Remote Sensing Method in Implementing REDD+

FRIM-FFPRI Research on Development of Carbon Monitoring Methodology for REDD+ in Malaysia

Remote Sensing Component

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FRIM-FFPRI Training Workshop on REDD+ Research Project in Peninsular Malaysia

10 February 2015

XCape Resort, Taman Negara Kuala Tahan, Pahang

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Forest Research Institute Malaysia

ISO 9001 : 2008

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Introduction

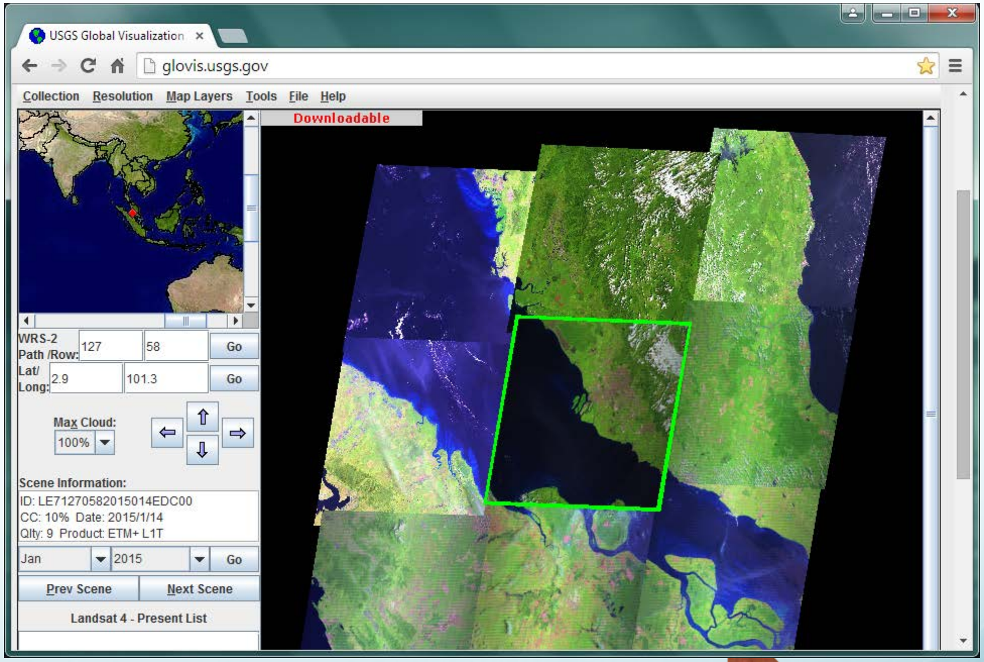
- REDD+ is a mechanism for providing financial rewards to countries that reduce carbon emissions caused by deforestation and forest degradation.
- Payments for avoided deforestation and forest degradation. Implementation requires comparison of actual forest change rates and the associated emissions, to a baseline.
- Remote sensing technology is expected to play a significant role as a transparent, replicable and long–term monitoring systems that needed for REDD+.
- This technology can be an essential data source, providing regular data that contribute to estimations of state and trends, including historical trends, of land use and carbon density in the landscape level.

Objectives

- The aims of this component, through some technical image processing and sampling can be explained as follow:
  - Identify an appropriate method for landuse classification
  - Design an effective sampling scheme of the ground truth for classification
- These objectives is being supported by some remote sensing ground survey sampling, and images processing.

Study Area & Data

- Study area
  - 4 scenes of Landsat Images (Path 126–127, Row 057–058) over Peninsular Malaysia, covering Kelantan, Terengganu, Pahang, Johor, Melaka, Negeri Sembilan, Selangor and Perak.
- Data
  - USGS Landsat images
    - ~ 200 images taken in 1990 – 2010
    - Cloud ≤ 50%
- Ground truths
  - ~ 100 field surveys
  - ~ 500 Google Earth interpretation



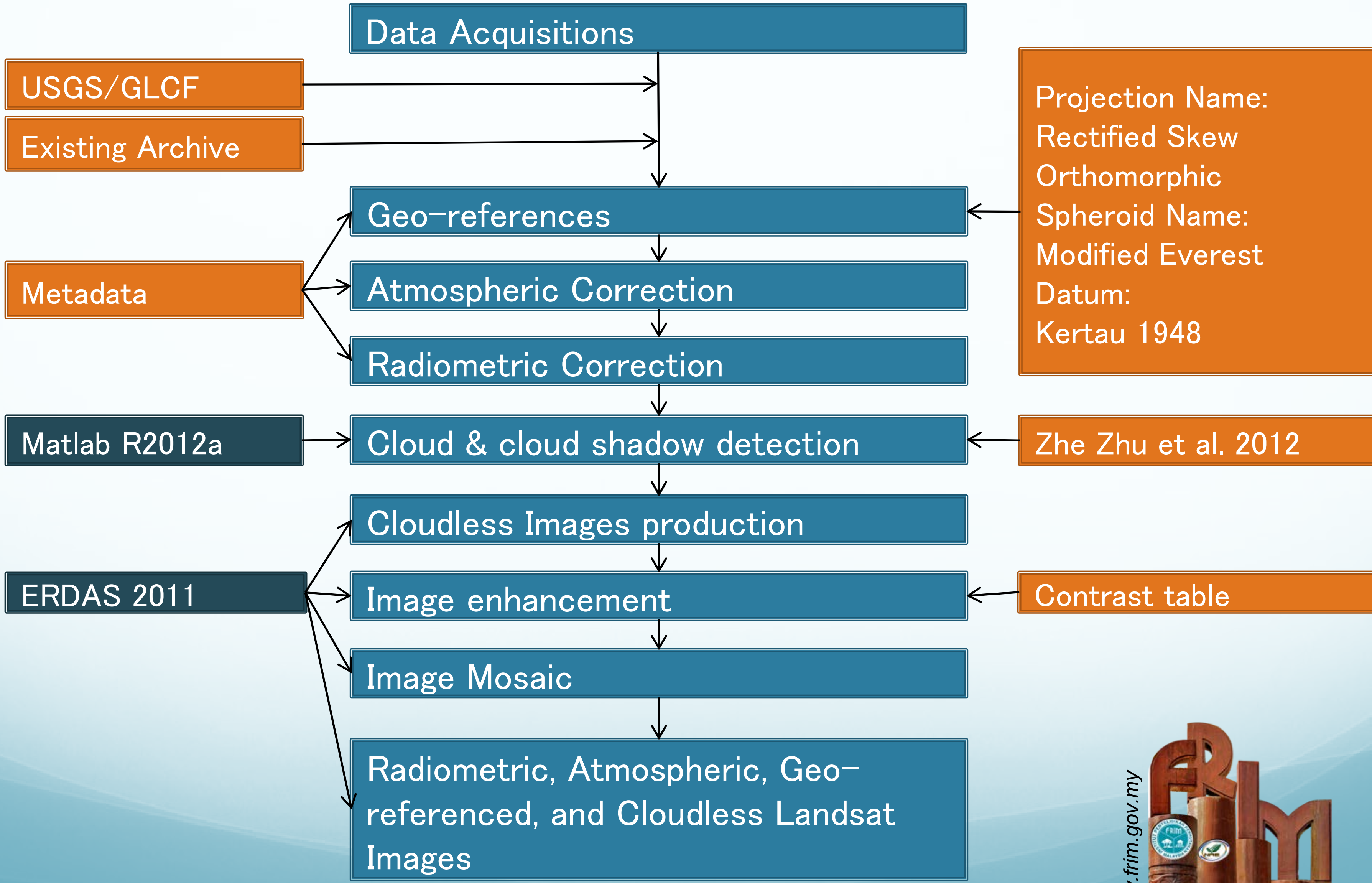
http://glovis.usgs.gov/

Methodology

Methodology : Remote Sensing data processing

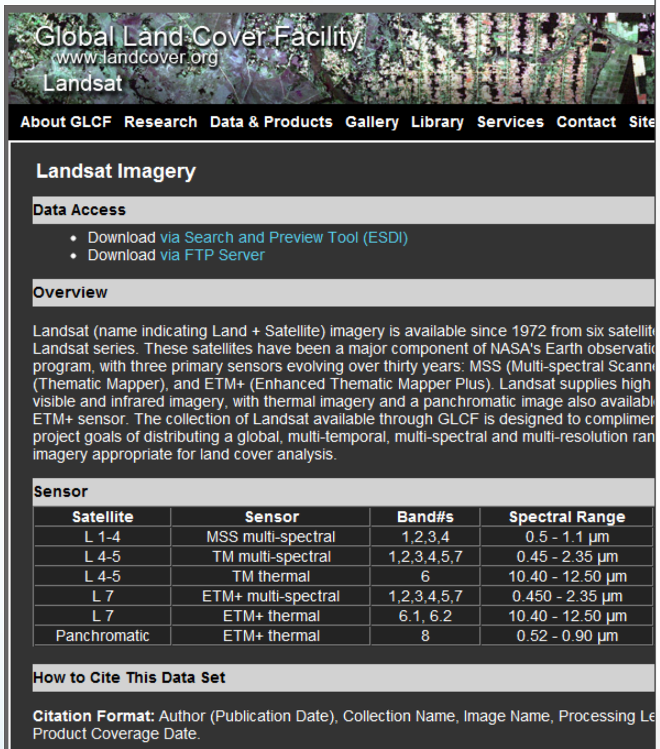
- Raw data Landsat TM & ETM can be download freely from http://glovis.usgs.gov/ – (.*tiff* format)
- Landsat data that provided 30m spatial resolution and 7 spectral bands is one of the most valuable datasets for studying landuse.
- Mostly covered by haze, cloud and cloud shadow especially in tropical area.
- Zhe Zhu et al. 2012 has successfully develop the Fmask algorithm to detect cloud and cloud shadow from Landsat Imagery.

- Data processing flow

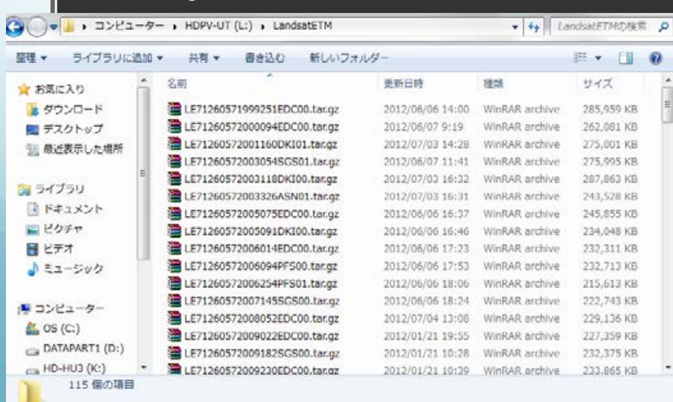


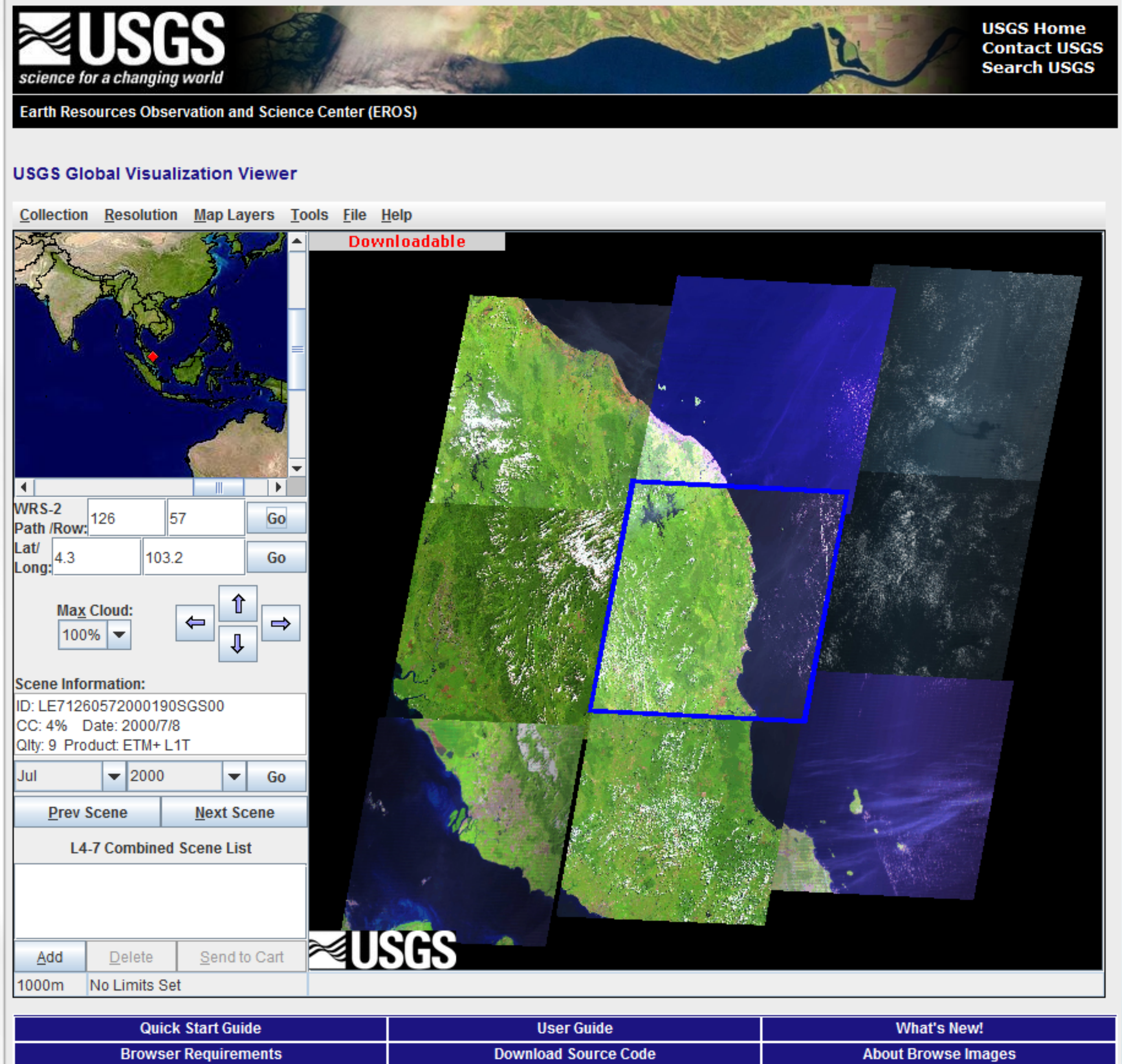
Data Acquisitions

1990,1992,1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010



Satellite	Sensor	Band#s	Spectral Range
L 1-4	MSS multi-spectral	1,2,3,4	0.5 - 1.1 µm
L 4-5	TM multi-spectral	1,2,3,4,5,7	0.45 - 2.35 µm
L 4-5	TM thermal	6	10.40 - 12.50 µm
L 7	ETM+ multi-spectral	1,2,3,4,5,7	0.450 - 2.35 µm
L 7	ETM+ thermal	6.1, 6.2	10.40 - 12.50 µm
Panchromatic	ETM+ thermal	8	0.52 - 0.90 µm





Total Landsat image (200):

- 126_057: 47
- 126_058: 48
- 127_057: 52
- 127_058: 53

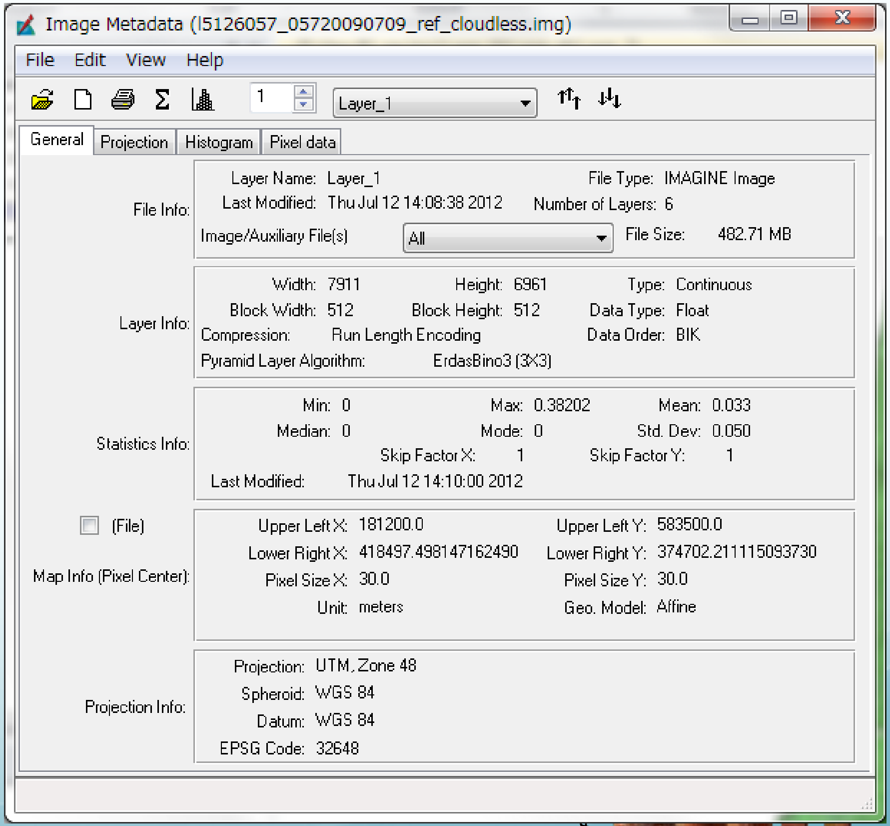
Geo-references image

Basically all the data from USGS & GLCF is already geo-referenced to standard world projection:

- Projection name: Universal Transverse Mercator (UTM)
- Spheroid name: WGS 84
- Datum name: WGS 84

Standard Peninsular Malaysia projection:

- Projection name: Rectified Skew Orthomorphic (RSO)
- Spheroid name: Modified Everest
- Datum name: Kertau 1948



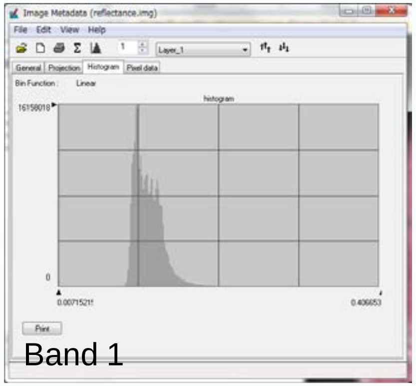
Raw Metadata

Radiometric & Atmospheric correction

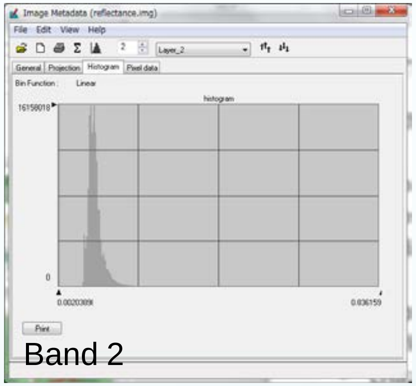
Using method that has been establish by Sergio M.V. et al 2008

- Radiometric correction
  - Conversion DN to satellite radiances
  - Radiances to TOA reflectance

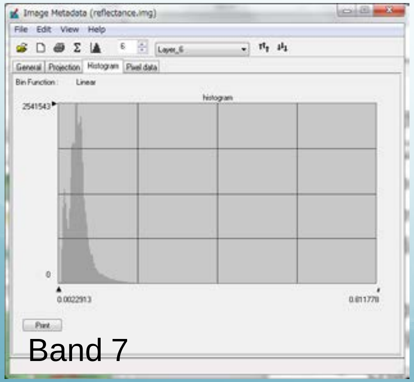
- Atmospheric correction
  - Dark Target Approach (DTA)
  - Lhaze from minimum radiances value



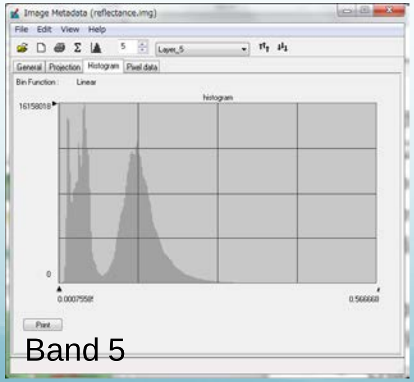
Band 1



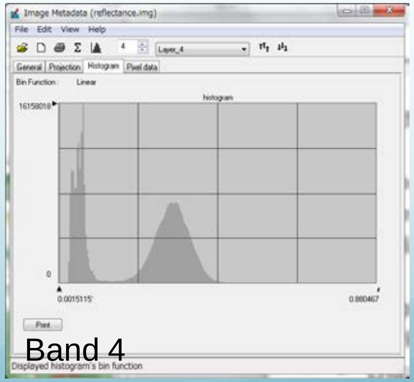
Band 2



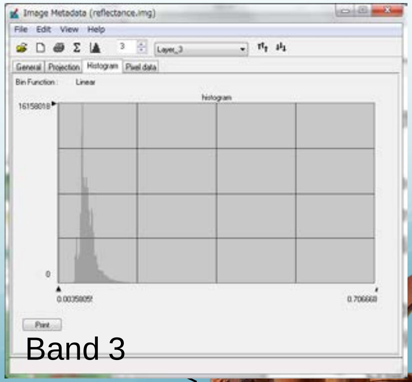
Band 7



Band 5



Band 4

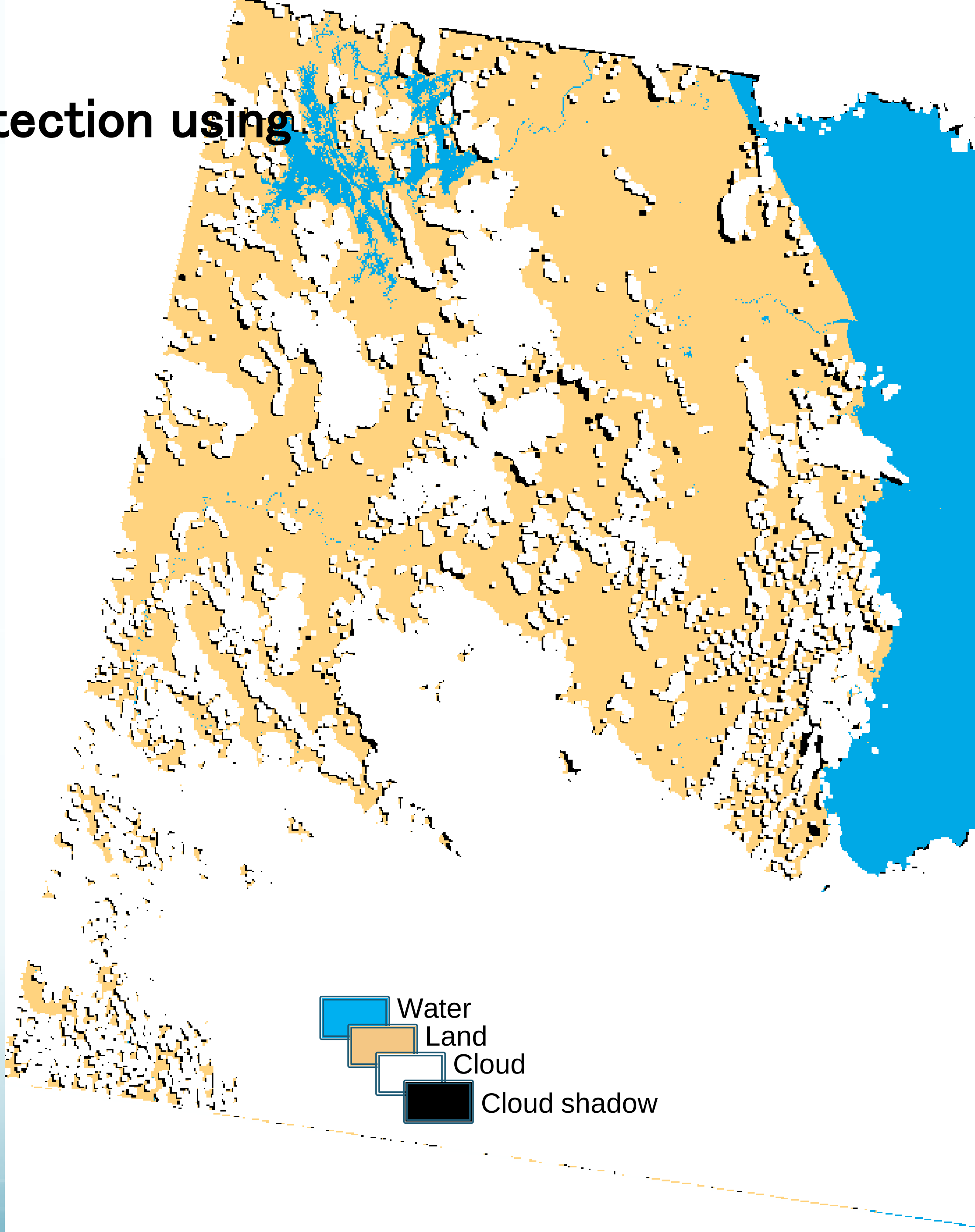


Band 3

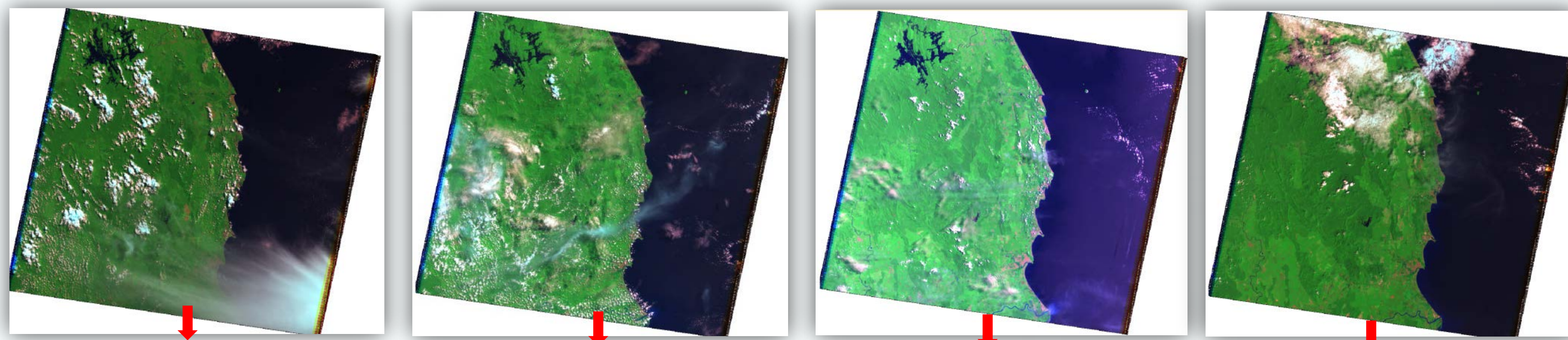
Cloud and cloud shadow detection using Matlab

Using Object-based cloud and cloud shadow detection by Zhe Zhu et al. 2012:

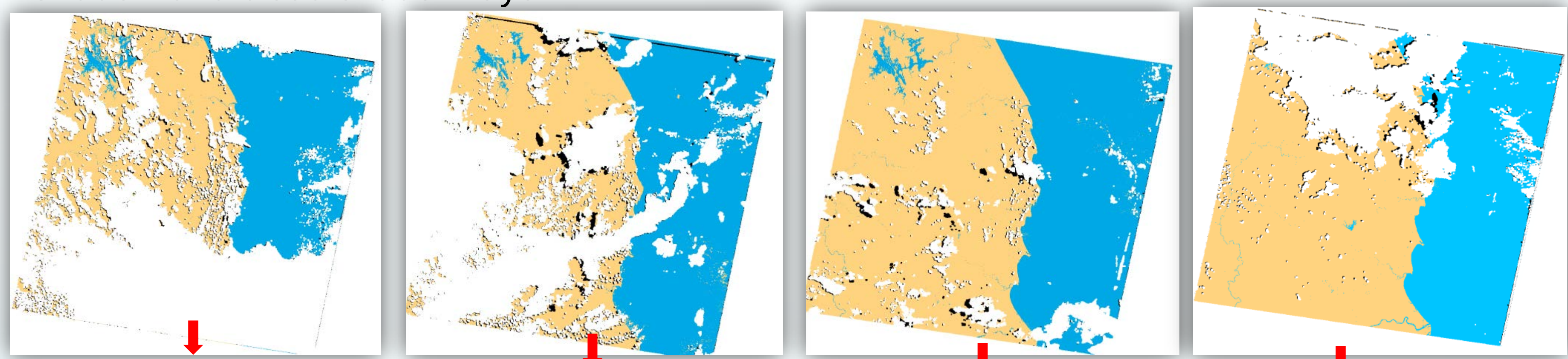
- Fmask algorithm
  - Potential cloud layer
  - Potential cloud shadow layer
- Buffer surrounding cloud and cloud shadow, 3 pixel (90m)



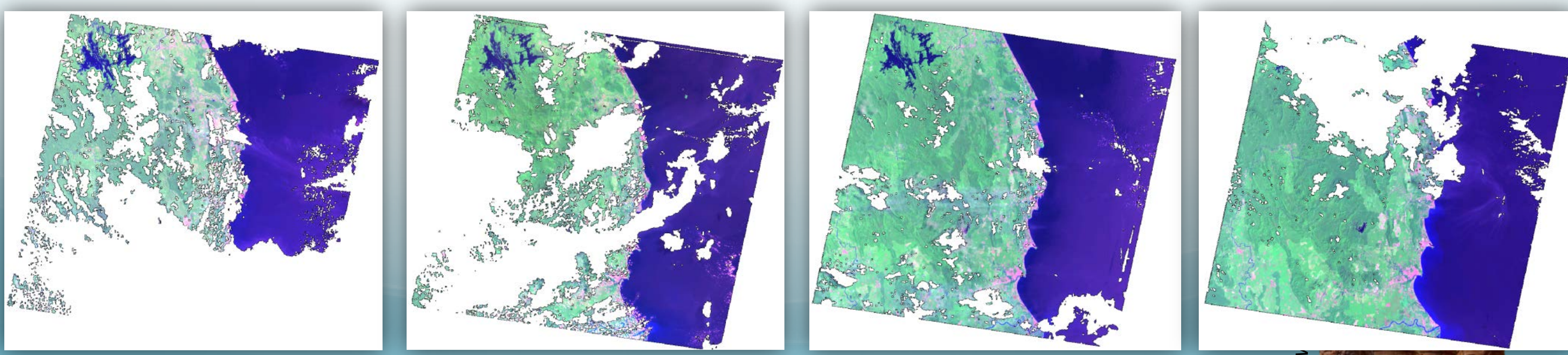
Landsat TM image (126_057)



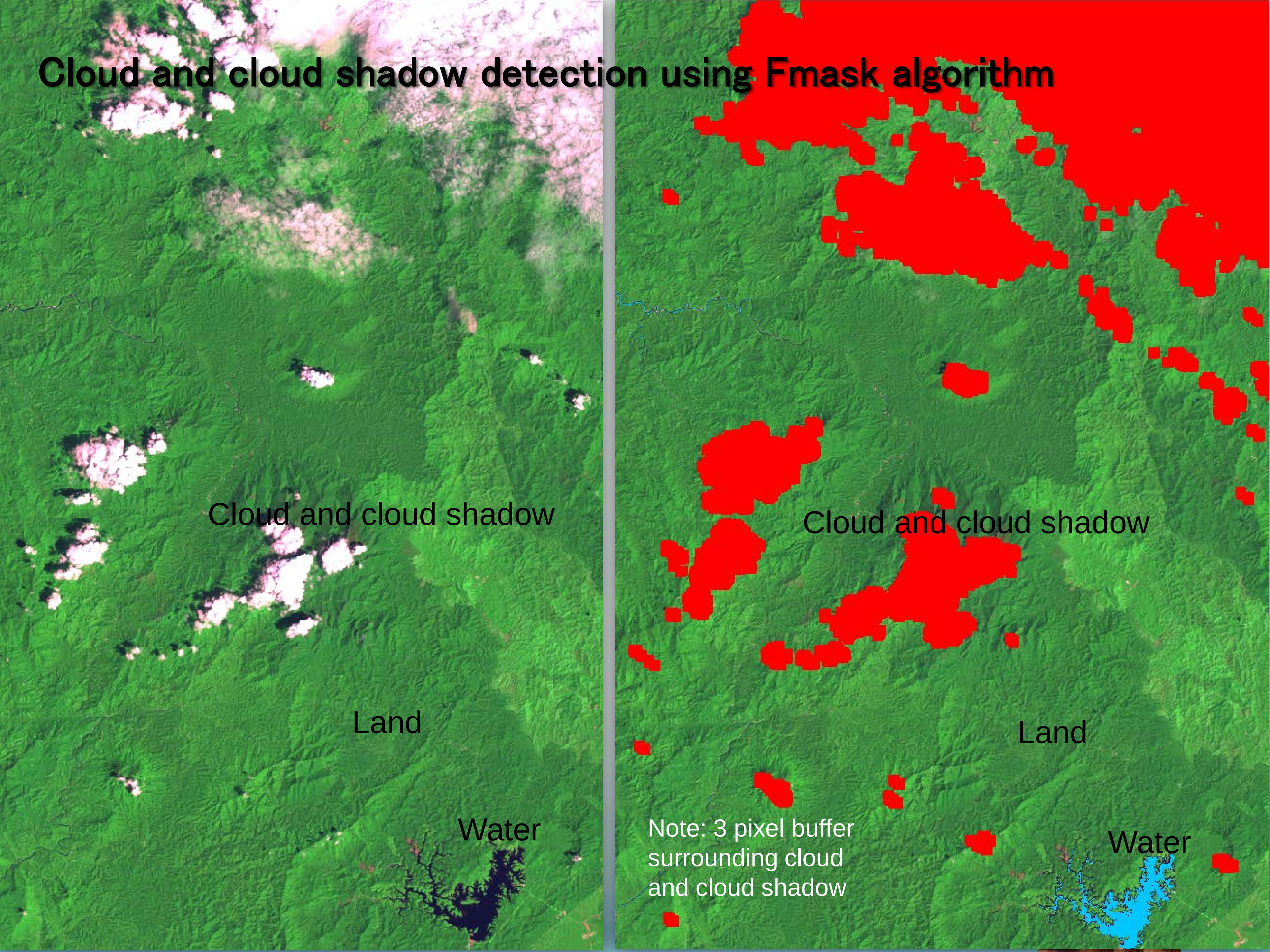
Shadow and cloud shadow layer



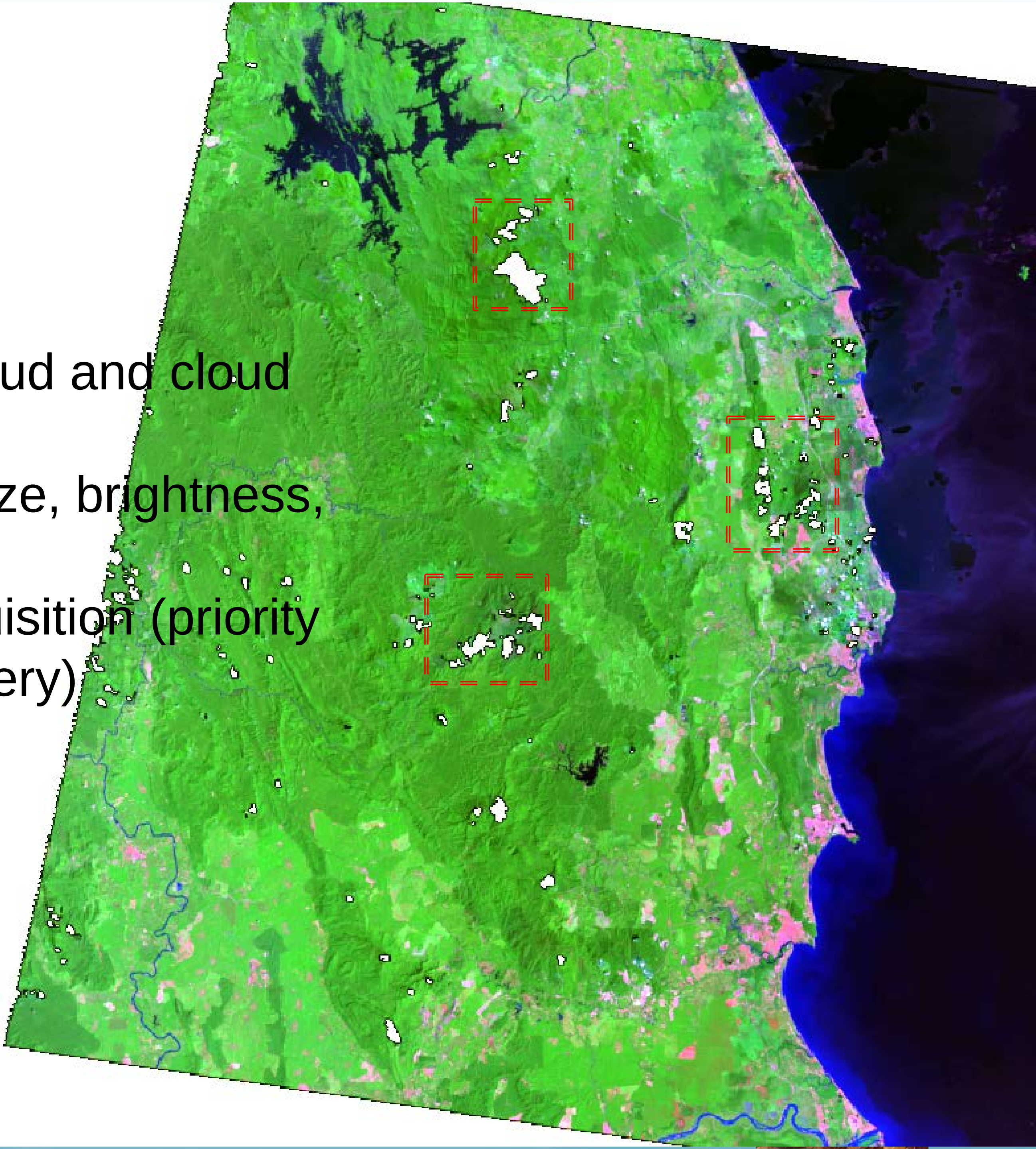
Cloudless, geocode, radiometric and atmospheric corrected image



Cloud and cloud shadow detection using Fmask algorithm



Mosaic Image

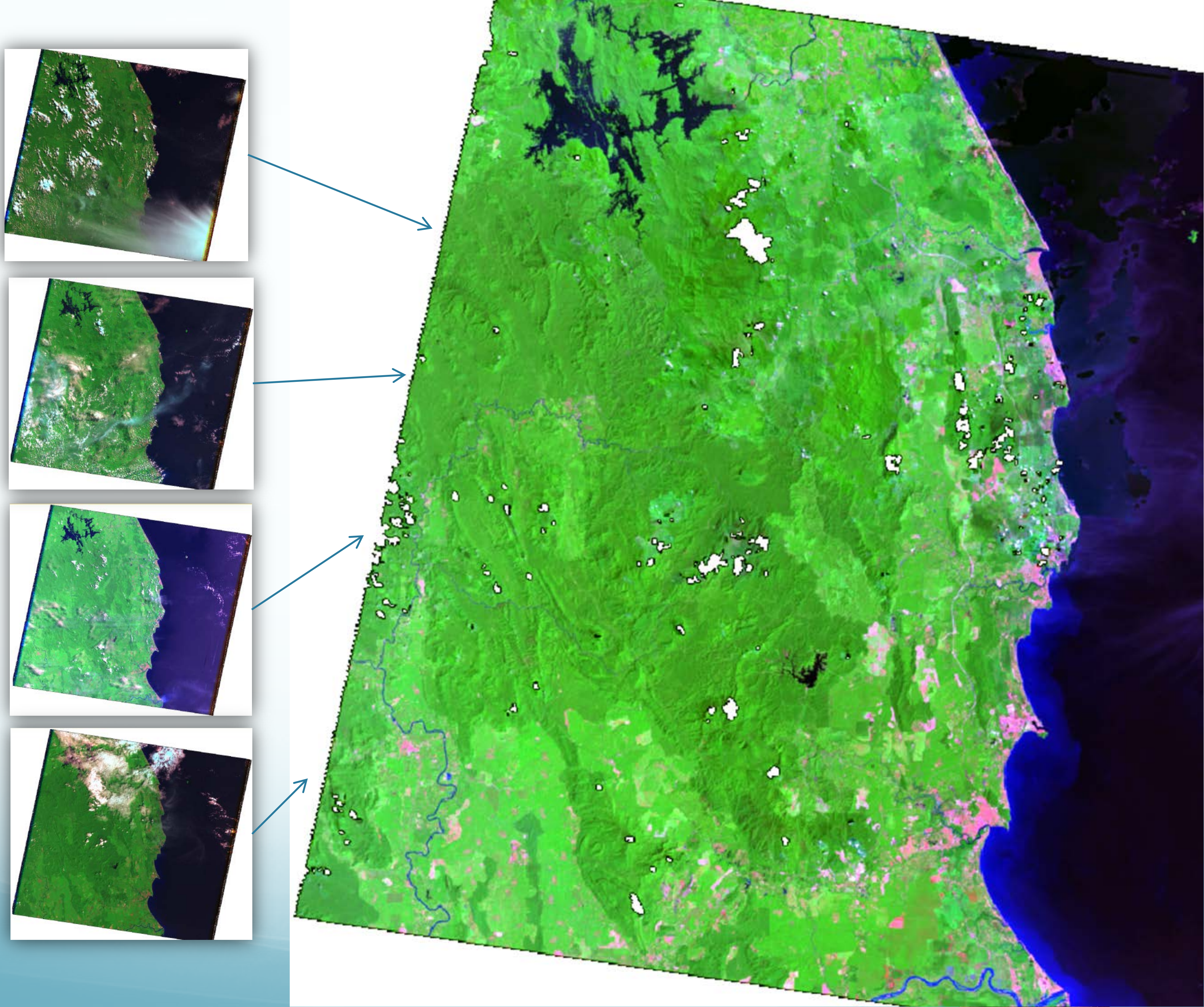


Selection Criteria:

1. Percentage of cloud and cloud shadow coverage
2. Image quality (haze, brightness, etc.,)
3. Date of data acquisition (priority to the latest imagery)

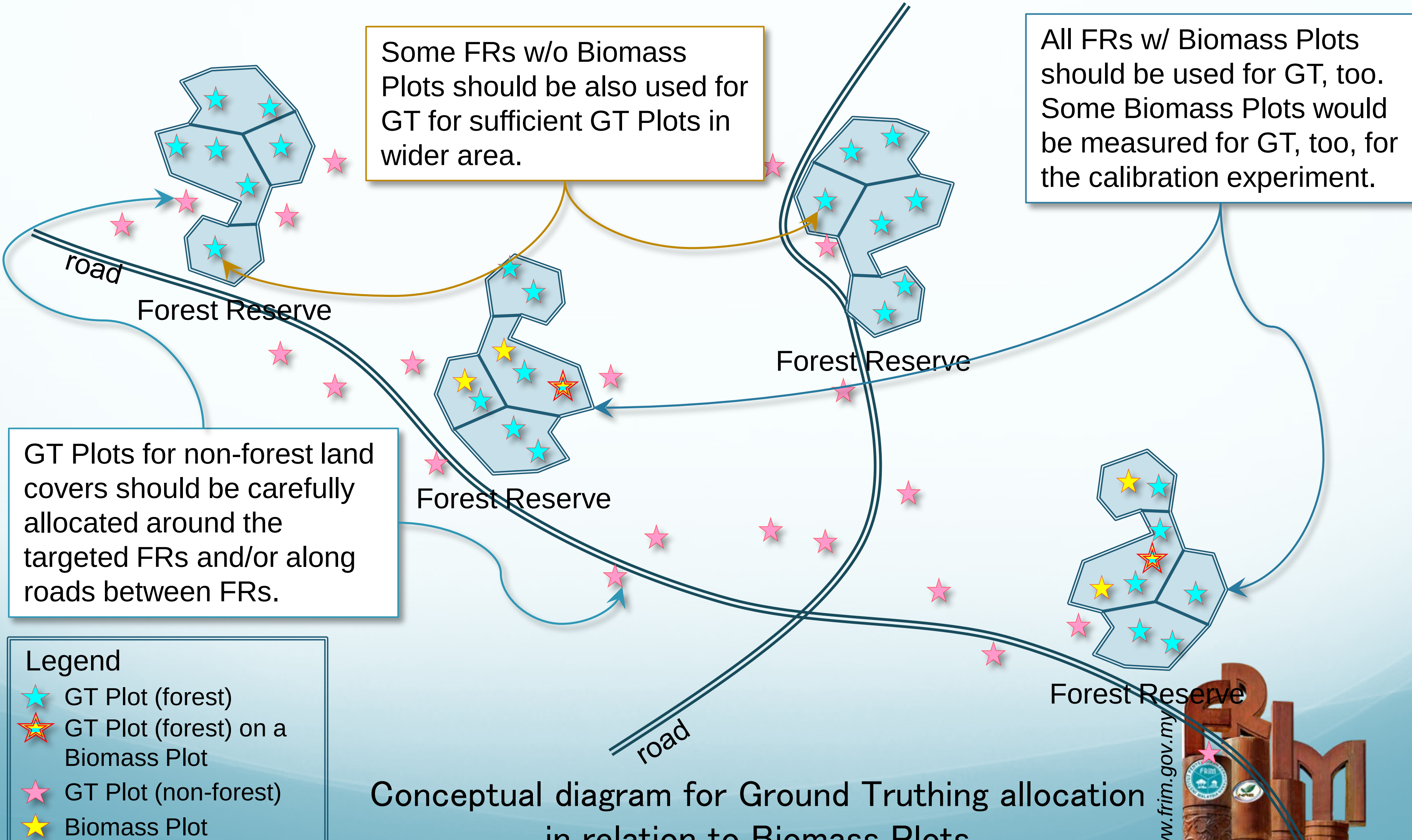
Note: No data (cloud and shadow detected on all scenes)

Radiometric, Atmospheric, Geo-referenced, and Cloudless Landsat Images



Methodology : Ground truth data for biomass estimation

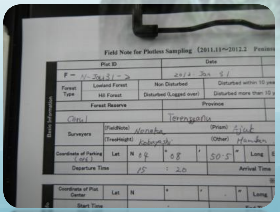
- Using Prism method for forest inventory activity



Conceptual diagram for Ground Truthing allocation in relation to Biomass Plots

Main activities during forest survey

1. Measurement of the positioning data of the plots by using GPS
2. Observation of the forest type
3. Identification of the dominant species
4. Measurement of the total basal area by applying Prism method
5. Measurement of DBH and total height
6. Taking photographs of the forest condition



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Procedure of the survey

1. Measurement of the positioning data of the plots by using GPS:
   - Position at the center of the plot (using GPS)
   - Slope direction and inclination (using Clinometers)

2. Observation of the forest type

   ①. Mangrove forest
   ②. Peat swamp forest
   ③. Low land forest
   ④. Hill forest

3. Identification of the tree species
   - Dominant tree species (local name if possible)
   - “Dipterocarp” or “Non Dipterocarp” (at least)

4. Measurement of the tree:
   - Counts trees by Bitterlich/Prism method

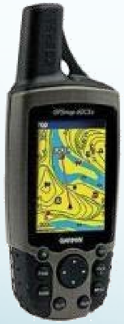
5. Measurement of DBH
   - Measure DBH (at the height of 1.3m)

   ※ All trees that have been counted in Bitterlich/Prism method.

6. Taking photographs of the forest condition
   - Photos toward 4 directions (N-E-S-W) and Vertically above
   - Photos from a proper position where the plot can be overlooked

Advantages of plotless sampling

- The cost is lower
- Data collection is faster
- Easily planned
- It gives better estimates of the mean than unrestricted random



GPS

Vertex transponder

Dbh Tape

Prism

Equipments for field survey

Ground truths data for remote sensing classification

- Ground truth is a term used in remote sensing; it refers to information collected on location.
- Ground truth allows image data to be related to real features and materials on the ground.
- The collection of ground–truth data enables calibration of remote–sensing data, and aids in the interpretation and analysis of what is being sensed.

Ground truths data for remote sensing classification

There are many methods to get the ground truth data for remote sensing classification. For example,

- Field work activity
- Interpretation from higher resolution images (aerial photo, Google earth images)
- From current reference data(forest map, vegetation map, etc.)

- The field work for ground truth data collection requires representative samples, and photos should tell the story of the selected landuse

Collecting ground truth data from Google Earth

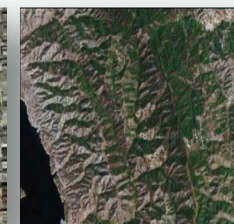
- Since field survey is time consuming and needs much budget, GE can be considered another complementary product for remote sensing analysis,
- The high spatial resolution images released from GE, as a free and open data source, have provided great supports for the traditional land use mapping.
- Can be treated as ancillary data to collect the training or testing samples for land use classification and validation or used as a visualization tool for land use maps.

Collecting ground truth data from Google Earth

There are several clues can be use to help for interpret images in GE:


- *Shape*
- *Size*
- *Pattern*
- *Tone and Color*
- *Shadow*





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CONCLUSION

This project component explore some technical image processing and sampling that can help in interpretation and analysis of remote sensing data that can help for implementing REDD+.

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THANK YOU