

Introduction on Land Use/Cover Classification using Let's SAR tool and PALSAR Mosaics.

GIS Seminar #145

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Dr. Rajesh Bahadur THAPA

thaparb@gmail.com

<http://publicationslist.org/rajesh.thapa>

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Manabu Watanabe, Itoh Takuya, Risako Dan*

Content

- Let's SAR toolbox
- Image processing flow and data
- Mapping examples
- Hands on practice
- Q&A

ALOS-2 / Tool - Windows Internet Explorer

http://www.eorc.jaxa.jp/ALOS-2/en/doc/pal2_tool.htm

Bing

www.eorc.jaxa.jp/ALOS-2/en/doc/pal2_tool.htm



Image Library

ALOS-2 Project

Calibration&Validation

**ALOS
Observation Strategy**

Use DATA

Dataset

**Conference
& Workshop**

**Kyoto & Carbon
Initiative**

**Research
Announcement**

[Home](#) | [Sitemap](#) | [Contact US](#) | [Japanese](#)

Advanced Land Observing Satellite ●●● DAICHI-2·DAICHI **ALOS-2·ALOS**

ALOS Research and Application Project of EORC, JAXA

[Home](#) > [Use DATA](#) > [Tool](#)

- Tool
- PALSAR-2 Product Format Description
- PALSAR-2 Sample Product
- PALSAR-2 Simulated Sample Data

ALOS-2 / Document - Tool

[>> Japanese](#)

* menu *

- JAXA Let's SAR

- JAXA Let's SAR -

Let's SAR is a simple tool package to use SAR data such as ALOS PALSAR mosaics for forest classification, change detection, and other major applications. The aim of the tool is providing the first step in the use of SAR to more people and expanding the utilization of SAR data.

New! Let's SAR ver. 1.0, 2014/11/14 (zip Compress / 294MB) 

The download file contains tools, instructions, and presentation materials used in JAXA's training courses. Currently, the following two functions are provided:

- LUC (Land Use/cover Classification): a tool for image classification with object-based machine learning algorithms.
- Gamma-zero change: a tool for extracting changes such as deforestation using differences of backscattering coefficients observed at two different times.

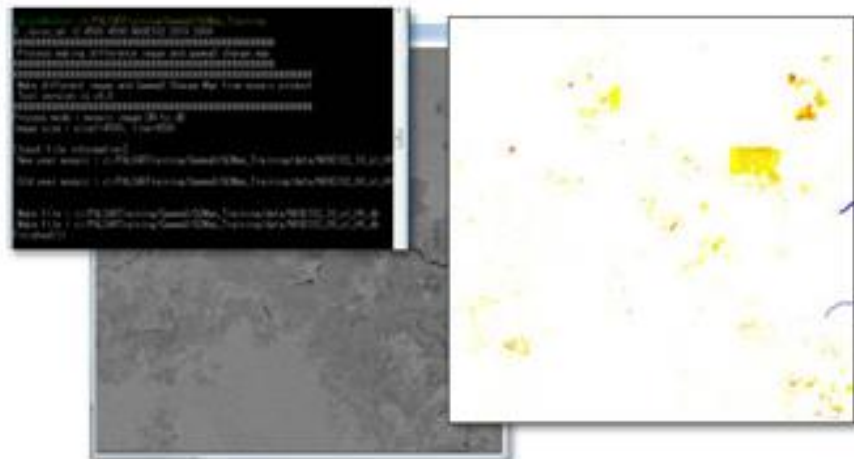
JAXA's capacity building trainings on forest issues...

JAXA Let's SAR

LUC (Land Use/cover Classification)



Gamma-zero change detection



Training course (Kyoto, Nov. 3-4, 2014)



Let's SAR - LUC

- **Name: Land Use/Cover Classification (LUC)**
 - Written in C++ Language (VC++.net)
 - Uses OpenCV libraries
- **Computer specifications**
 - OS: Windows 7 64 bits
 - Memory: 60 times of an input image, for example, if the size of input image is 100 Mbytes, then $60 \times 100 \text{ Mbytes} = 6 \text{ Gbytes}$. The size of 1 file is critical than the number of the files. Check the available memory before processing!
 - Hard-disk: 20 times of an input image size
- **Data specifications**
 - Reads image data in ENVI format
 - All data layers should be in same size, i.e., columns & rows
- **Documentation**
 - Introduction on Land Use/Cover Classification using PALSAR mosaics
 - Training Manual
- **Copyright 2012-2015, JAXA/EORC**

Software: updates on Land Use/Cover Classifier (LUC)

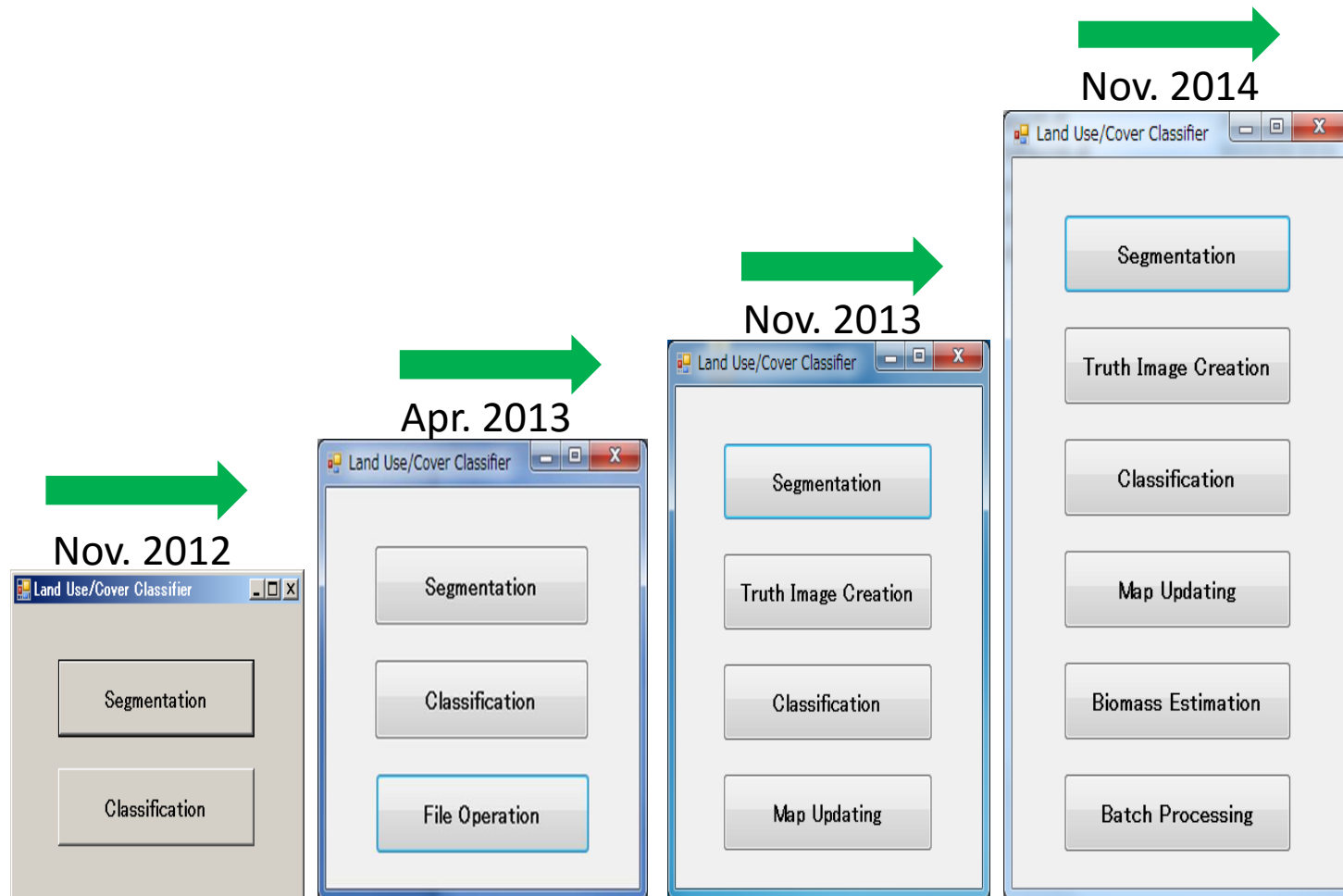
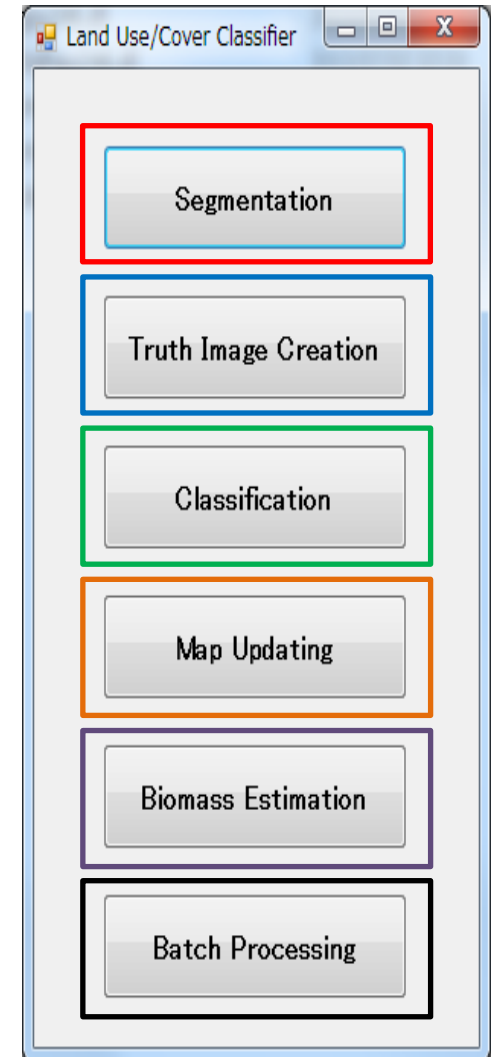


Image processing flow in LUC tool

- Segmentation
- Truth image creation
- Classification
- Map updating
- Biomass estimation
- Batch processing



Data: PALSAR 25m Mosaic

- PALSAR (Phased Array L-band SAR) of ALOS (Advanced Land Observing Satellite)
- Two polarizations in mosaic data
 - ✓ HH (horizontal transmit and horizontal receive)
 - ✓ HV (horizontal transmit and vertical receive)
- Data collection from 2006 to 2011
- Mosaic data available for 2007, 2008, 2009, & 2010
- Orthorectified and slope corrected data products

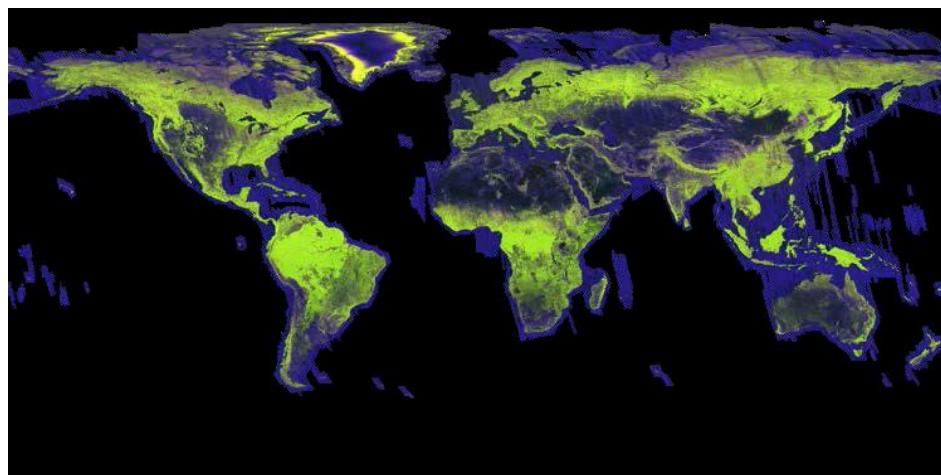
More about the mosaic product @

Shimada, M. (2010), *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 3, 657-671.

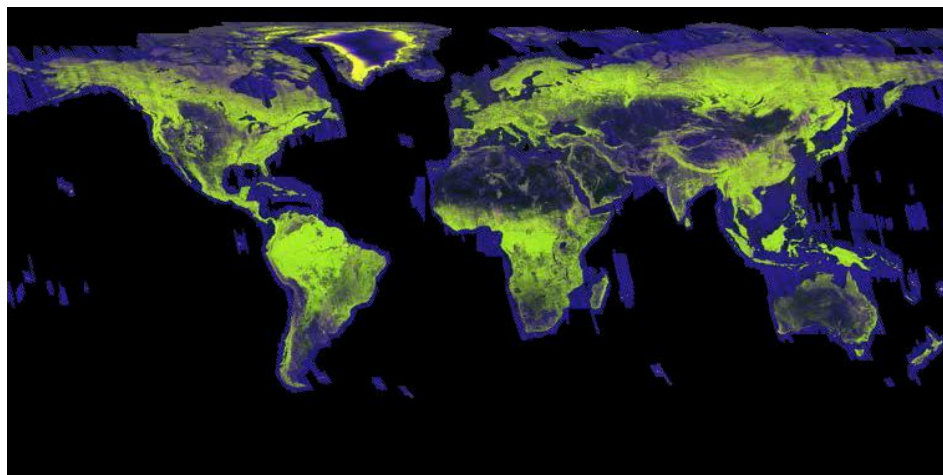
Shimada, M. & Ohtaki (2010), *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 3, 637-656.

PALSAR 25m Global Mosaics

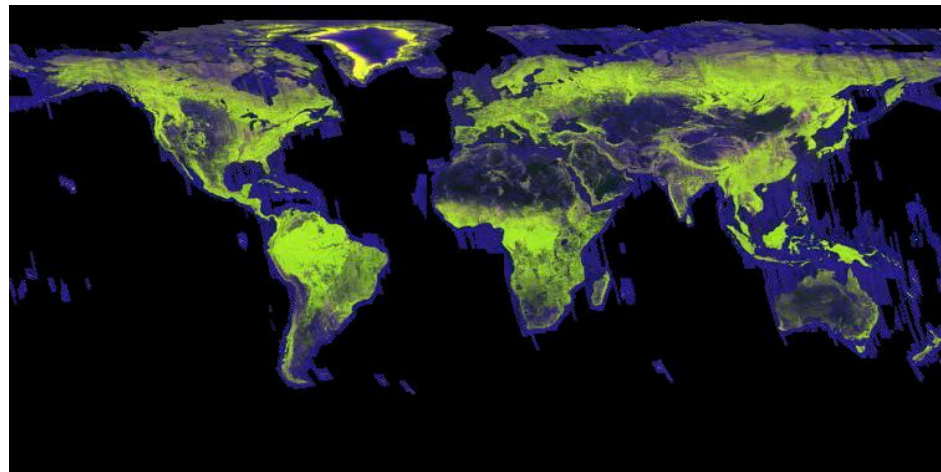
2007



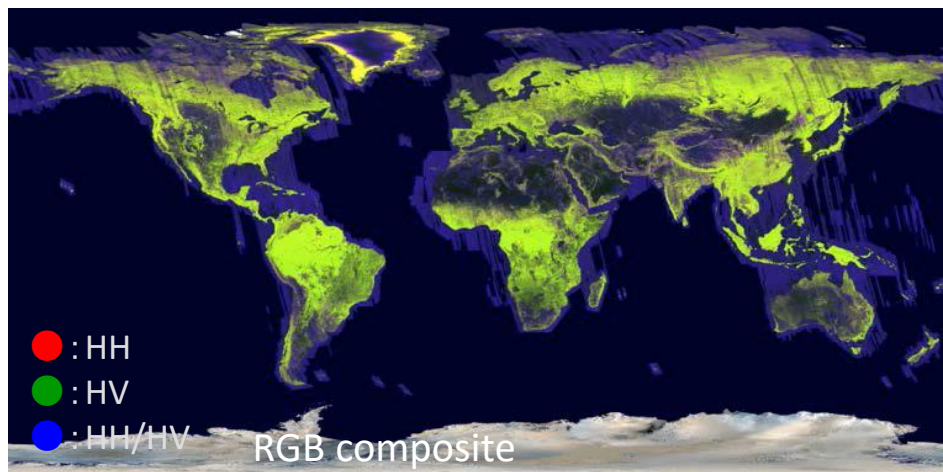
2008



2009



2010

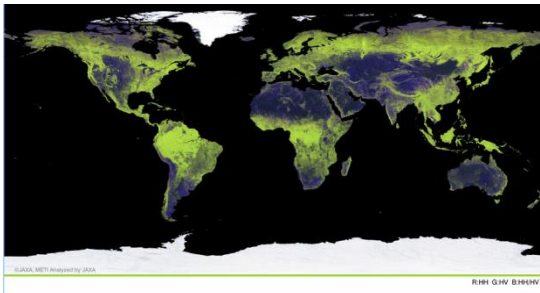


Global 25 m mosaics PALSAR and Forest/Non-forest dataset

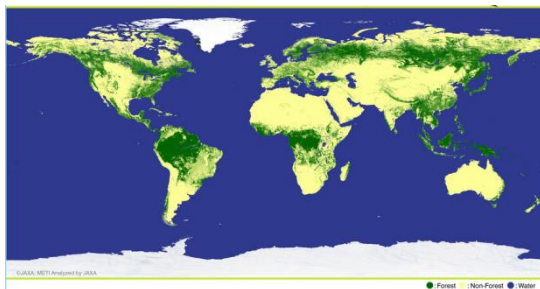
- Access to “New global 25m-resolution PALSAR mosaic and forest/non-forest map (2007-2010)”

http://www.eorc.jaxa.jp/ALOS/en/palsar_fnf/fnf_index.htm

- Data you can get
 - PALSAR 25m Mosaic



- Forest Non-Forest Map (25m and 100m)



Contained data:
PALSAR HH, HV backscatter

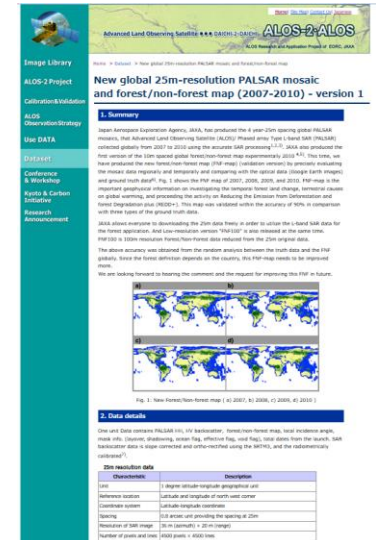
Forest/Non-Forest Map

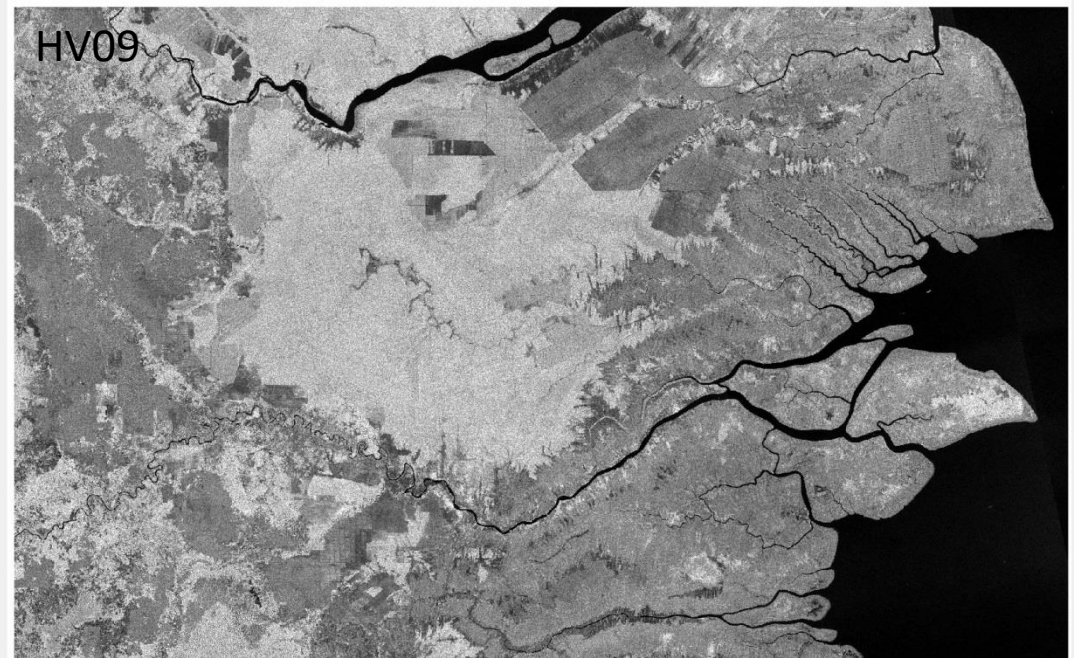
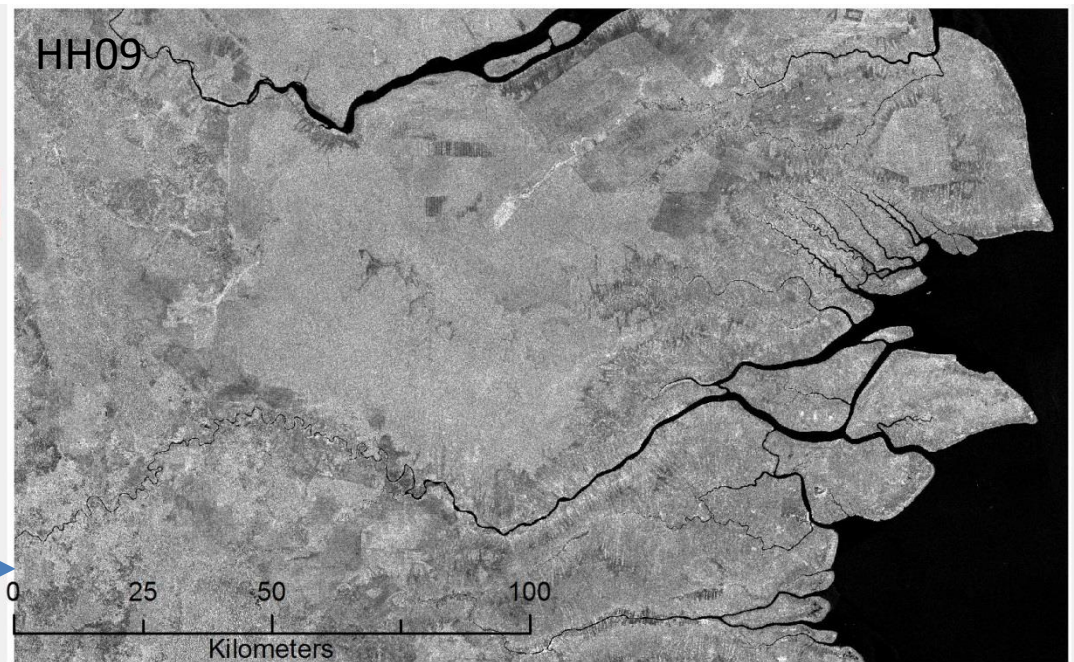
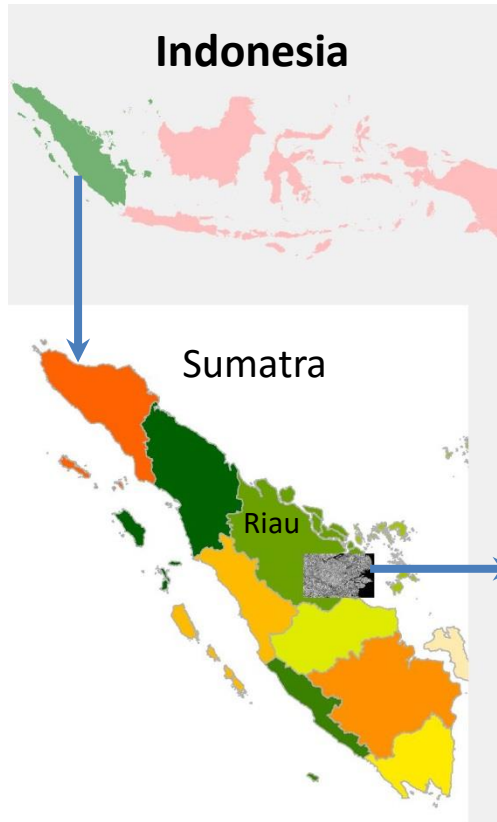
Local incidence angle

Mask info. (layover, shadowing, ocean flag, effective flag, void flag)

Total dates from the launch

✂ backscatter data is slope corrected and ortho-rectified using the SRTM3.





Data for exercise:
PALSAR 25m
Mosaic (2009)

Ground truth data

| | A | B | C | D | E | F | |
|----|--------------|----------------|-----------|-----|-----|----|--|
| 1 | # Latitude | Longitude | ClassName | R | G | B | |
| 2 | # Forest | 0 | 155 | 0 | | | |
| 3 | 0-18'48.00"N | 102-40'5.60"E | Forest | 0 | 155 | 0 | |
| 4 | 0-16'40.00"N | 102-33'29.60"E | Forest | 0 | 155 | 0 | |
| 5 | 0-4'16.00"N | 102-31'43.20"E | Forest | 0 | 155 | 0 | |
| 6 | 0-7'48.80"S | 102-30'8.00"E | Forest | 0 | 155 | 0 | |
| 7 | 0-14'32.00"S | 102-37'55.20"E | Forest | 0 | 155 | 0 | |
| 8 | 0-17'48.00"S | 102-48'8.00"E | Forest | 0 | 155 | 0 | |
| 9 | 0-18'46.40"S | 103-40'5.60"E | Forest | 0 | 155 | 0 | |
| 10 | 0-34'11.20"S | 102-39'6.40"E | Forest | 0 | 155 | 0 | |
| 11 | 0-43'40.00"S | 102-20'59.20"E | Forest | 0 | 155 | 0 | |
| 12 | 0-44'26.40"S | 102-45'16.00"E | Forest | 0 | 155 | 0 | |
| 13 | | | | | | | |
| 14 | # Mangrove | 0 | 255 | 0 | | | |
| 15 | 0-20'19.20"N | 102-56'41.60"E | Mangrove | 0 | 255 | 0 | |
| 16 | 0-2'8.00"S | 103-39'32.80"E | Mangrove | 0 | 255 | 0 | |
| 17 | 0-2'11.20"N | 103-33'9.60"E | Mangrove | 0 | 255 | 0 | |
| 18 | 0-2'37.60"S | 103-32'53.60"E | Mangrove | 0 | 255 | 0 | |
| 19 | 0-6'49.60"S | 103-30'50.40"E | Mangrove | 0 | 255 | 0 | |
| 20 | 0-4'20.00"S | 103-26'29.60"E | Mangrove | 0 | 255 | 0 | |
| 21 | 0-7'8.80"S | 103-27'4.00"E | Mangrove | 0 | 255 | 0 | |
| 22 | 0-20'5.60"S | 103-46'12.00"E | Mangrove | 0 | 255 | 0 | |
| 23 | 0-29'39.20"S | 103-32'22.40"E | Mangrove | 0 | 255 | 0 | |
| 24 | 0-33'57.60"S | 103-25'39.20"E | Mangrove | 0 | 255 | 0 | |
| 25 | | | | | | | |
| 26 | # ReGrowth | 180 | 255 | 70 | | | |
| 27 | 0-20'30.40"N | 102-34'25.60"E | ReGrowth | 180 | 255 | 70 | |

GroundTruthData

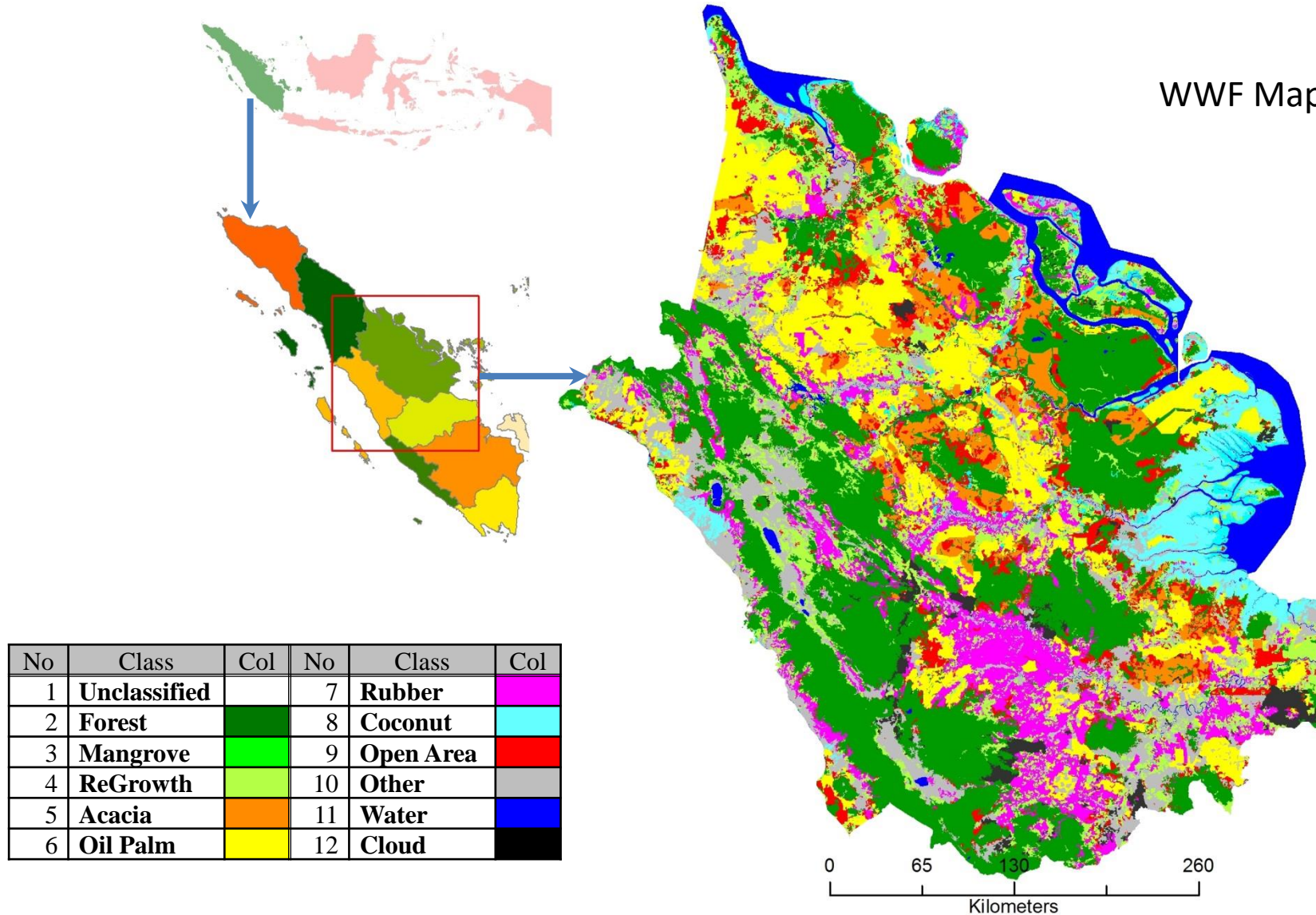
Ready

Software: more on segmentation and classification

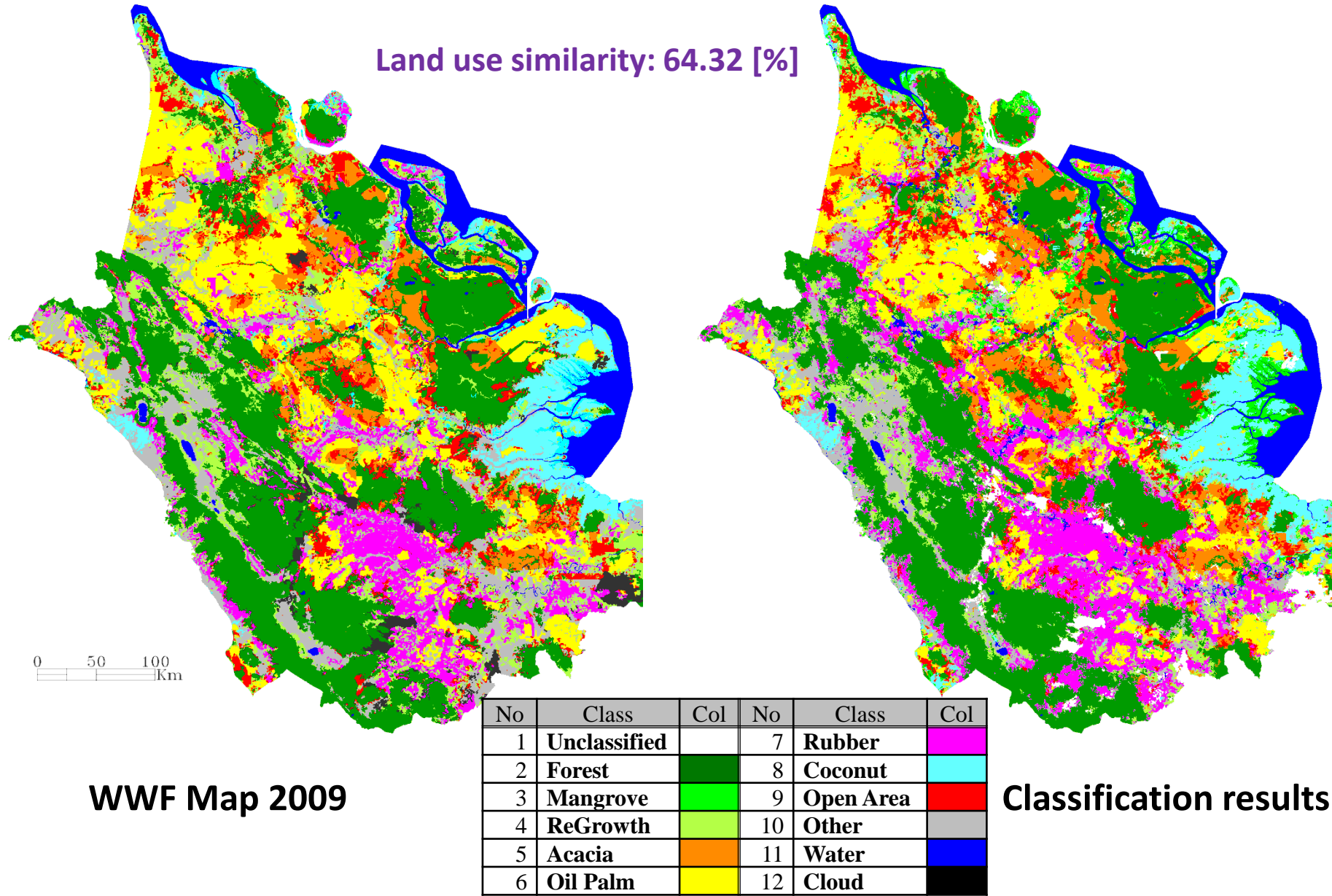
- **Segmentation** – region growing algorithm
- **Classifiers** – machine learning algorithms
 - Random Tree
 - Support Vector Machine
 - Multi-Layer Perceptron
 - Bayesian
 - Boosting

Example application: Classification experiment in Central Sumatra

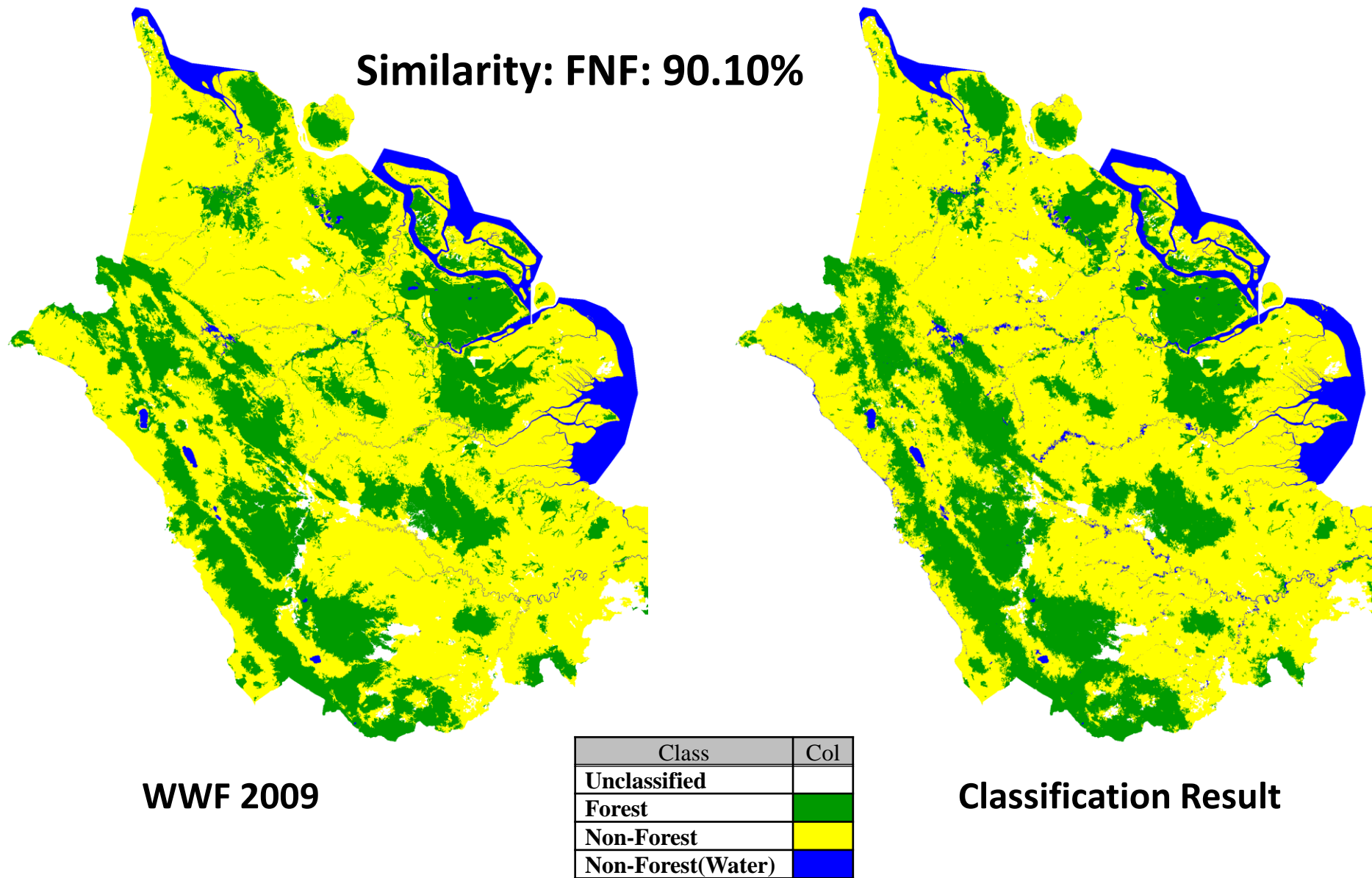
WWF Map 2009



Example application: Classification results using random tree



Example application: Classification results using random tree

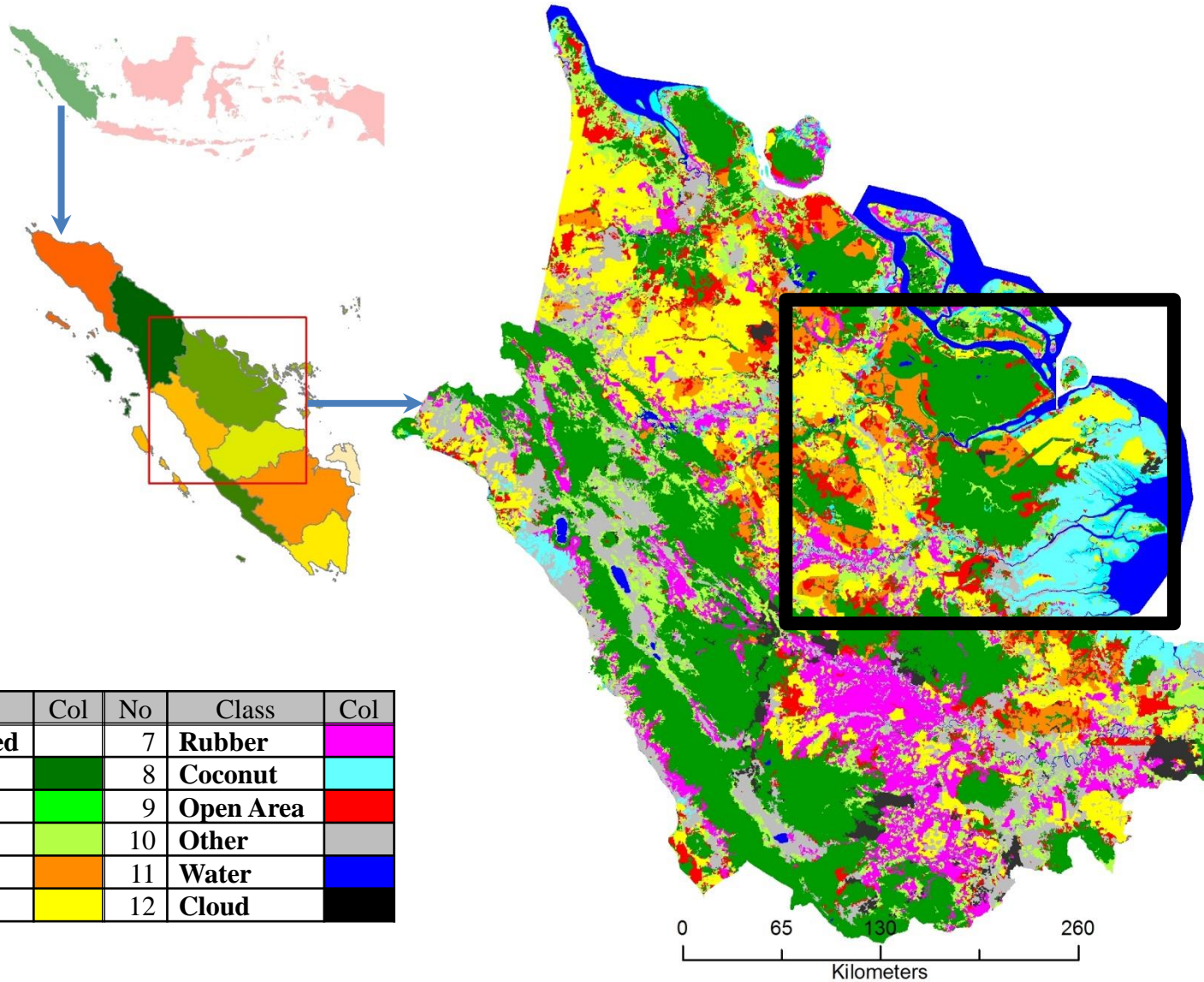


Classification results comparison by classifier types

| Classifier | Classification Accuracy [%] | | Processing Time for Classification [min] |
|---------------------|-----------------------------|--------------|--|
| | 10classes | FNF | |
| SVM | 58.15 | 88.42 | 2989 |
| Bayes | 55.97 | 86.36 | 27 |
| Decision Tree | 42.98 | 76.50 | 2 |
| Boosting | 48.11 | 85.64 | 45 |
| Random Trees | 64.32 | 90.10 | 58 |
| MLP | 57.31 | 88.77 | 966 |
| Subspace | 44.89 | 85.05 | 623 |
| Nearest Neighbor | 49.41 | 86.58 | - |

- ① PALSAR Data: HH & HV for 2007, 2008, 2009, and SRTM3, File size: 1.2 GB/file)
- ② Classes: natural forest, mangrove, re-growth, acacia, oil palm, rubber, coconut, open area, other, and water
- ③ Supervisor number: 300 segments per class.
✕In case of Nearest Neighbor & Decision Tree, 10 segments per class.
- ② OpenCV software library = SVM, Bayes, Decision Tree, Boosting, Random Trees.
- ③ Subspace is original software.
- ④ Nearest Neighbor is included in eCognition software package.
- ⑤ Windows 7, 32bits, 4 GB RAM, CPU Intel Core (TM) i5 @2.3 GHz 2.3 GHz

Prospective application of ALOS 2: using Pi-SAR-L2 data



Prospective application of ALOS 2: using Pi-SAR-L2 data (R201)

HH (horizontal transmit and horizontal receive)

HV (horizontal transmit and vertical receive)

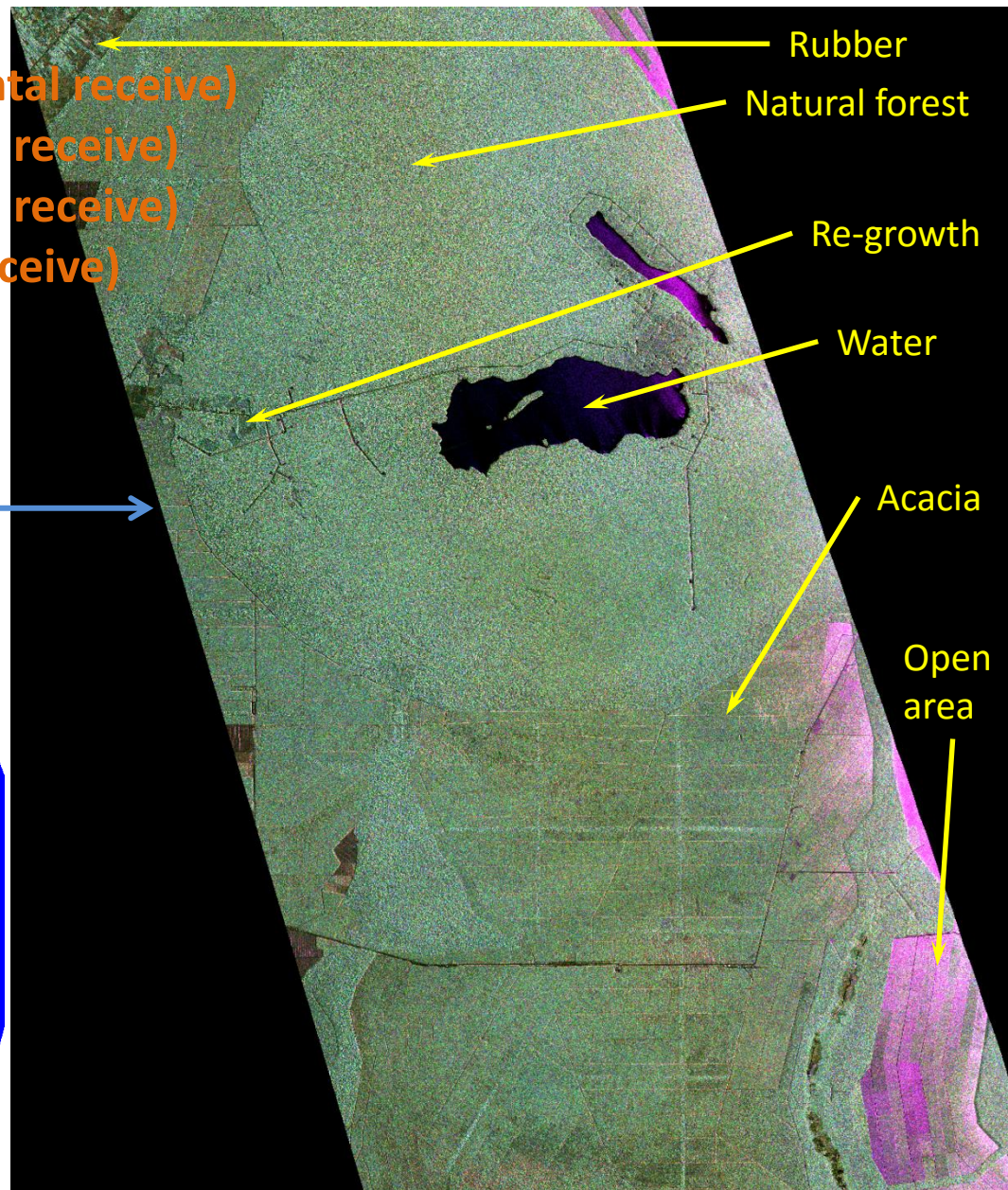
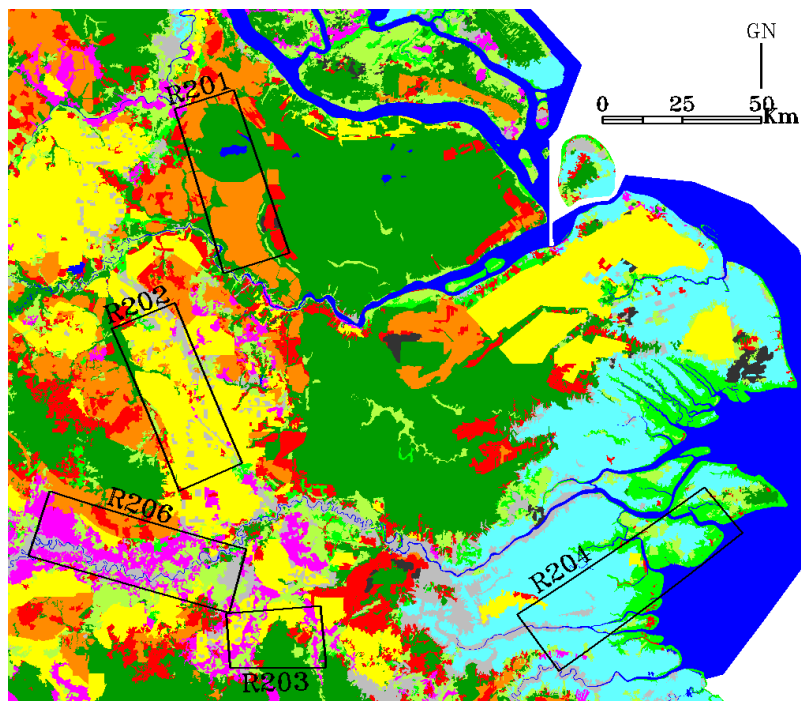
VH (vertical transmit and horizontal receive)

VV (vertical transmit and vertical receive)

Spatial resolution 3 meters

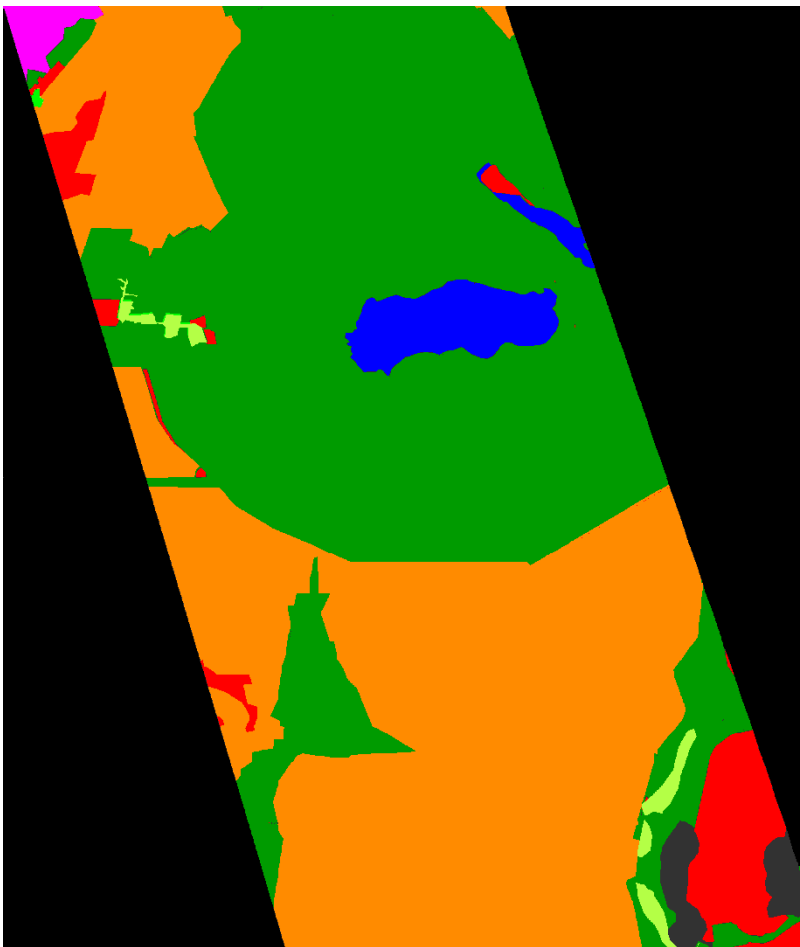
Color composite

R: HH, G: HV, B: VV

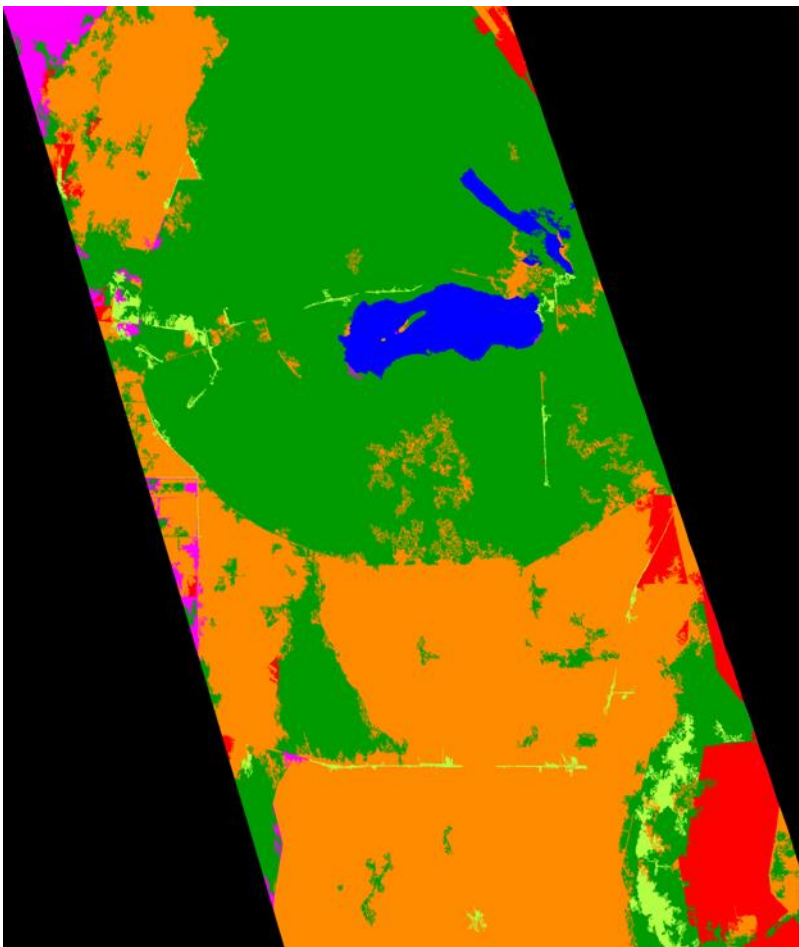


Prospective application of ALOS 2: R201 classification results using Random Tree

Similarity: Land Use : 88.21%



WWF 2009

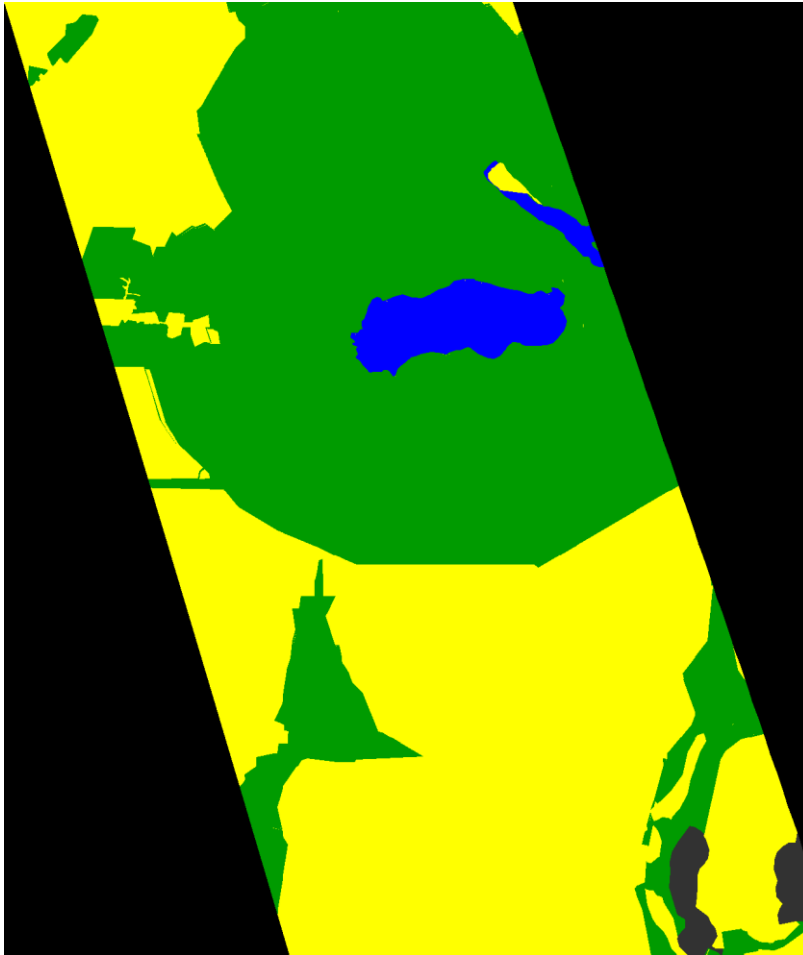


Classification Result
(Majority: Acacia & Peat-swamp forest)

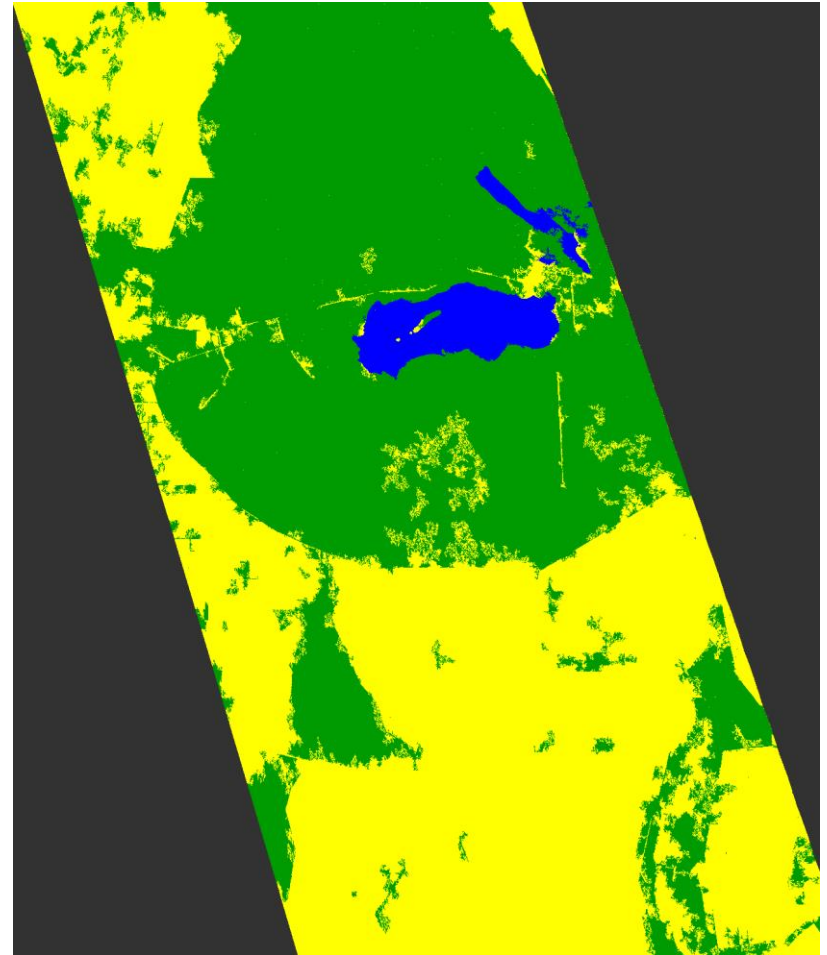
| No | Class | Col | No | Class | Col |
|----|--------------|-----|----|-----------|-----|
| 1 | Unclassified | | 7 | Rubber | |
| 2 | Forest | | 8 | Coconut | |
| 3 | Mangrove | | 9 | Open Area | |
| 4 | ReGrowth | | 10 | Other | |
| 5 | Acacia | | 11 | Water | |
| 6 | Oil Palm | | 12 | Cloud | |

Prospective application of ALOS 2: R201 classification results using Random Tree

Similarity: Forest/Non-forest: 90.61%



WWF 2009



Classification Result

| Class | Col |
|------------|--------|
| Forest | Green |
| Non-Forest | Yellow |
| Water | Blue |

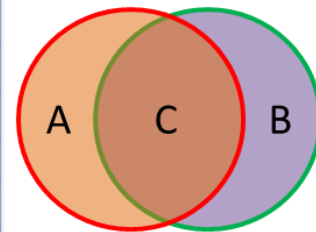
Prospective application of ALOS 2: R201 classification results using Random Tree

Confusion Matrix and Accuracies

Classification map

| Classes | Natural forest | Natural re-growth | Acacia | Rubber | Open area | Water | Producer's accuracy |
|-------------------|----------------|-------------------|---------------------|--------|-----------|---------|---------------------|
| Natural forest | 57517603 | 901394 | 3195497 | 521273 | 820945 | 743695 | 90.29% |
| Natural re-growth | 224877 | 725727 | 51007 | 5810 | 1 | 0 | 72.04% |
| Acacia | 4159583 | 449432 | 48272240 | 439091 | 934342 | 682 | 88.97% |
| Rubber | 70266 | 0 | 94 | 872456 | 2610 | 6 | 92.28% |
| Open area | 663901 | 100930 | 936244 | 73766 | 3933916 | 1068 | 68.90% |
| Water | 854474 | 40529 | 66755 | 7665 | 25 | 2916622 | 75.05% |
| User's accuracy | 90.59% | 32.72% | 91.91% | 45.44% | 69.12% | 79.64% | 88.21% |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| Classes | Forest | Non-forest | Producer's accuracy | | | | |
| Forest | 57517603 | 6182804 | 90.29% | | | | |
| Non-forest | 5973101 | 59831018 | 90.92% | | | | |
| User's accuracy | 90.59% | 90.63% | 90.61% | | | | |
| | | | | | | | |

Reference Classification



$$PA = C/A + C$$

$$UA = C/B + C$$

$$OA = C/A + B + C$$

Note:

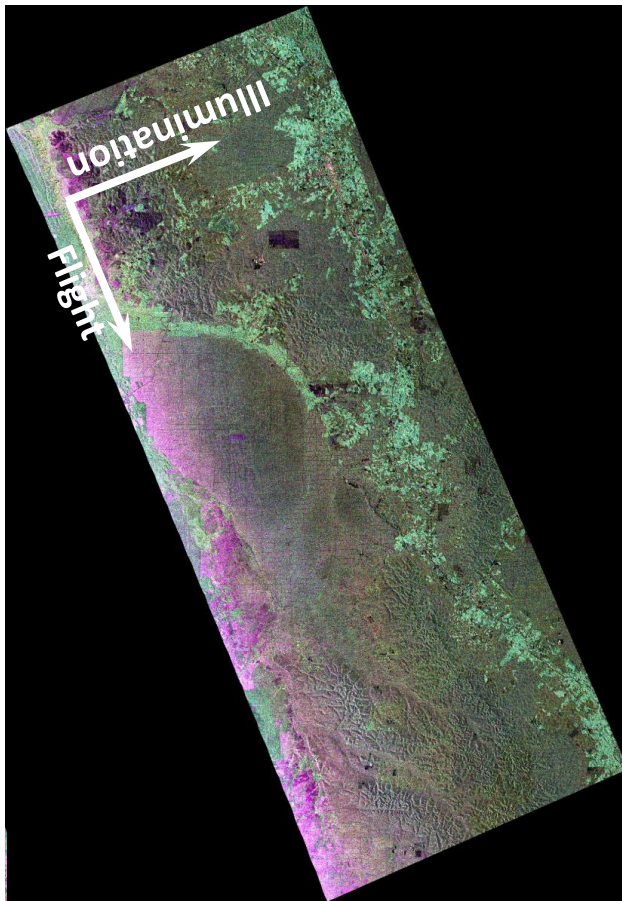
PA = Producer's Accuracy

UA = User's Accuracy

OA = Overall Accuracy

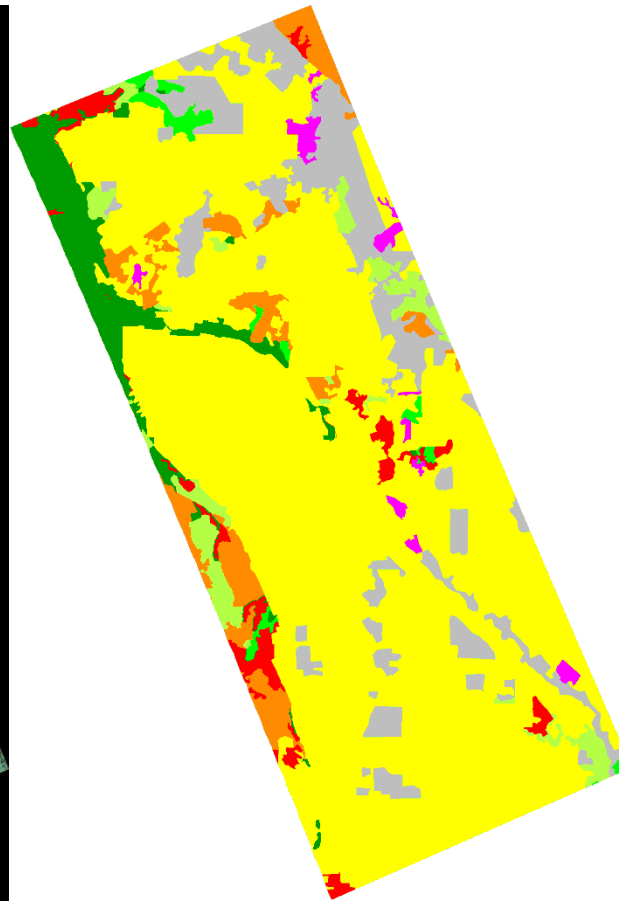
Overall accuracy

Prospective application of ALOS 2: R202 classification results using Random Tree

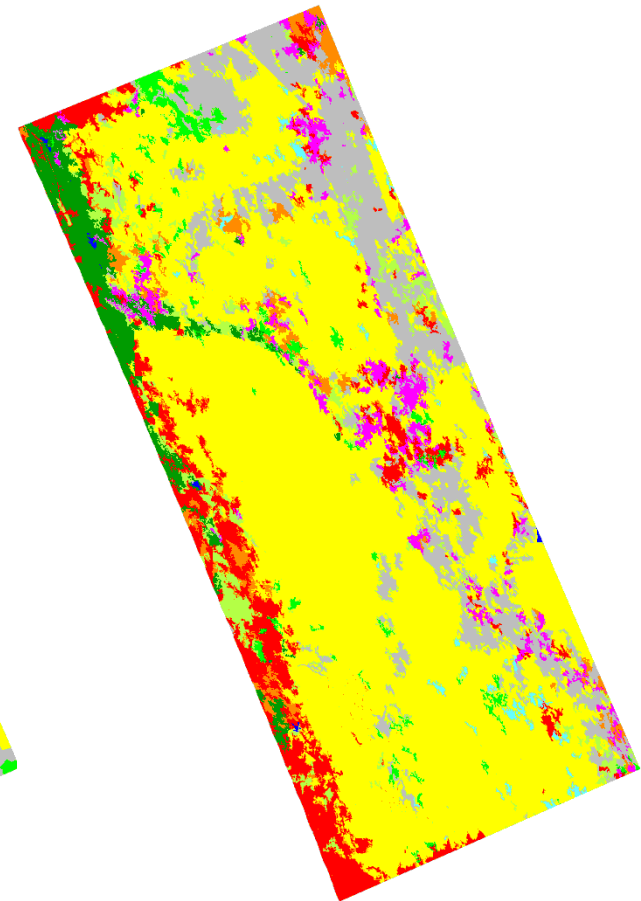


Pi-SAR-L2(HH:HV:VV)

| No | Class | Col | No | Class | Col |
|----|--------------|-----|----|-----------|-----|
| 1 | Unclassified | | 7 | Rubber | |
| 2 | Forest | | 8 | Coconut | |
| 3 | Mangrove | | 9 | Open Area | |
| 4 | ReGrowth | | 10 | Other | |
| 5 | Acacia | | 11 | Water | |
| 6 | Oil Palm | | 12 | Cloud | |



WWF Map 2009



Classification result
(Majority: Oilpalm)

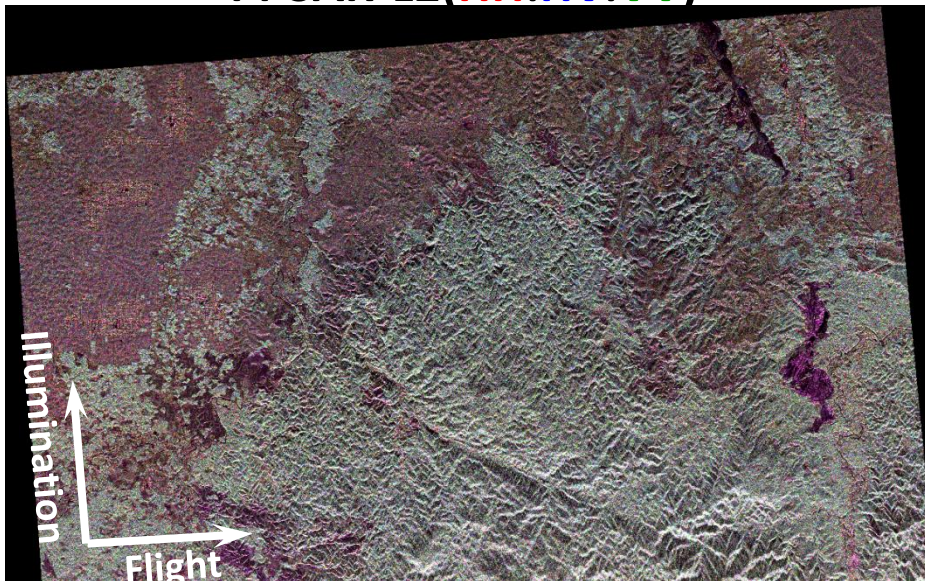
【Spatial similarity】

Land use : 72.23 [%]

Forest/Non-forest: 96.66 [%]

Prospective application of ALOS 2: R203 classification results using Random Tree

Pi-SAR-L2(HH:HV:VV)

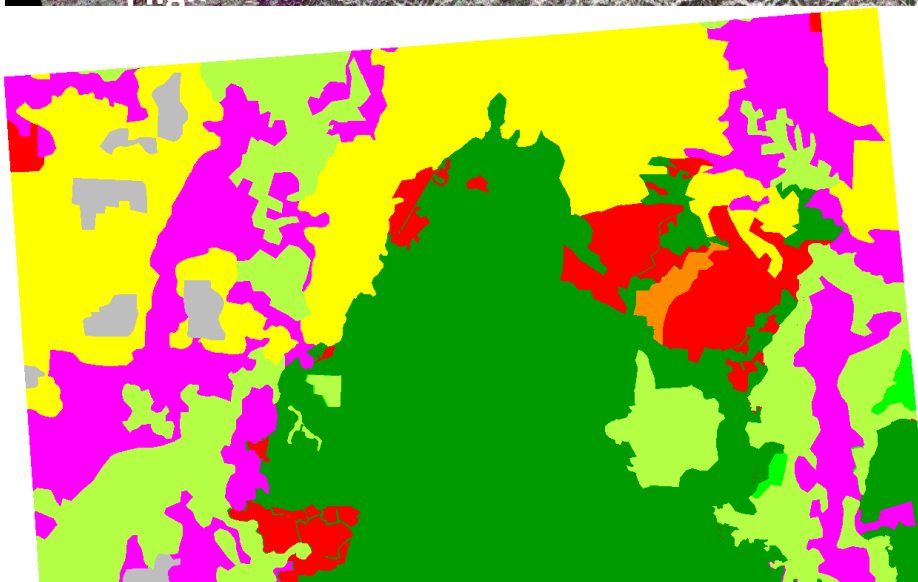


| No | Class | Col | No | Class | Col |
|----|--------------|-----|----|-----------|-----|
| 1 | Unclassified | | 7 | Rubber | |
| 2 | Forest | | 8 | Coconut | |
| 3 | Mangrove | | 9 | Open Area | |
| 4 | ReGrowth | | 10 | Other | |
| 5 | Acacia | | 11 | Water | |
| 6 | Oil Palm | | 12 | Cloud | |

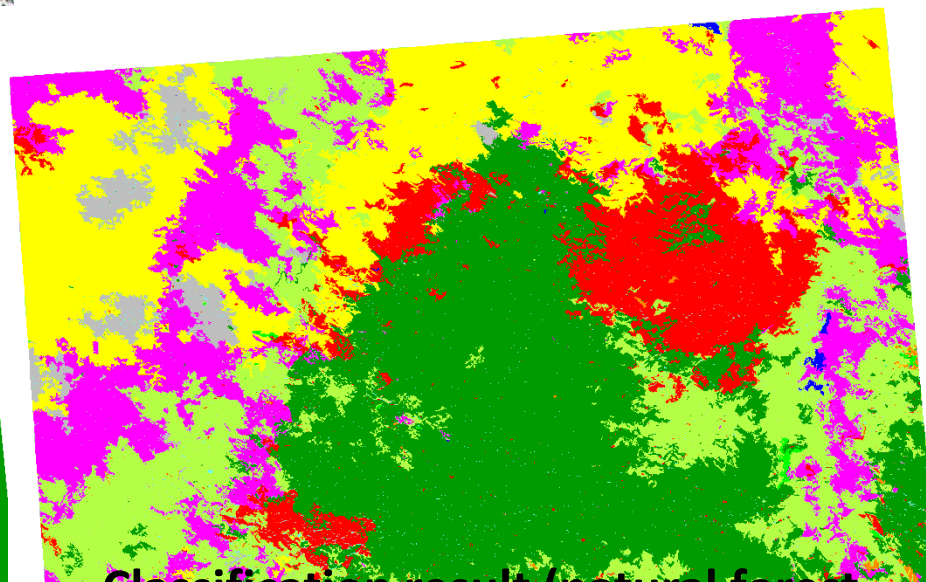
【Spatial similarity】

Land use : 75.46 [%]

Forest/Non-forest : 91.08 [%]

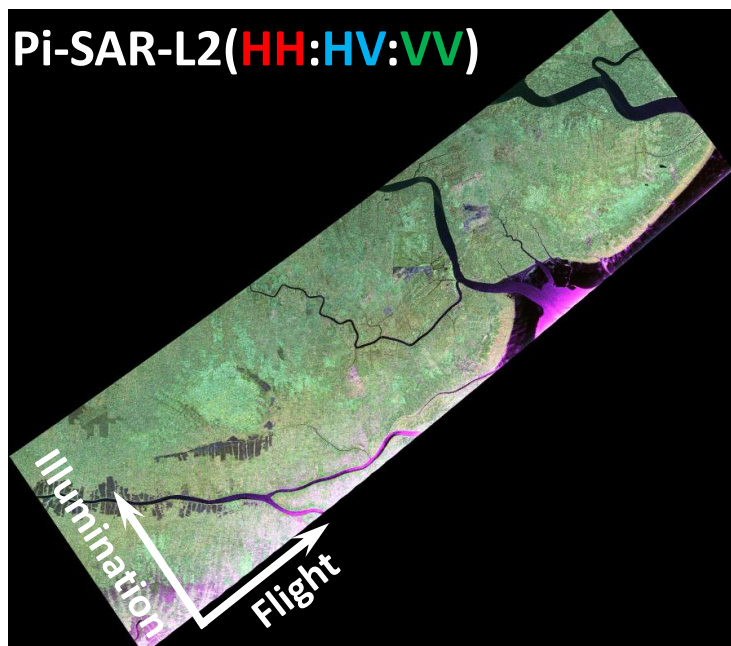


WWF Map 2009



Classification result (natural forest,
rubber and oil-palm)

Prospective application of ALOS 2: R204 classification results using Random Tree

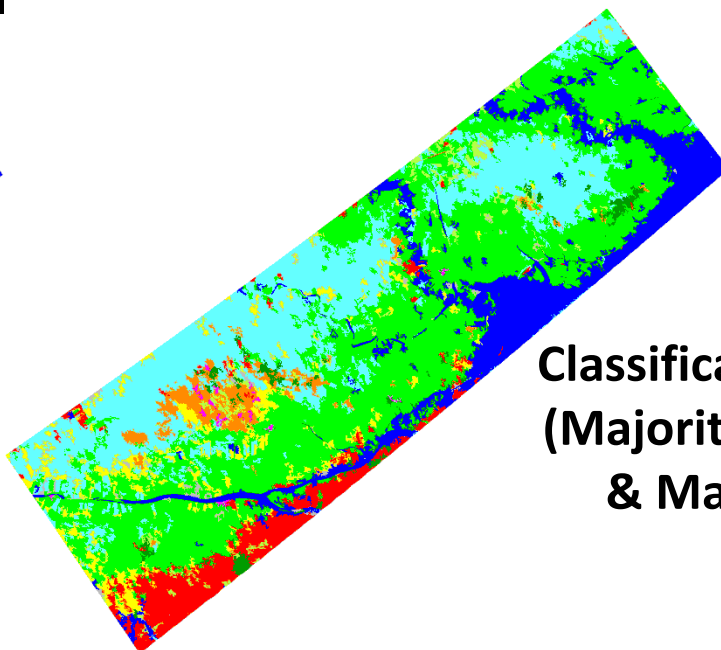
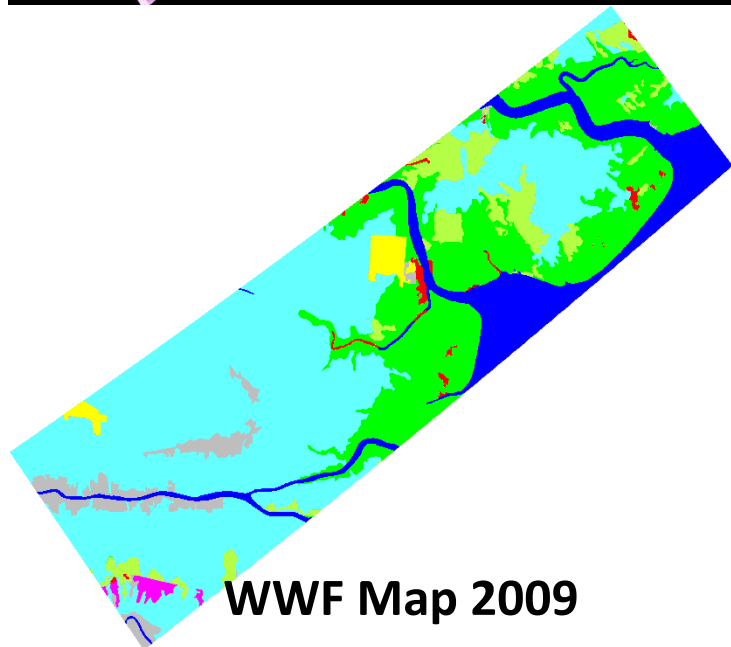


| No | Class | Col | No | Class | Col |
|----|--------------|-----|----|-----------|-----|
| 1 | Unclassified | | 7 | Rubber | |
| 2 | Forest | | 8 | Coconut | |
| 3 | Mangrove | | 9 | Open Area | |
| 4 | ReGrowth | | 10 | Other | |
| 5 | Acacia | | 11 | Water | |
| 6 | Oil Palm | | 12 | Cloud | |

【Spatial similarity】

Land use : 51.89 [%]

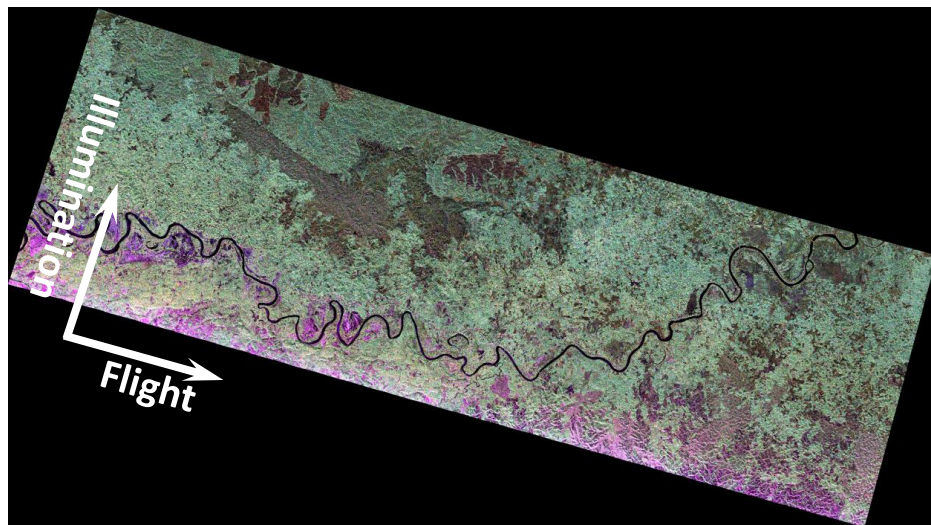
Forest/Non-forest : 98.69 [%]



Classification result
(Majority: Coconut
& Mangrove)

Prospective application of ALOS 2: R206 classification results using Random Tree

Pi-SAR-L2(HH:HV:VV)



| No | Class | Col | No | Class | Col |
|----|--------------|-----|----|-----------|-----|
| 1 | Unclassified | | 7 | Rubber | |
| 2 | Forest | | 8 | Coconut | |
| 3 | Mangrove | | 9 | Open Area | |
| 4 | ReGrowth | | 10 | Other | |
| 5 | Acacia | | 11 | Water | |
| 6 | Oil Palm | | 12 | Cloud | |

【Spatial similarity】

Land use : 53.75 [%]

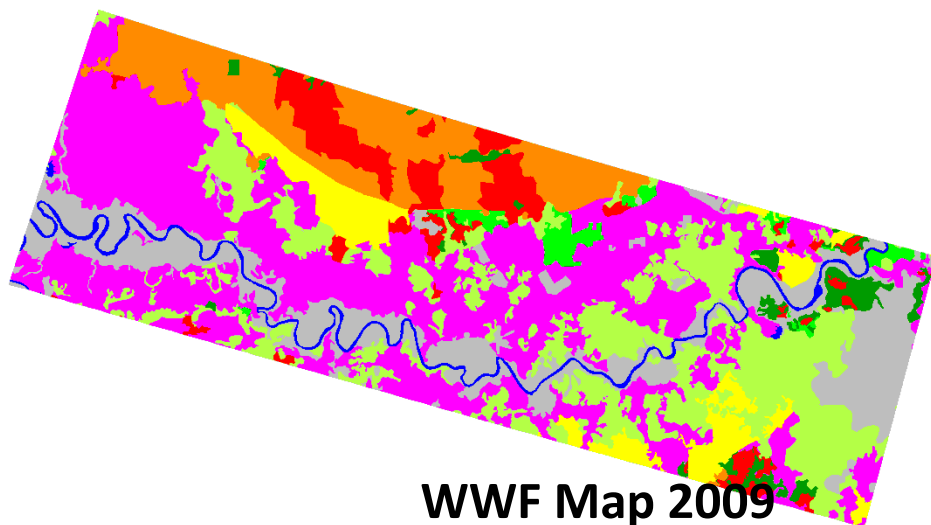
Forest/Non-forest : 96.38 [%]

=====

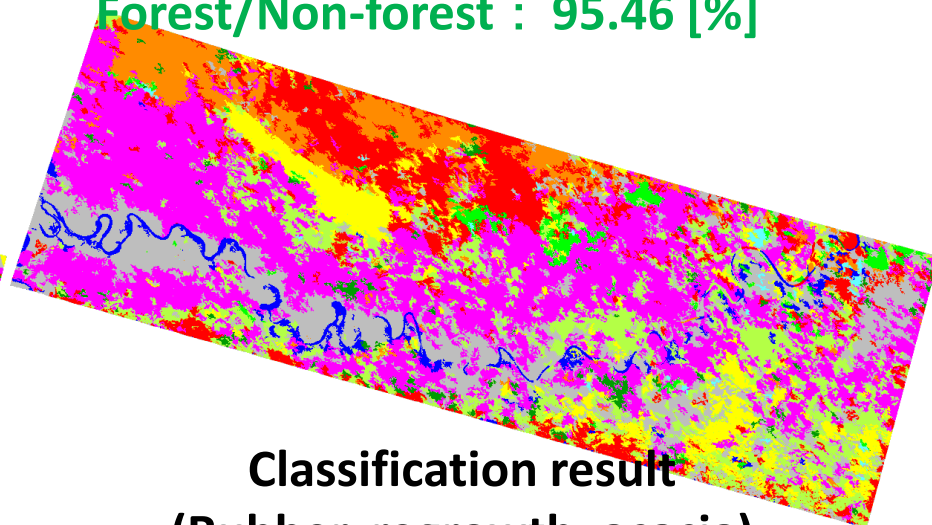
【Spatial similarity for all 5 paths】

Land use : 66.15[%]

Forest/Non-forest : 95.46 [%]



WWF Map 2009



Classification result
(Rubber, regrowth, acacia)

LUC Tool Update, training material and video?

http://www.eorc.jaxa.jp/ALOS-2/en/doc/pal2_tool.htm

JAXA SAR Workshops, trainings, K&C, Research Announcement...?

<http://www.eorc.jaxa.jp/ALOS/en/index.htm>

Free ALOS data

http://www.eorc.jaxa.jp/ALOS/en/dataset/dataset_index.htm

Using the tool for commercial and profit-making purposes without JAXA's consent is prohibited. If users wish to use the tool for such purposes, please make contact us at the following address.

JAXA EORC ALOS/ALOS-2 group: aproject@jaxa.jp

The usage of the tool is introduced at our training courses. For details, please find the following page (http://www.eorc.jaxa.jp/ALOS/en/conf/conf_index.htm).

New! Video tutorial: Let's SAR Land use and land cover classification.



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PALSAR Applications:

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Hands on practice: LUC Tool

Questions/comments