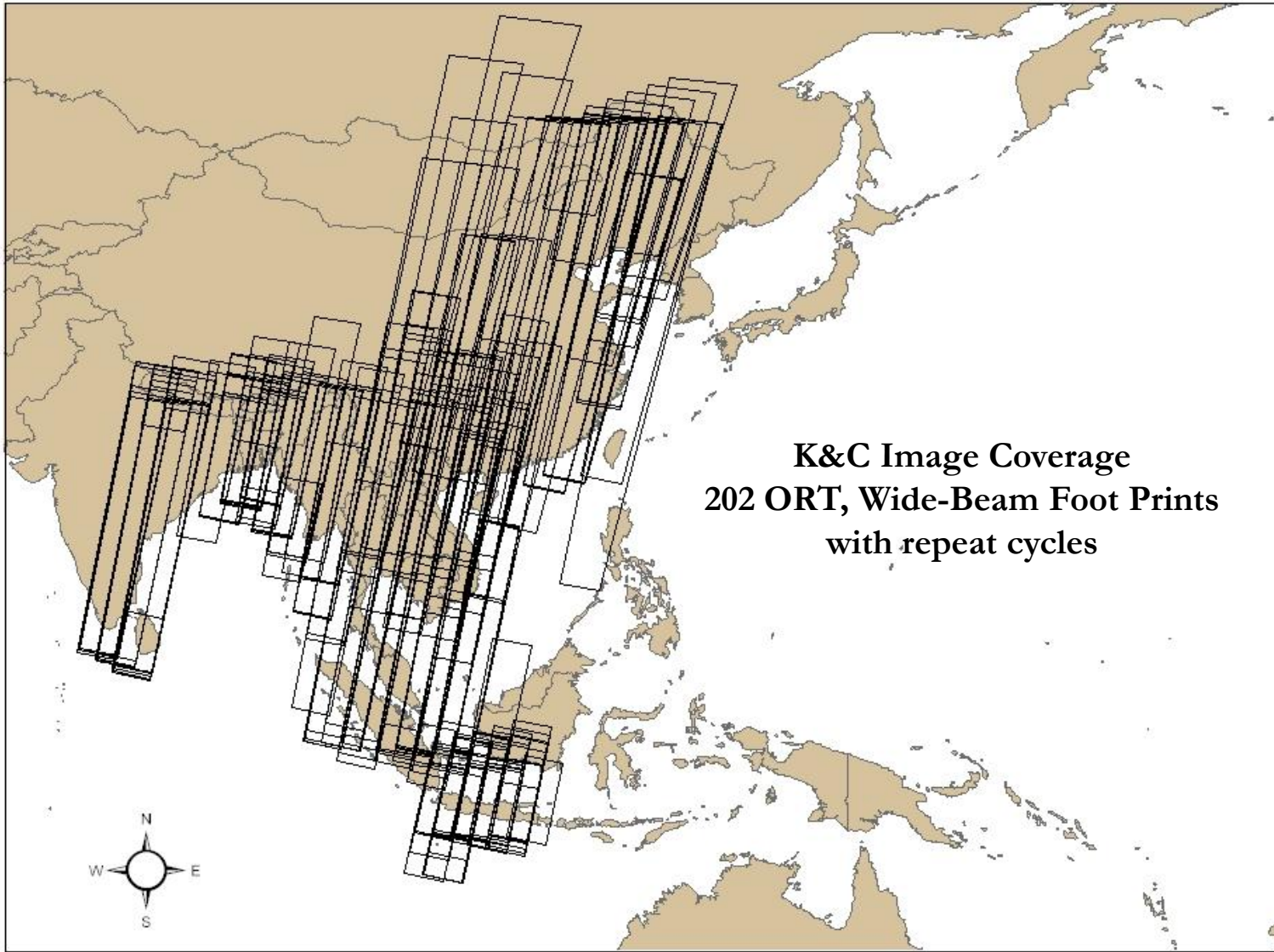
**(3). Develop biophysical data products from analysis of multi-temporal ScanSAR, and single/dual/polarimetric PALSAR images;**

**(4). Support ongoing projects by the team members (e.g., the global irrigation area mapping, the risk assessment of highly pathogenic avian influenza) and the international scientific projects (e.g., MAIRS) and evaluate scientific uses of these data products.**

# **Study area and satellite image data**

# Spatial domain of the project





**ALOS PALSAR K&C Image over eastern Asia (China)  
November 11, 2007, ORT, Cycle 15, Path 103; S-N Extent: 16 to 53 N**



## Both Landsat ETM+ and L-band PALSAR images are used in this project

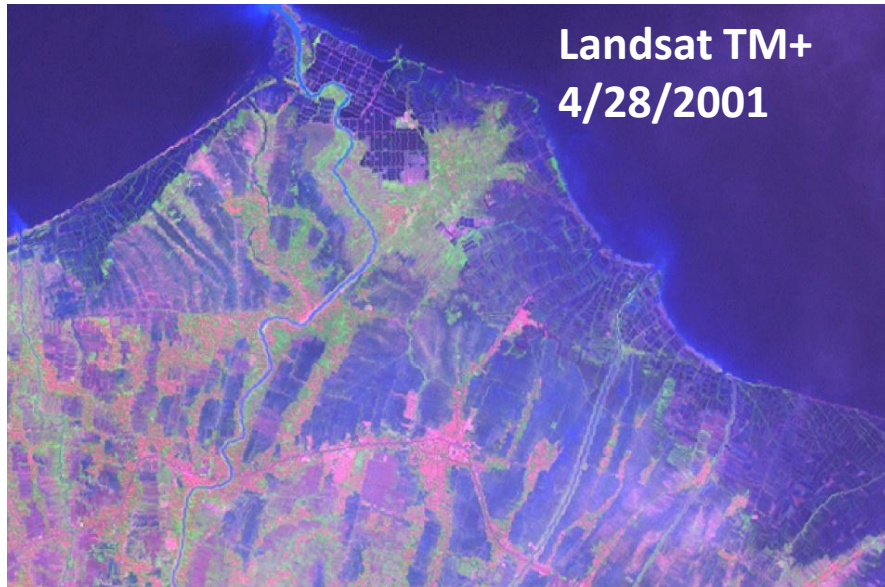


Figure 1. Landscape in Kendal, Java, Indonesia. The left scene is the false-color composite of Landsat ETM+ image acquired on April 28, 2001, Red: Band 7, Green: Band 4 and Blue: Band 3. The right scene is two fine-resolution PALSAR images (HH) acquired on 6 December, 2006 and 21 January, 2007, respectively. Open water (dark color), fish ponds and rice paddies (green and pink color) could be visually detected easily from this two-date composite image. Green color indicates crop fields flooded in December 2006 but planted in January 2007; Purple color indicates crop fields planted in December 2006 but harvested in January 2007.

The image is approximately ~20km width.

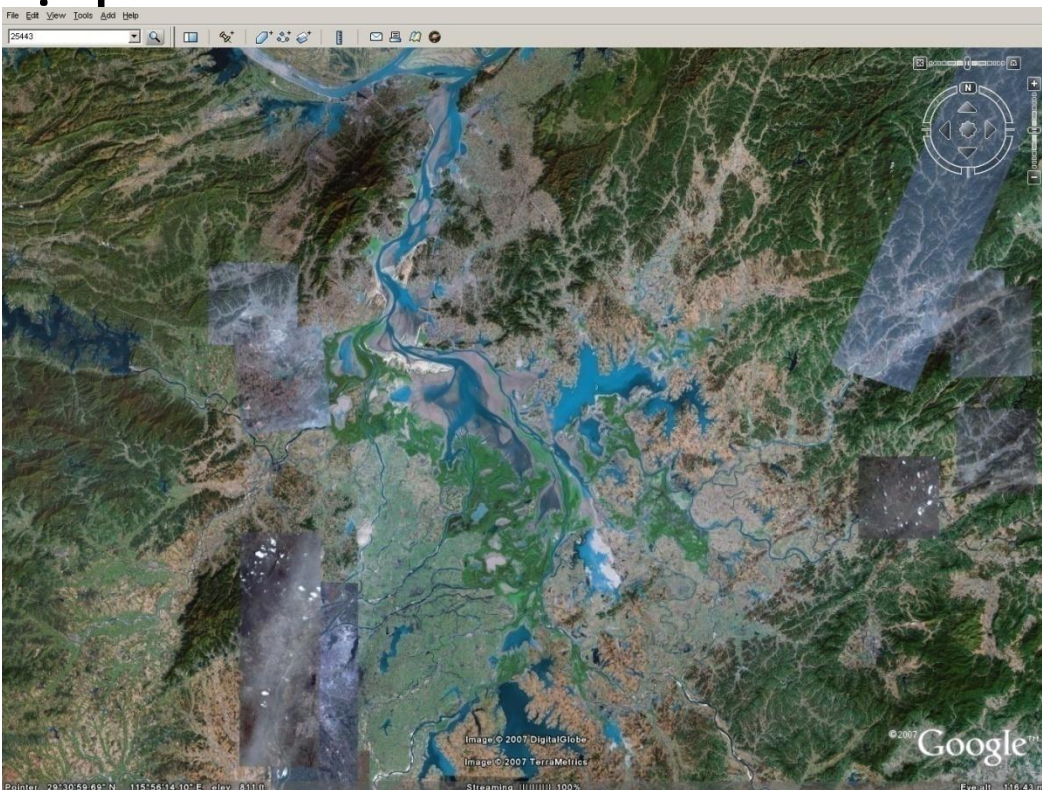
**Ground truth data -- Calibration and validation strategy**

# Ground Truth Data and Cal/Val Strategy

## (1) Intensive field study -

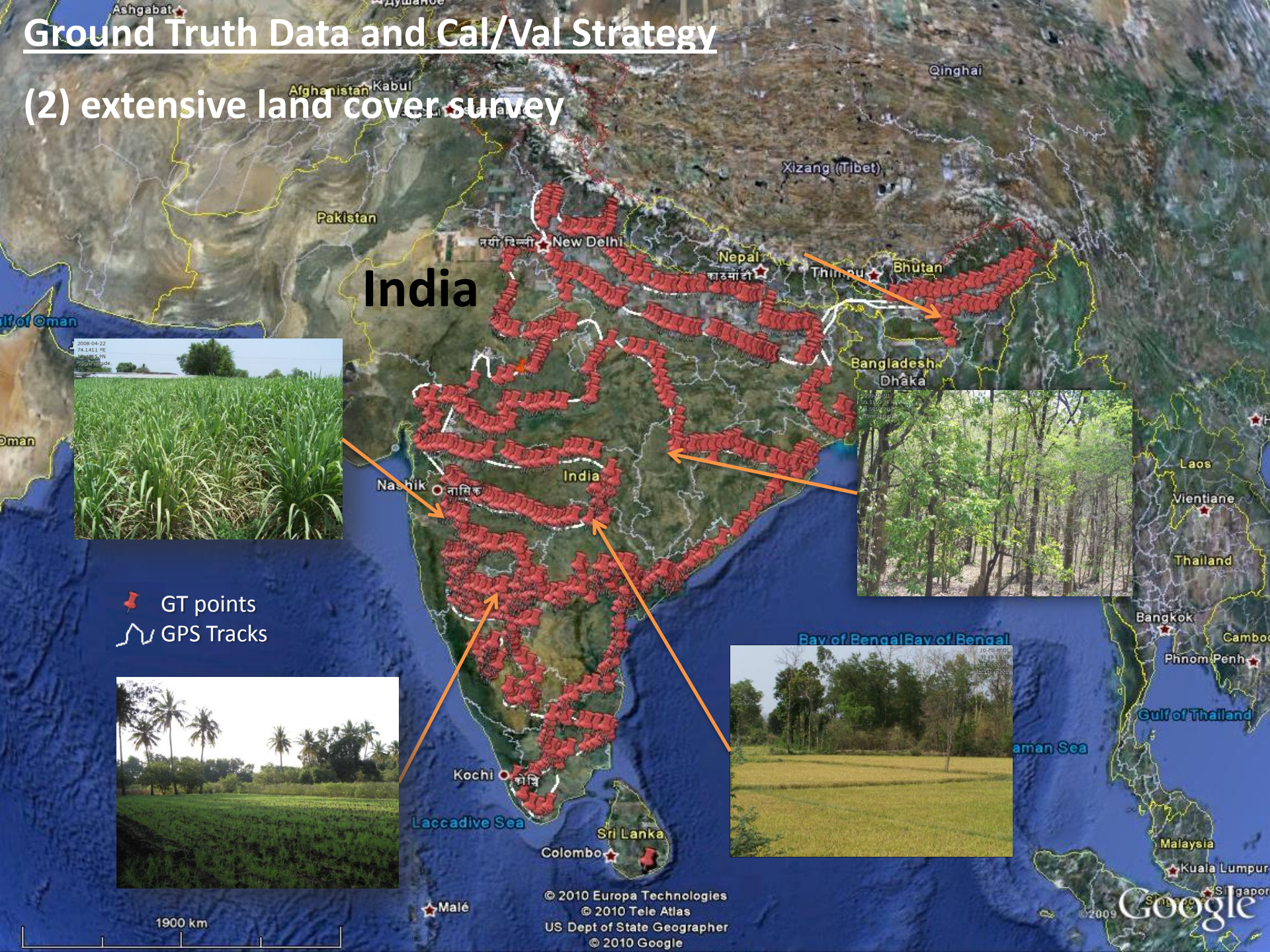
Poyang Lake in Jiangxi Province, China

Biophysical parameter measurements of paddy rice at 8-day interval  
rice plant height, aboveground biomass, leaf area



# Ground Truth Data and Cal/Val Strategy

## (2) extensive land cover survey



# Ground Truth Data and Cal/Val Strategy

(2) extensive land cover survey

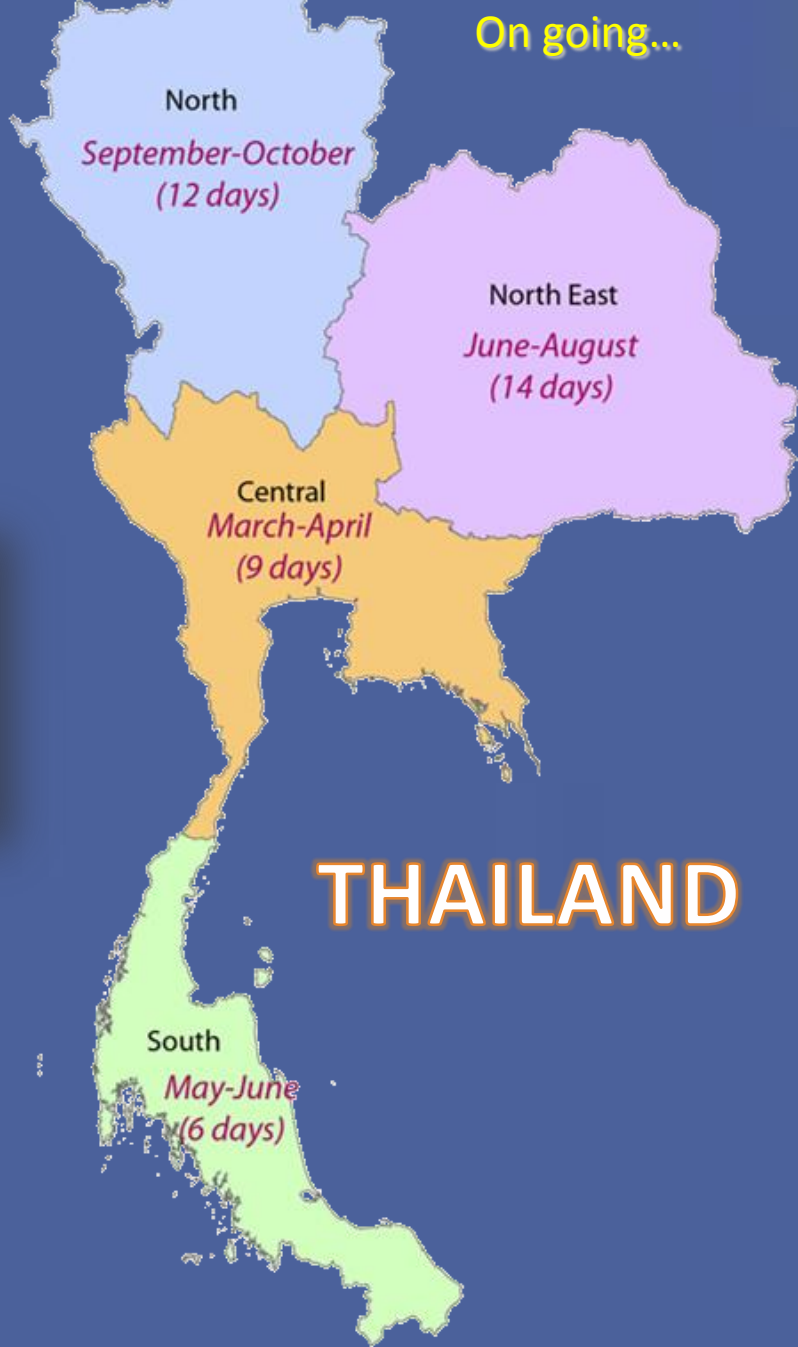
## JAWA, Indonesia



104 km

# Ground Truth Data and Cal/Val Strategy

(2) extensive land cover survey



# Ground Truth Data and Cal/Val Strategy

(2) extensive land cover survey



© 2010 Europa Technologies  
 US Dept of State Geographer  
 © 2010 Tele Atlas  
 © 2010 Google

Swatch of Nal lat 23.929777° lon 90.356514° elev 0 m

# BANGLADESH

On going...



## Legend

- |               |                   |                     |
|---------------|-------------------|---------------------|
| — Route One   | — Route Nine      | □ District Boundary |
| — Route Two   | — Route Ten       | □ River             |
| — Route Three | — Route Eleven    |                     |
| — Route Four  | — Route Twelve    |                     |
| — Route Five  | — Route Thirteen  |                     |
| — Route Six   | — Route Fourteen  |                     |
| — Route Seven | — Route Fifteen   |                     |
| — Route Eight | — Route Sixteen   |                     |
|               | — Route Seventeen |                     |
|               | — Route Eighteen  |                     |

# Ground Truth Data and Cal/Val Strategy

## (3) Citizen-based field data collection

-- web-enabled field photo library <http://www.eomf.ou.edu/photos/>

The screenshot shows a web browser window titled "Global Geo-Referenced Field Photo Library - Query - Mozilla Firefox". The address bar contains the URL <http://remotesensing.unh.edu/photo-browser/query.php?longmin=&longmax=&latmin=&latmax=&>. The page content includes a navigation menu with links for [Main], [Log in], [Register], [Query], and [Map Query]. Below this is a search interface with two main sections: "Search by coordinates" and "Search by date".

**Search by coordinates:**  
Longitude min:  Longitude max:   
Latitude min:  Latitude max:

**Search by date:**  
From: Jan 1 1990  
To: Oct 27 2008

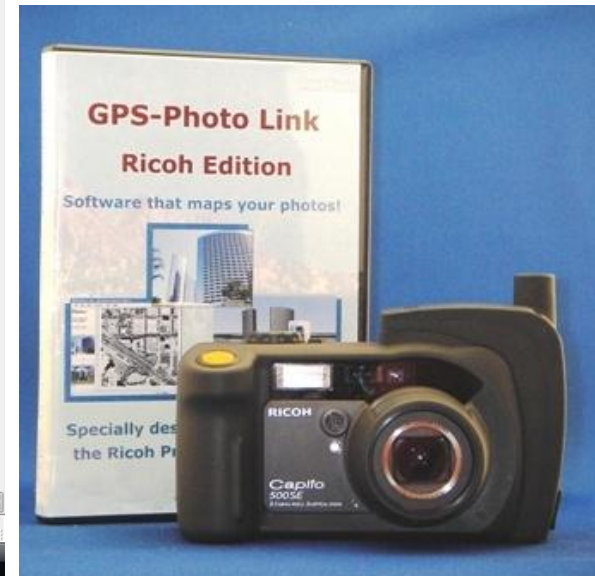
**Categories:** All  
**Users:** All

**Search by keywords:**

Public: (74) Private: (0) Deleted: (2)  
[Check All](#) | [Uncheck All](#)

Four photo thumbnails are displayed, each with a date and coordinates:

Date taken	Longitude	Latitude
2006-07-07	68.857 °E	40.3854 °N
2005-05-07	68.8595 °E	40.3838 °N
2006-08-03	68.8574 °E	40.3904 °N
2006-08-03	68.8563 °E	40.3896 °N

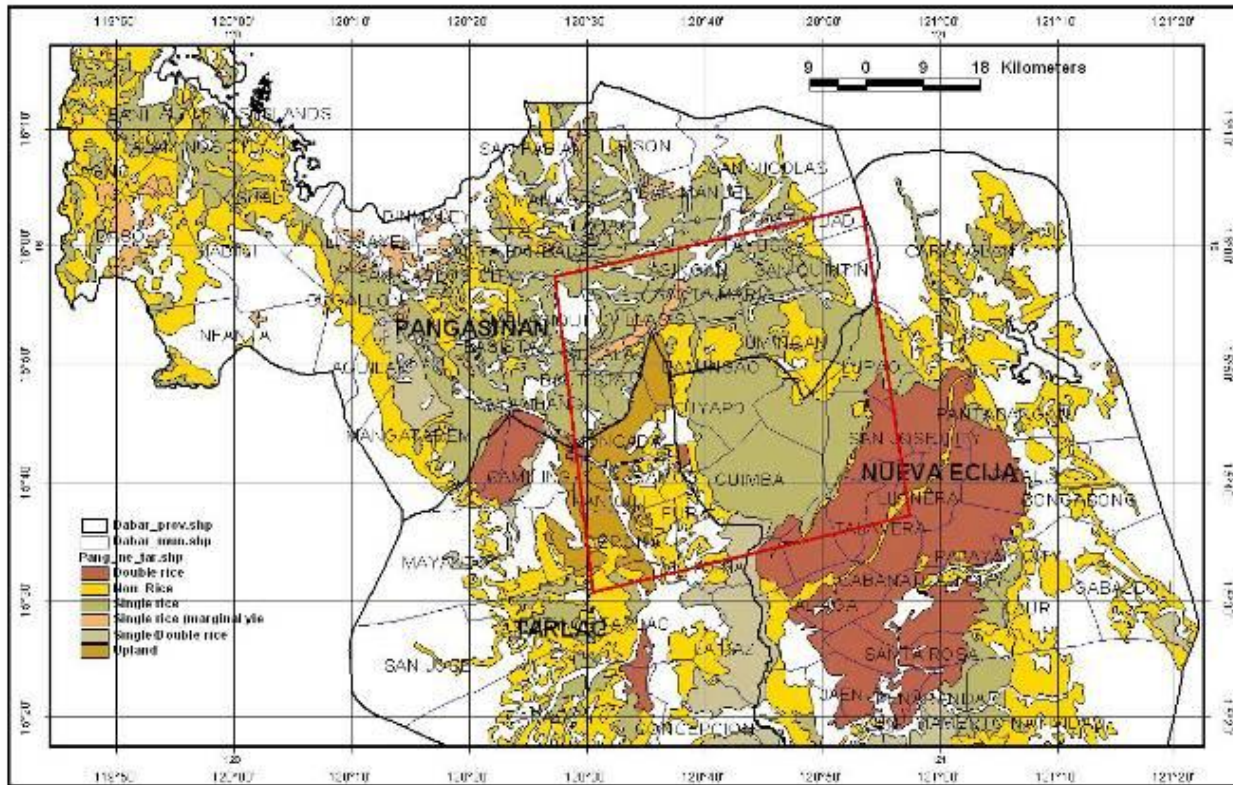




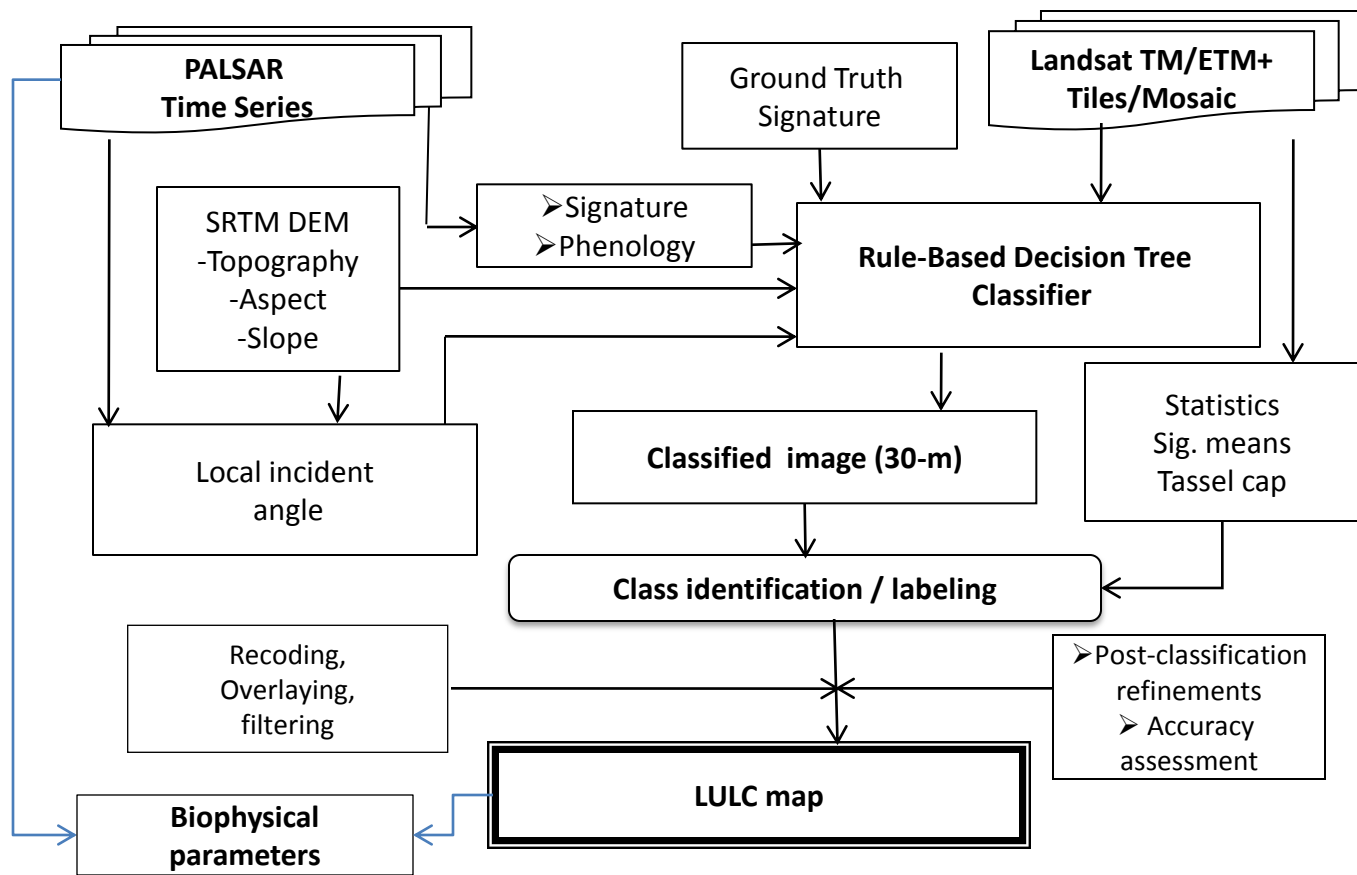
# Ground Truth Data and Cal/Val Strategy

(4) Collecting available fine resolution land cover maps from the community through collaboration (e.g., AIT, IWMI, others)

Philippines: Pangasinan and Nueva Ecija



# **Algorithms and work flow**



**Overall scheme of the Land use / land cover classification system in the project**

## *Two mapping approaches using PALSAR*

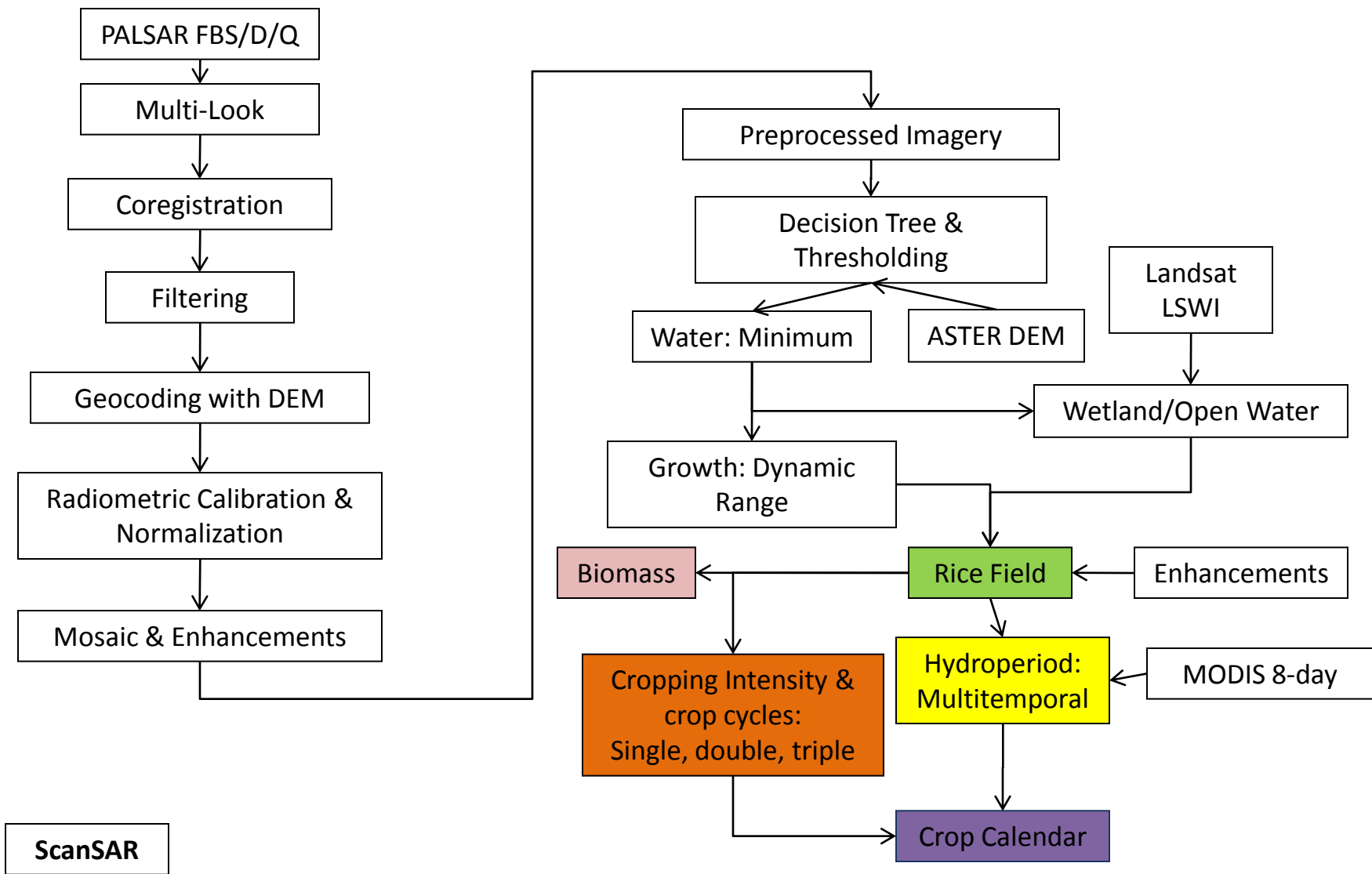
### ➤ **Operational rice monitoring**

- Using sigma nought/gamma thresholding approach
  - Optical data used as masks/phenology descriptors
- Uses multitemporal JAXA ALOS PALSAR K&C Strips (~75m; HH mode)
- Products include:
- Rice paddy extent
  - Hydroperiod
  - Cropping Intensity
  - Crop calendar

### ➤ **Decision Tree LULC maps**

- LCCS hierarchical framework using CART algorithm
- Ranging scales from fine-beam to continental
  - FBS/D/Q @ ~12-15m spatial resolution
  - PALSAR Mosaics (HH:HV) twice a year @ 50m res
  - Integrate Landsat GLS2005 mosaics with PALSAR @ variety of scales
  - K&C Strips & MODIS used for phenology/attributes

# Operational Rice Products from SAR & optical imagery



Colors highlight primary operational products

## Operational mapping of crop cycles.& calendar

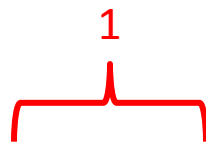
- characterize number of 'peaks' and temporal windows
- rules to utilize PALSAR overpasses and temporal windows of rice growth (i.e., example crop 90-120 days)

single crop

Rice: threshold

rice phenology

time



double crop

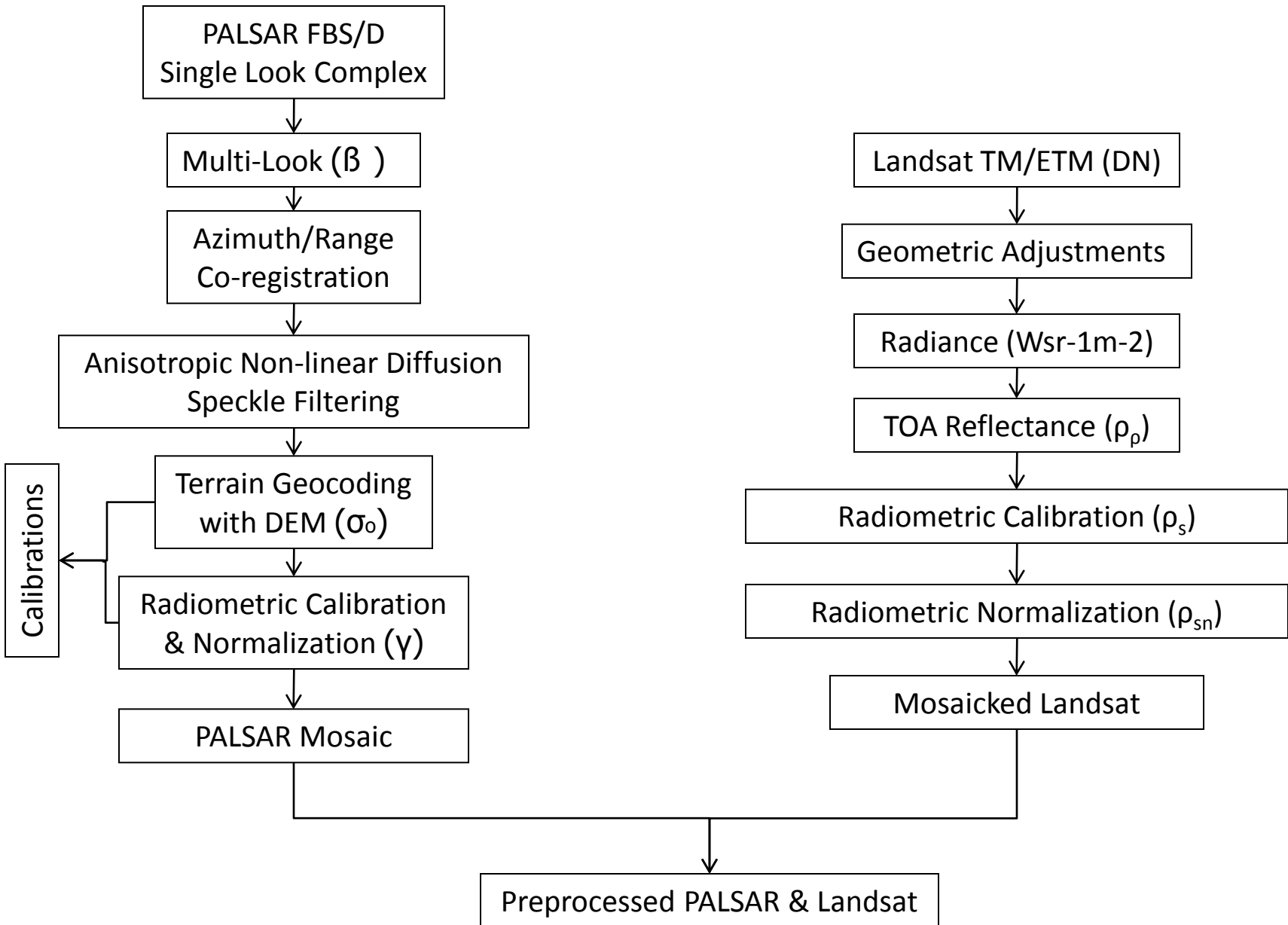
Rice: threshold

rice phenology

time

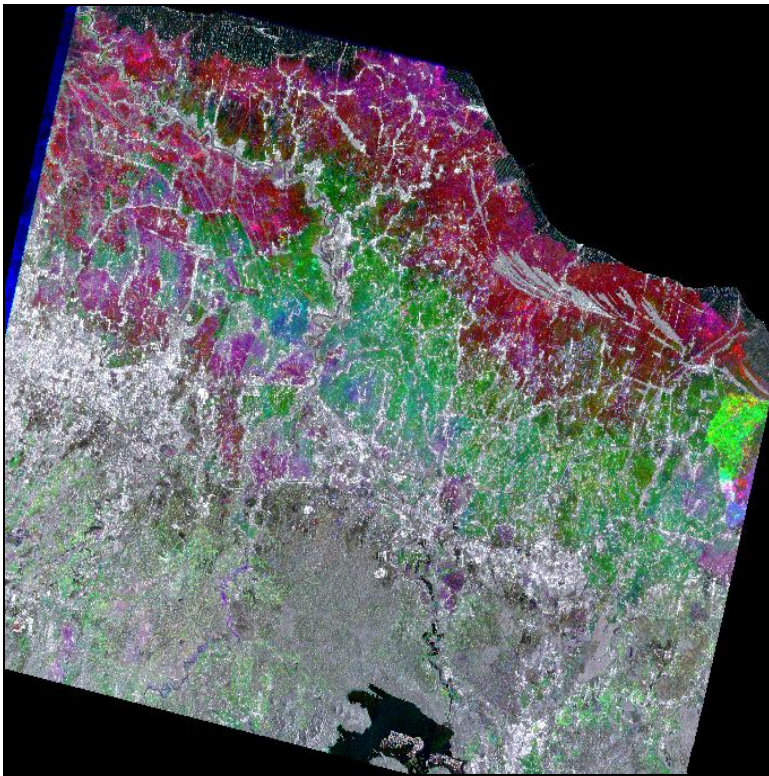


# Example preprocessing fine-beam PALSAR & Landsat integration

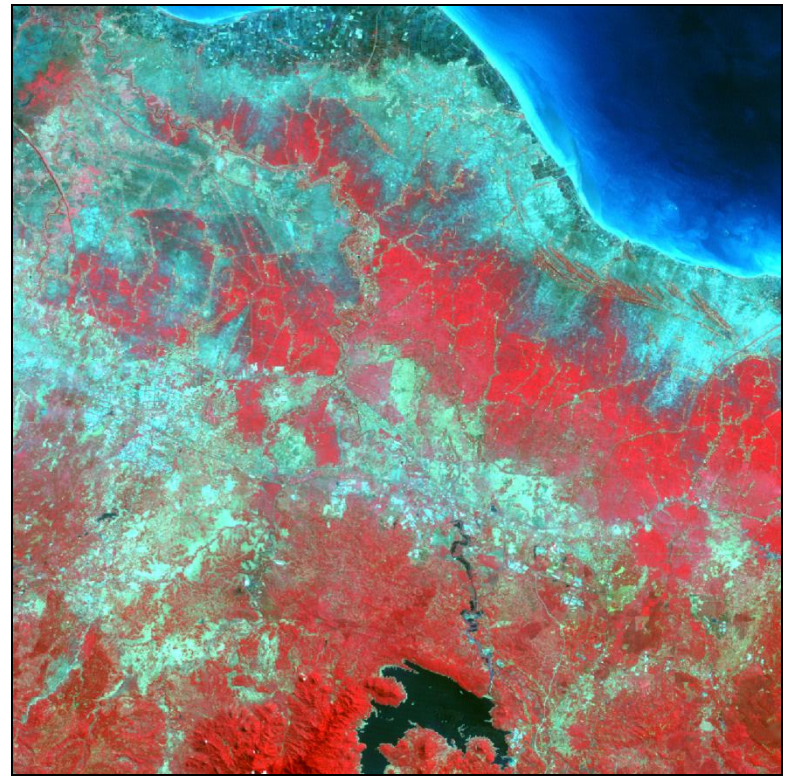


## Fused PALSAR FBS (HH) & Landsat for LULC classes

- PALSAR FBS/D/Q and Landsat
- ScanSAR used for hydro-period monitoring & crop calendar
- CART (Classification and Regression Tree) algorithm
  - Jawa Barat; Bekasi & Karawang areas of Indonesia



Multi-temporal FBS HH

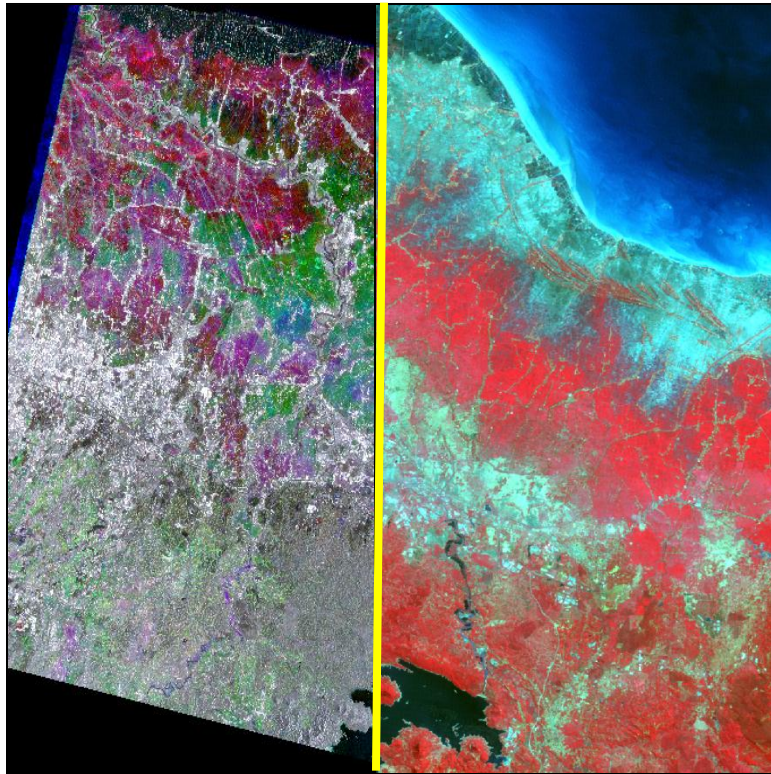


Landsat TM False Color 4:3:2

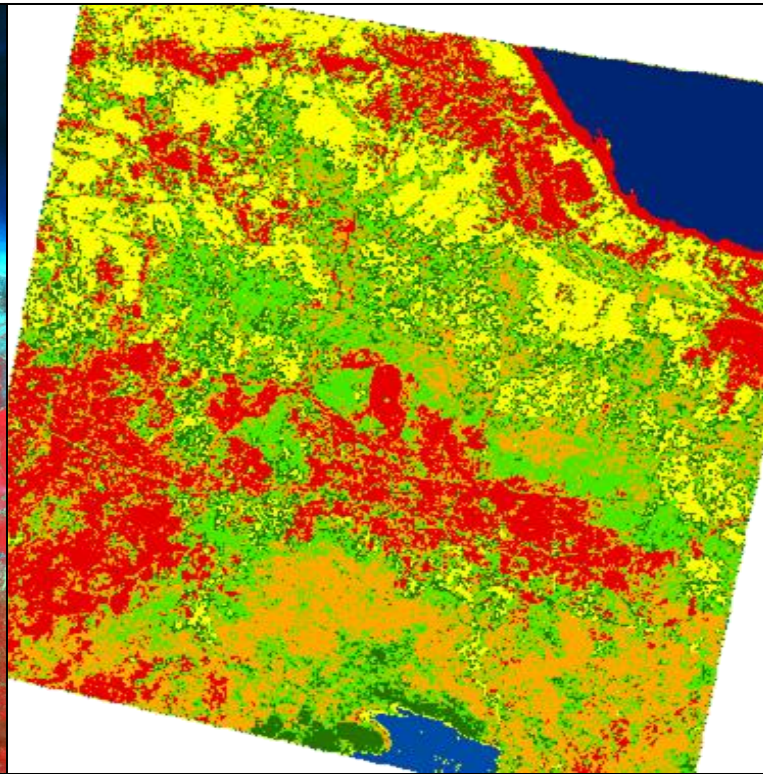


# Fused PALSAR FBS (HH) and Landsat images

Multi-temporal FBS & Landsat



Decision Tree (Level 1)  
Integrated Classification



## Jawa Barat

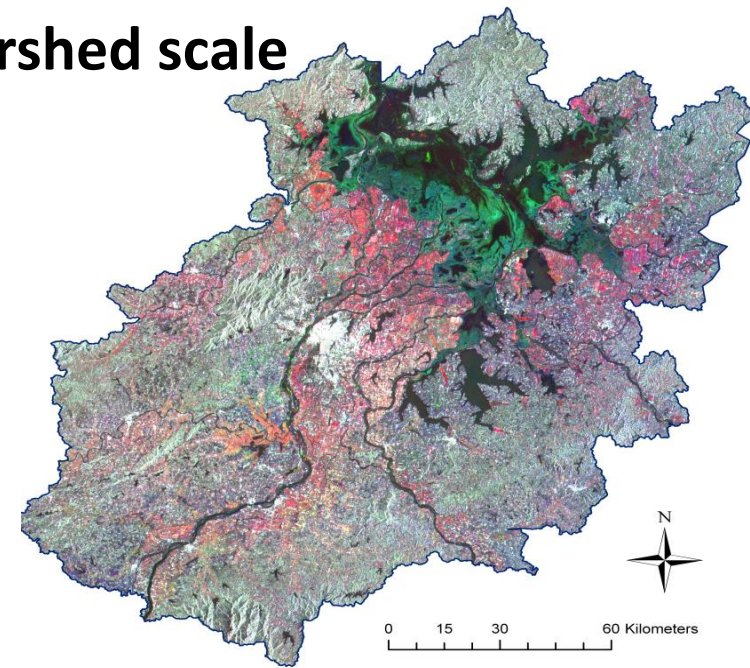
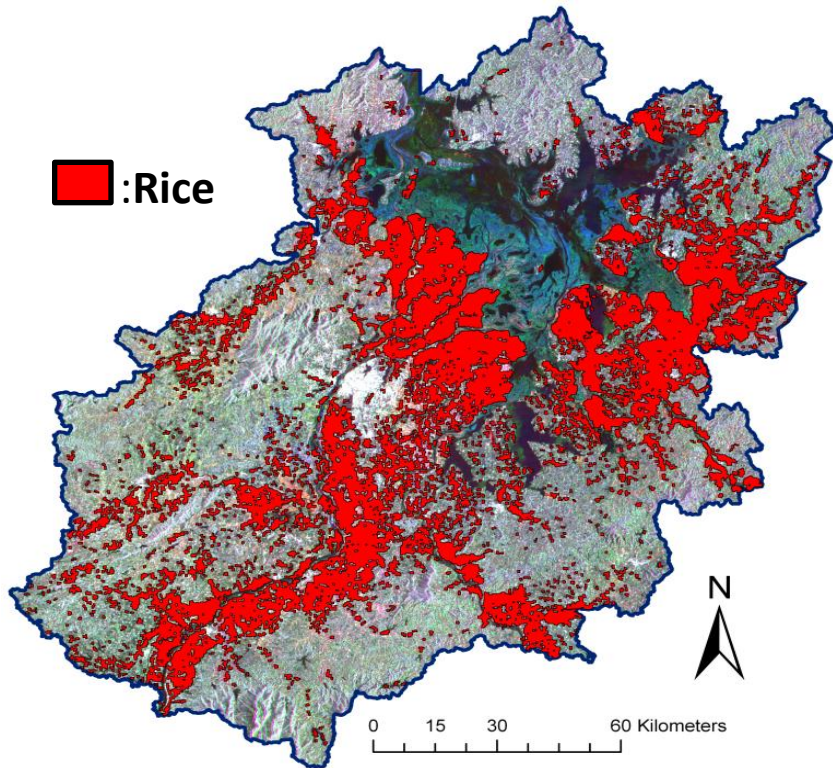


- Integrated Landsat & multitemporal (FBS) PALSAR products
- CART algorithm; 90% overall accuracy for Level 1
- Open scrub (drier) vs. closed scrub (higher biomass) most confused
- Now integrating climate & DEM to improve descriptors
- Multi-temporal ScanSAR showed 2 crop intensity dominated region

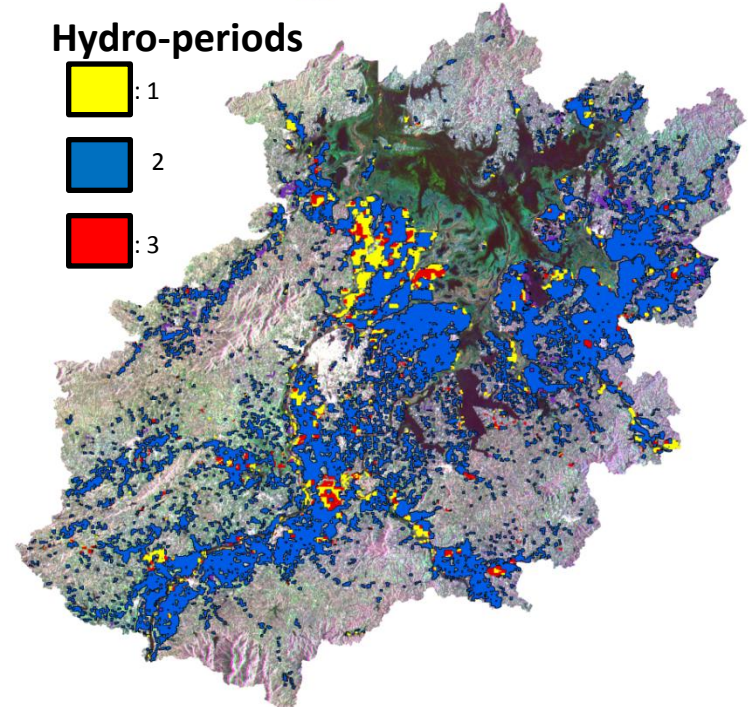
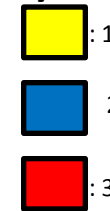
**A sample of sub-country maps of land cover**

# ScanSAR operational rice products at watershed scale

- ~84% overall accuracy @ Poyang Lake Watershed
- Identify crop calendar based on hydro-period & growing season length
- Identify crop intensity (single, double, triple)
- Transitioning to continental wide (K&C Strips)



## Hydro-periods

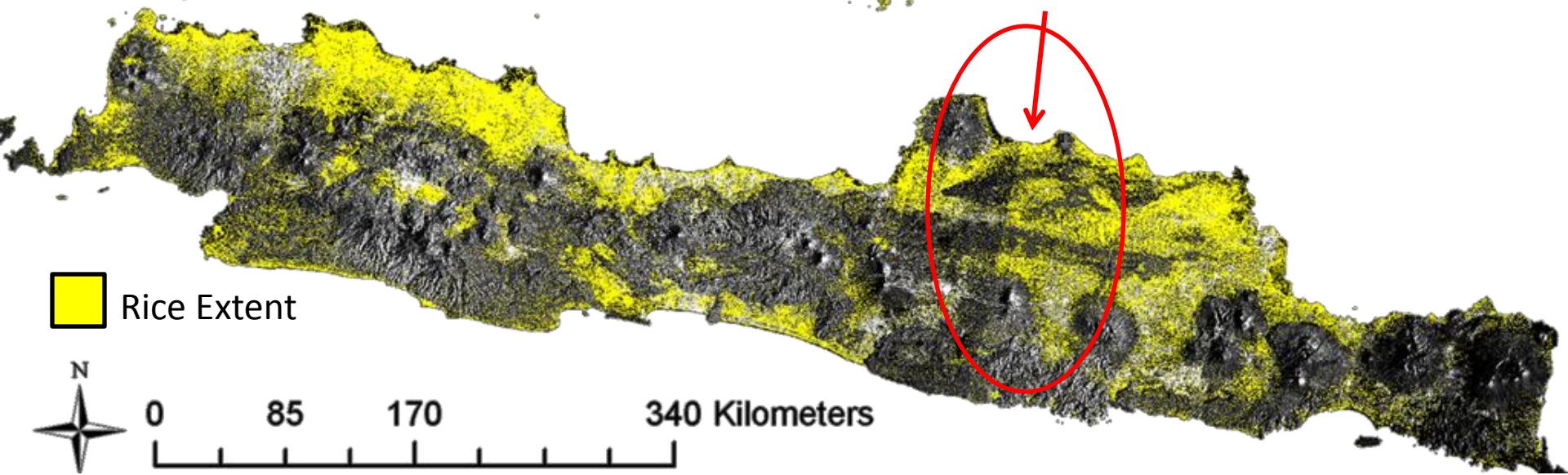


Poyang Lake Watershed, Jiangxi Province, China

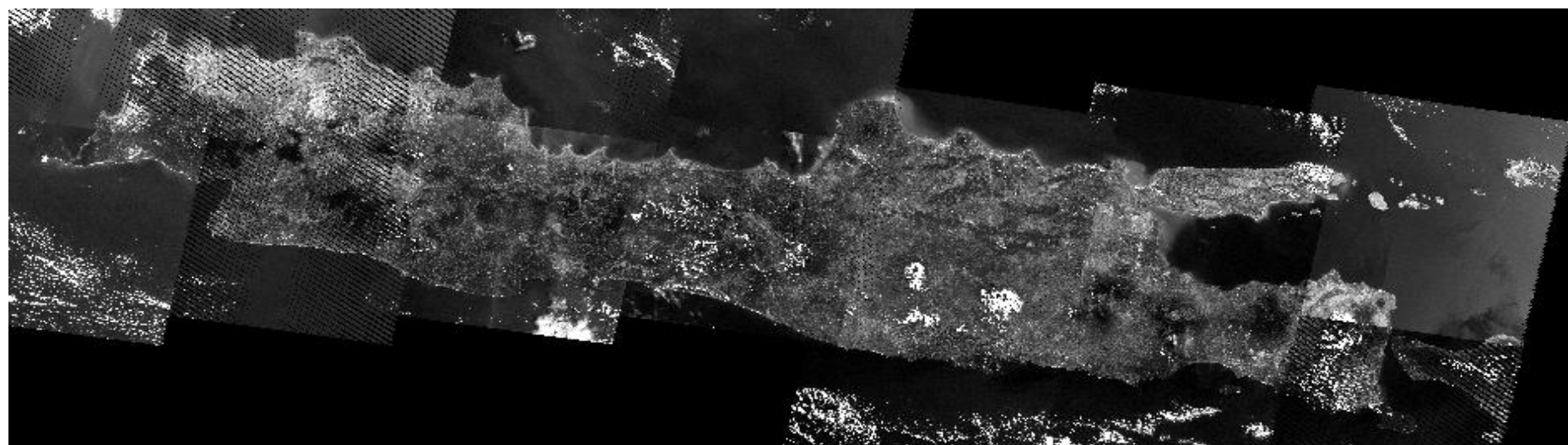
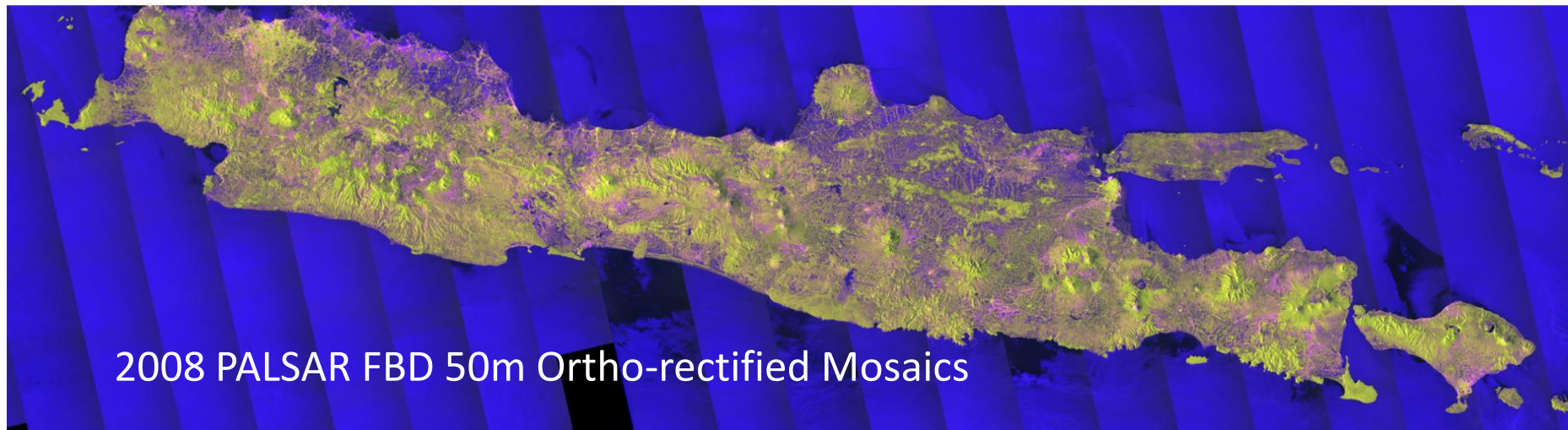
Optical imagery limited by clouds in many rice growing regions

- Utilizing multi-temporal K&C Strips (~75m:HH) in operational approach;
- Beam geometry adjustments remove artifacts from viewing geometry (i.e., near (1<sup>st</sup>) and far (5<sup>th</sup>) range beams in ScanSAR mode) no longer impacting rainfed rice paddy detection
- Accuracy for small and isolated terraced paddy attributes limited by ScanSAR spatial resolution

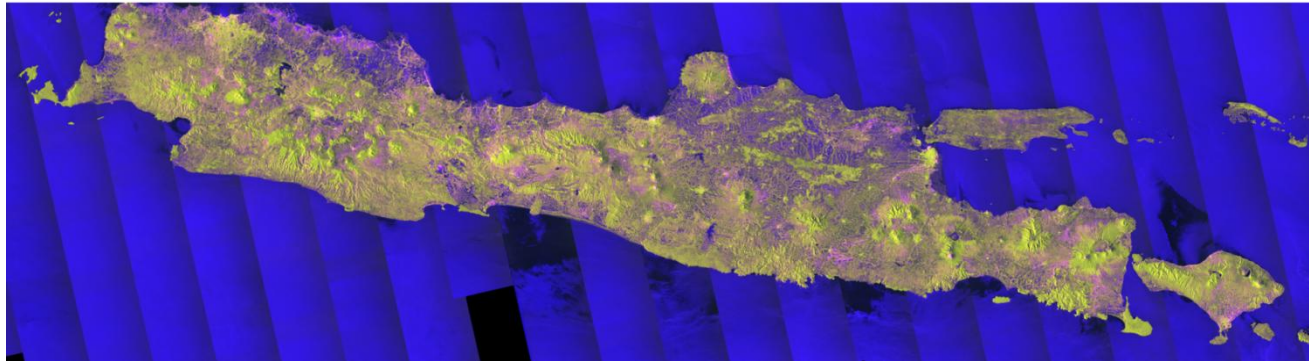
Final preprocessing reduces ScanSAR striping



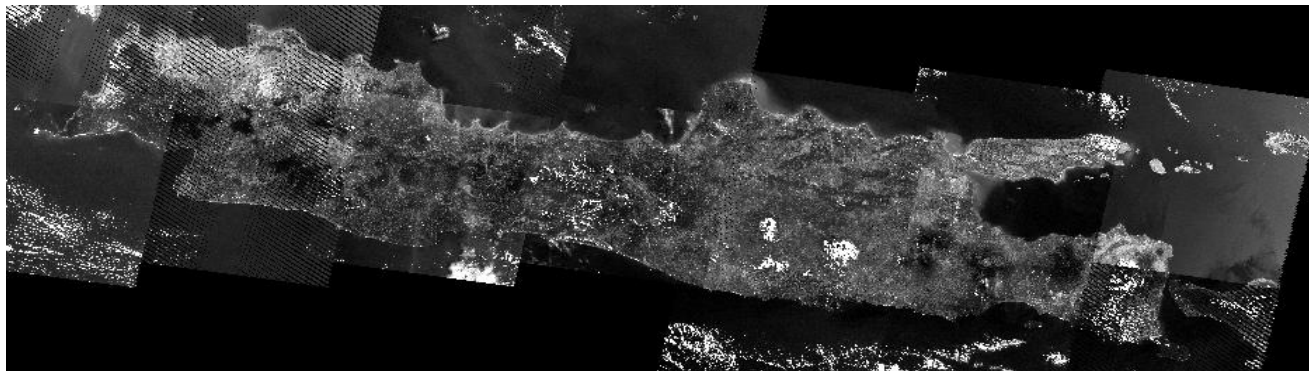
# Extrapolating Merged CART Classifier for Large Area Products (Java Example)



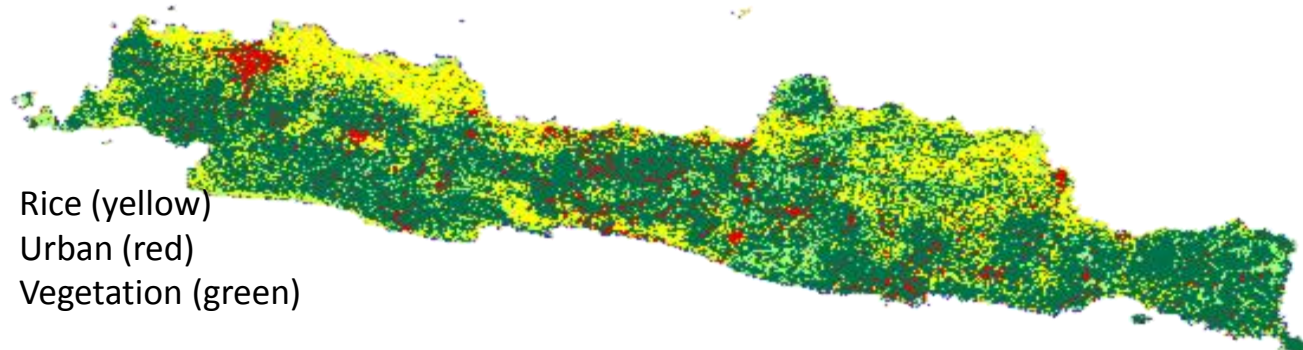
# Extrapolating Merged CART Classifier for Large Area Products (Java Example)



2008 PALSAR FBD 50m Orthorectified Mosaics



200X Landsat TOA 30m / GLS Mosaic

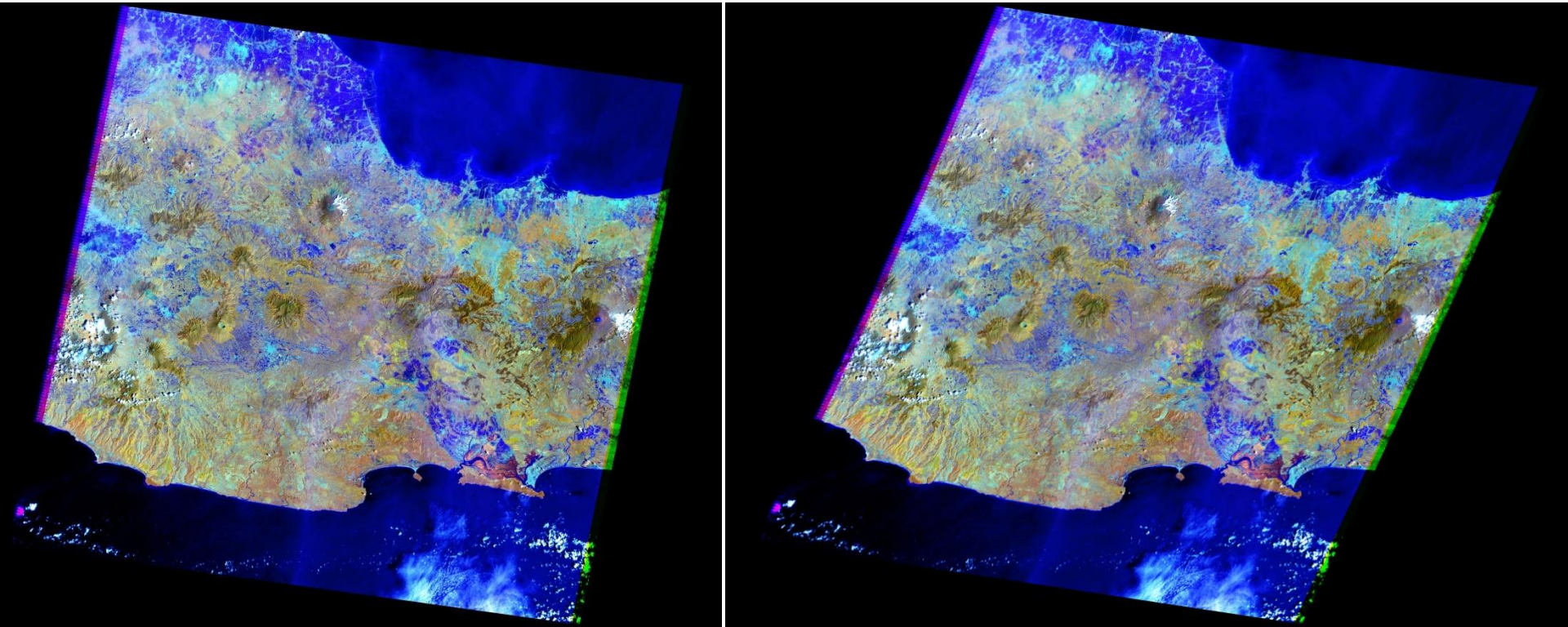


Integrated CART LULC Classification (8 land cover classes: rice, crop/veg mosaic, water, aquaculture, forest, open scrub/shrub, closed canopy shrub/low-biomass woodland/forest)

**A transitional to the continental-scale mapping  
of land cover**

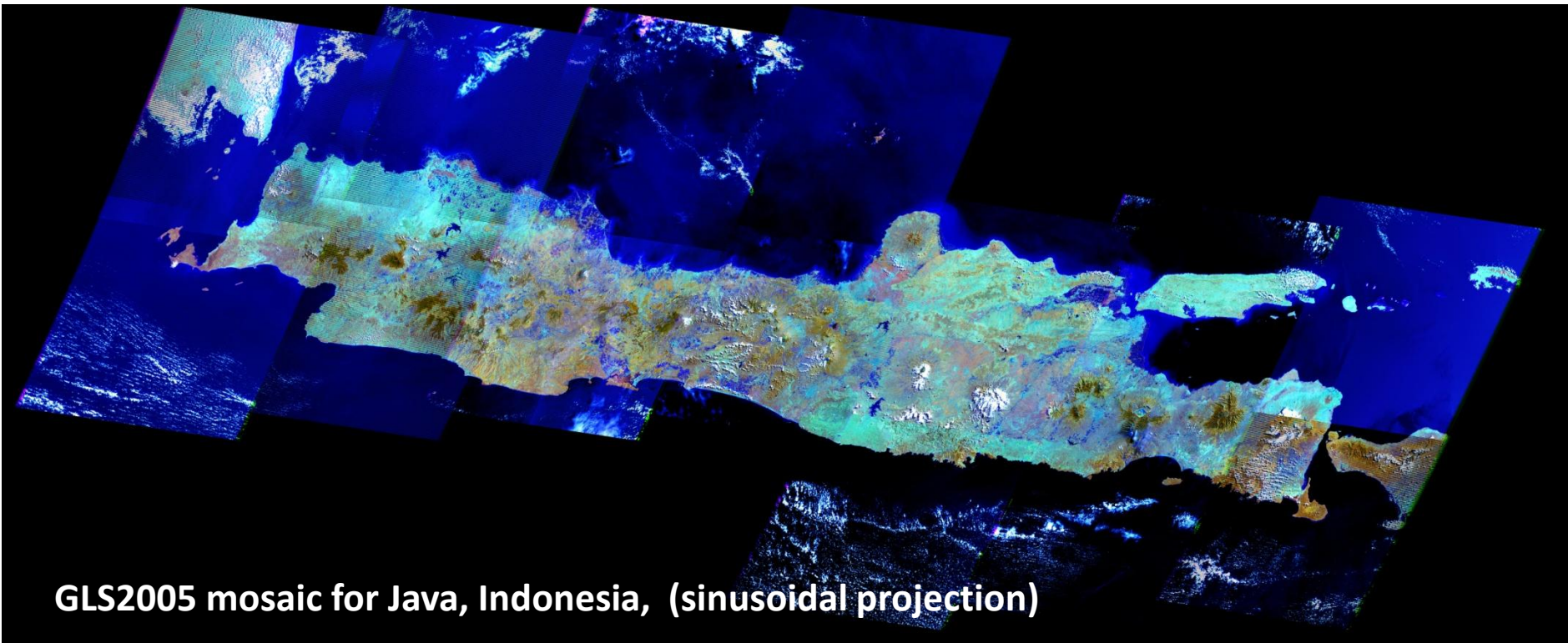
Re-project Landsat images from UTM to sinusoidal projection  
Re-project PALSAR images to sinusoidal projection

-- Landsat - PALSAR – MODIS data



Landsat 7 ETM+ L7121065\_06520030119 (Java, Indonesia), band 453 (RGB) composite





## **Work plan in next 6-months**

- 1.Reprojection of Landsat and PALSAR to be completed by April 2010**
- 2.Implementation of the integrated CRT mapping algorithm for the rest of study domain by June 2010**
- 3.Initial data product evaluation by August 2010**
- 4.Data product refining by October 2010**



*Thank you for your attention.  
and  
Welcome to visit Oklahoma, USA.*

