Grant Aid for Environment and Climate Change
for the Independent State of Papua New Guinea

# - The Forest Preservation Programme -

April, 2011

JICS: Japan International Cooperation System

Kokusai Kogyo Co., Ltd (Consultant)

## Forest Preservation Programme (FPP) Grant Aid Objective Components

**Objectives**

1) Forest Basemap Development
2) Forest State Monitoring

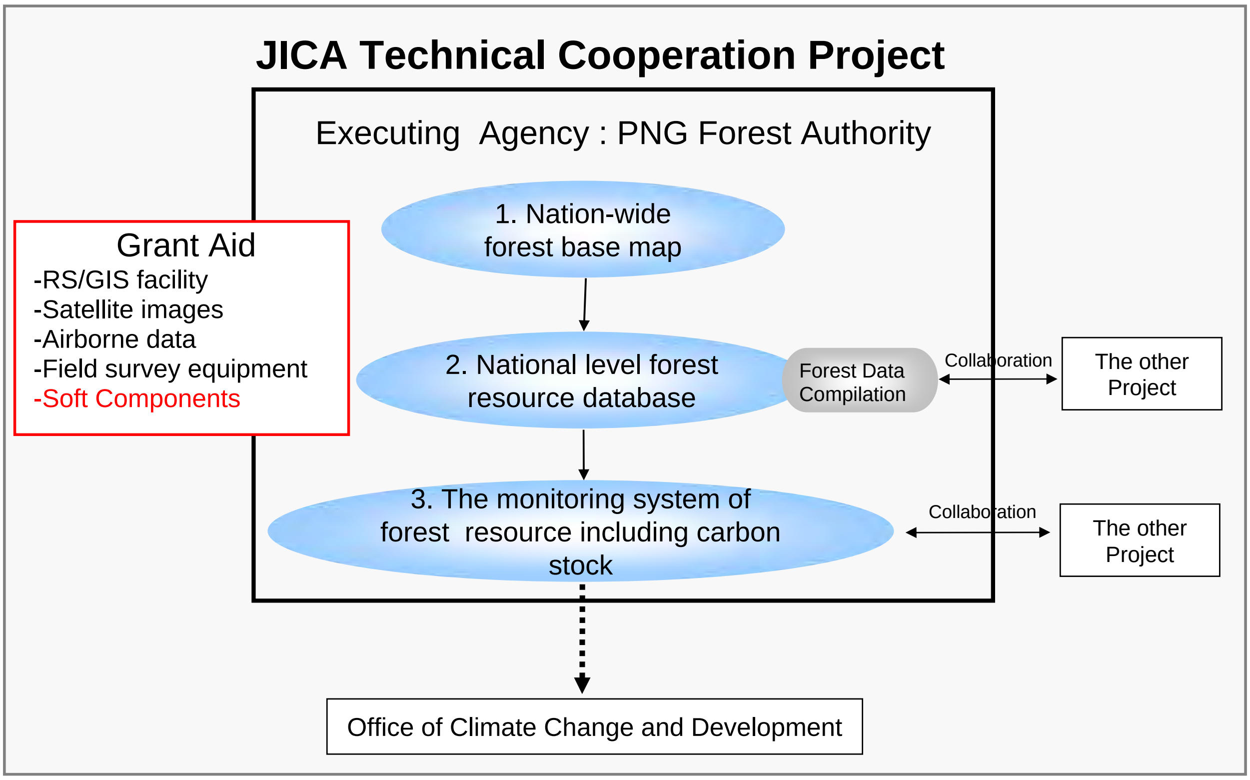
To Implement

**Components**

1) Equipment Procurement
   - Items & Numbers are proposed from JICS/consultant based on the application from PNGFA (July,2010) and the result of discussion (December,2010)
   - Item & Numbers (draft) will be decided at the committee

2) Soft Component (Technical Assistance)
   - Scope & Activities to go will be discussed between PNGFA & JICS/consultant based on the equipment procurement agreement
   - Deep/Close discussion with JICA Technical Cooperation for detail plan

# JICA Technical Cooperation Project & Grant Aid "Forest Preservation Programme"






# Forest Preservation Programme (FPP) Grant Aid Schedule (Tentative)

| | 2010 | | | | | | | | 2011 | | | | | | | | | | 2012 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | | 3 |
| E/N | ▼ | | | | | | | | | | | | | | | | | | | |
| A/A | | | ▼ | | | | | | | | | | | | | | | | | |
| Detail Design Study | | | | | | | ■ | ■ | | | | | | | | | | | | |
| Internal Analyzing / Preparing Tender Doc | | | | | | | | □ | □ | □ | □ | □ | | | | | | | | |
| Selection of the goods | | | | | | | | | | | | ▼ | | | | | | | | |
| Consultative Committee | | | | | | | | | | | | ▼ | | | | | | | | |
| Finalizing Tender Doc | | | | | | | | | | | | | □ | | | | | | | |
| Posting of GPN | | | | | | | | | | | | | | □ | | | | | | |
| Distribution of Tender Documents | | | | | | | | | | | | | | | □ | | | | | |
| Tender Opening | | | | | | | | | | | | | | | ▼ | | | | | |
| Tender Evaluation | | | | | | | | | | | | | | | | □■ | | | | |
| Conclusion of Contract | | | | | | | | | | | | | | | | ▽ | | | | |
| Manufacturing Lead Time | | | | | | | | | | | | | | | | | ▥ | ▥ | ▥ | |
| Transportation | | | | | | | | | | | | | | | | | ▥ | | ▥ | |
| Arrival of the goods | | | | | | | | | | | | | | | | | ▼ | | ▼ | |
| Payment | | | | | | | | | | | | | | | | | ▼ | | ▼ | |

□ Survey/Implementation in Japan ■ Survey/Implementation in PNG GPN: Posting of General Procurement Notice

## Applied & Proposing Equipments: A) GIS related

| Item | | Remarks |
|---|---|---|
| A) GIS related equipment; hardware/software | | |
| A-1 | Computer Hi-Tech (GIS Capacity) | Desktop PC |
| A-2 | Laptop | Laptop PC |
| A-3 | GPS (Mobile Mapper) | Portable GPS |
| A-4 | A3 Printer (Color) | |
| A-5 | A3 Scanner | |
| - | A1 Scanner | |
| A-6 | A0 Scanner | |
| A-7 | A0 Plotter | |
| A-8 | Data Server | |
| - | ER Mapper license & backup software | Included in ERDAS Pro. |
| A-9 | ERDAS | Level & Extensions |
| A-10 | eCognition | Several license type |
| A-11 | ArcGIS license | Level & Extensions |
| A-12 | ArcGIS Server | For Web data-sharing |
| A-13 | Database Management System | MS SQL Server |
| A-14 | Integrated Development Environment | MS Visual Studio |
| A-15 | MapInfo Upgrade | Minimum upgrade |
| - | Satellite Imagery (SPOT/ALOS) | No archive |
| A-16 | Satellite Imagery 2010 (ALOS/PALSAR) | 332 scene (tentative) |
| A-17 | Satellite Imagery 2010 (RapidEye) | 1055 tile |
| A-18 | Satellite Imagery 2007 (ALOS/PALSAR) | 332 scene (tentative) |
| A-19 | Airborne RADAR Data | DTM & DSM |
| A-20 | Airborne LiDAR Data | Validation/verification |



## Applied & Proposing Equipments: B) Surveying C) Others

| Item | | Remarks |
|---|---|---|
| B) Surveying (Ground Truthing) | | |
| B-1 | Compass | |
| B-2 | Clinometer | |
| B-3 | Diameter Tape (10m) | |
| B-4 | Distance Tape (100m) | |
| B-5 | Distance Tape (50m) | |
| B-6 | Digital Camera | |
| B-7 | Wedge Prism (Angle Count) Factor 1 & 2 | |
| - | Realacope | Unable to procure JPN/PNG |
| B-8 | Hypsometer | Substitute of Realacope |
| - | Chain (elastic) | same with distance tape (Fibre) |
| B-9 | Wood density measurement | Desitometer |
| C) Other Equipments | | |
| C-1 | Storage | |
| C-2 | Cabinet (with longitudinal doors) | |
| C-3 | Cabinet (with horizontal drawers) | |
| C-4 | Multimedia Projector | Not include mic |
| C-5 | Portable Generator | |

# Forest Monitoring: Overall Concept

## Background & Needs

National Level Forest Resource Monitoring
Forest Resource Basemap for Biomass/Carbon Estimation

## Challenges & Countermeasures

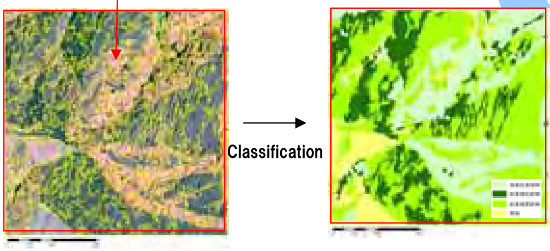
Overall Comprehension using Radar Satellite (ALOS/PALSAR)
Biomass/Carbon Modeling & Estimation by Sampling Analysis

### National Level ForestMonitoring with Radar Satellite

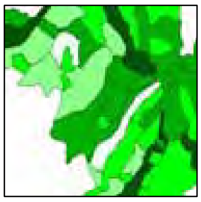

Nation-wide Expansion

Multi Platform Sensing

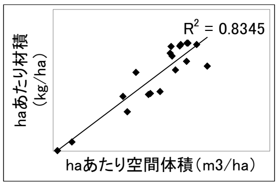
### Forest Basemap Development with Optical Satellite




### Biomass/Carbon Modeling based on Spatial Volume

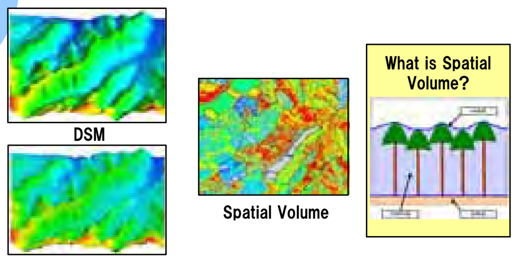


Tree Stand Volume




Relational Expression of Spatial Volume & Tree Stand Volume

### Sampling Analysis for Spatial Volume Estimation




2D: Area of Forest/Vegetation Type

3D: Spatial Volume for Carbon



# Forest Monitoring: Benchmark Map & Change Detection

## Background & Needs

Accurate Forest Base-map for Forest Management & Development Planning
Sustainable Monitoring System for Forest Change (Deforestation) Detection

## Challenges & Countermeasures

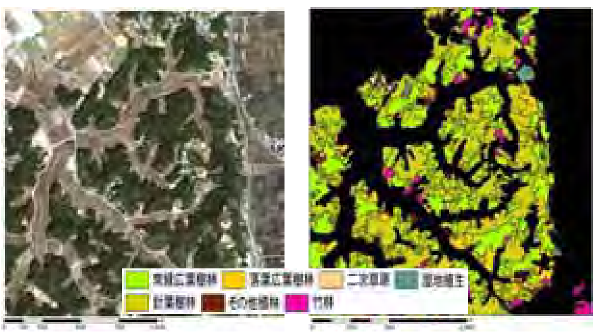
Developing Forest Base-map with Constellation of Optical Satellites
Change Detection with Multi-temporal Radar Image (ALOS/PALSAR)

### Constellation of Optical Satellites

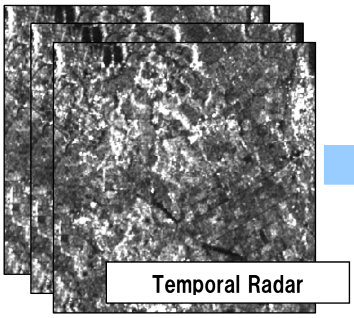
RapidEye A.G.

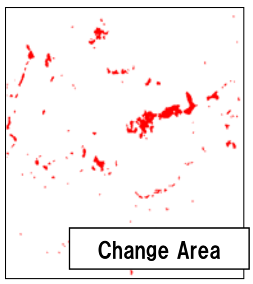
### Weather-independent of Radar Satellite

### Vegetation Type Classification for Forest Benchmark map



### Change Detection with Multi-temporal Radar




Benchmark Map by Optical Satellite

Change Detection by Radar Satellite

# Target Analysis for Forest Monitoring in PNG

【To-Be】
1. National forest resource basemap is developed & utilized

【To-Be】
2. National level forest resource GIS/Database is developed & utilized

【To-Be】
3. Carbon/Biomass stock is estimated for

【Problem】
- PNGFA does not have data and facility to develop
- Need time to develop national level map

【Problem】
- The work flow does not fit with FIMS any more
- Existing data are not well compiled into the system

【Problem】
- More than 90 % of PNG land is customary land
- No access road to do field survey for whole country

To-Be (Goals)

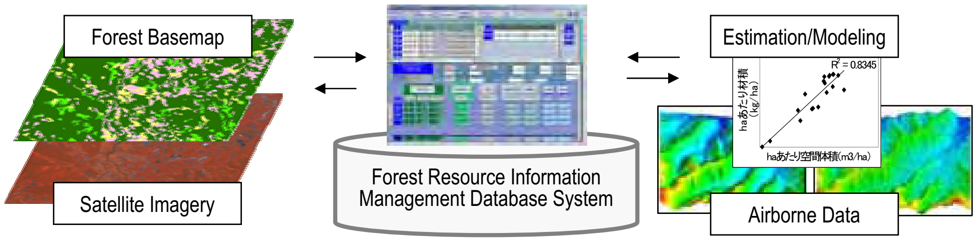
Problem

As-Is (Current)

【As-Is】
1. National level forest basemap is not developed since 1972

【As-Is】
2. FIMS (Forest Inventory Mapping System) is not updated since 1998

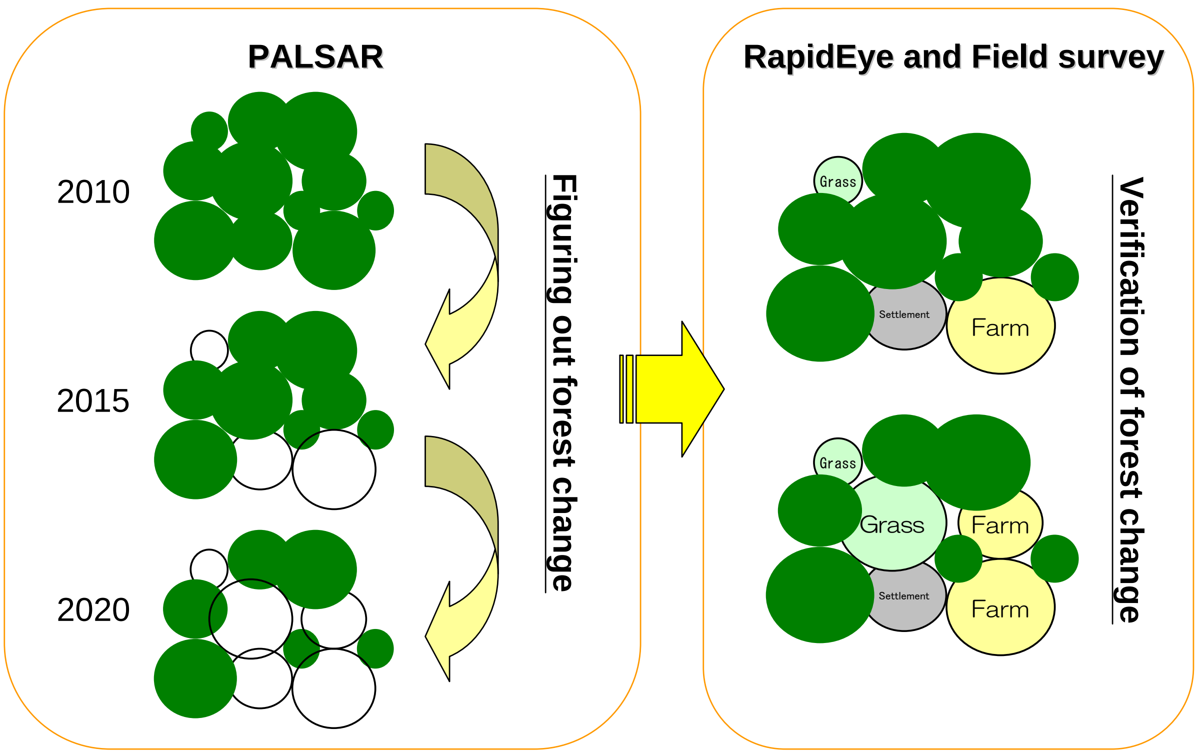
【As-Is】
3. Carbon stock estimation is necessary but no good data for it



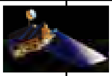
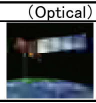
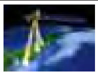
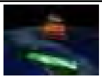
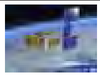



# Basic Concept for Forest Monitoring

- Proposed monitoring system -



# Satellite Imagery Comparison

| Satellite | Terra (Aqua) | | LANDSAT(5/7) | | ALOS | | | SPOT(2/4/5) | RapidEye |
|---|---|---|---|---|---|---|---|---|---|
| Sensor | MODIS (Optical) | ASTER (Optical) | TM (Optical) | ETM+ (Optical) | PRISM (Optical) | AVNIR-2 (Optical) | PALSAR (Radar (SAR)) | HRVIR (Optical) | RapidEye (Optical) |
| Overview |  | |  |  |  |  |  |  |  |
| Resolution | 250m (Visible – Near-infrared) 500m (Visible – Shortwave infrared) 1,000m (Visible – Thermal infrared) | 15m (Visible – Near-infrared) 30m (Shortwave infrared) 90m (Thermal infrared) | 30m (Visible – Short-wave infrared) 120m (Thermal infrared) | 15m (Panchromatic) 30m (Visible – Shortwave infrared) 60m (Thermal infrared) | 2.5m (Panchromatic) | 10 m (Visible – Near-infrared) | 10m (High resolution) 25m (Multi polrizations) 100m (Wide area observation) | 2.5m/5 m (Panchromatic) 10m (Visible – Near-infrared) 20m (Mid-infrared) | 6.5m (Multi spectral) 5m (After resampling) |
| Swath width | 2,330km | 60km | 185km | 185km | 70km (Nadir) 35km (Triplet) | 70 km (Nadir) | 70km (High resolution) 20km (Multiple polarizations) 250～350km (Wide observation area) | 60km | 78km |
| Revisit cycle /Frequency | 16 days /Daily | 16 days | 16 days | 16 days | 46 days | 46 days /Within 3 days | 46 days | 26 days /Within 3 days | 5 days |
| Providing Agency | JAXA | ERSDAC | USGS | | RESTEC | | | Tokyo SPOT Image K.K. | Japan Space Imaging Co. |
| Web site | http://kuroshio.eorc.jaxa.jp/ADEOS/mod nrt/index.html | http://imsweb.aster.ersdac.or.jp/ims/html/MainMenu/MainMenu j.ht | http://earthexplorer.usgs.gov | | https://cross.restec.or.jp/ | | | http://sirius.spotimage.fr/PageSearch.aspx?language=UK | http://www.spaceimaging.co.jp/ |
| Features | Able to make observations on a daily basis. | Equipped with a number of bands. Have proven past results in resource exploraion and vegetation analysis. | Able to make observations for a relatively wide area with high resolution. Have proven past results in land-use map development. | Equipped with TM and panchromatic sensors. | Able to conduct Triplet/Nadir & Backward stereo observations. | Able to make observations for emergent situations using pointing function. | Equipped with an all-weather sensor. | Commercialization in combination with DEM. Guarantee of quality. | Equipped with Red edge band, which is highly reactive to chlorophyll. |
| Notes | | | | Data gaps are included because the sensor was broken in July, 2003. | | | | Prices are high because satellites are commercial. | |



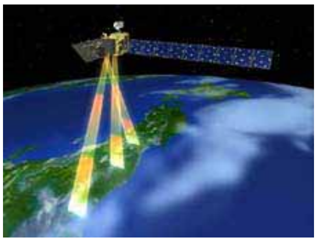
# Satellite & Airborne Characteristic

| Type | Satellite/Sensor | Advantage | Disadvantage | Usage |
|---|---|---|---|---|
| Mid Resolution | LANDSAT | Free, archive, wide coverage | Limitation of interpretation/classify | Analysis in the past |
| National Level | ALOS/ PRISM&AVNIR2 | Good panchro resolution, value added service | Pan & MS are different sensor | National level development |
| High Resolution | SPOT5 | Comparing with past, abundant archive | Expensive (cmp. to ALOS), No blue band | National level development /partly update |
| | RapidEye | Quick collection, Good MS resolution, RedEdge band | No Pan imagery, few archive imagery, no experiences, sub-distributor system | Urgent/Short term development (new tasking) |
| Very High Resolution (VHR) | QuickBird GeoEye | Possible to interpret tree kinds, village roads | Expensive, impossible to cover national level | Field survey complement, modeling validation |
| Airborne | LiDAR | DSM & DTM, high accuracy | Hilly area or high density area | Contribution for tree stand volume table |
| Radar/ SAR | ALOS/ PALSAR | Regularly, assured collection, strong for change detection | Limitation for using in mountain area | Regularly change monitoring |

# ALOS Information

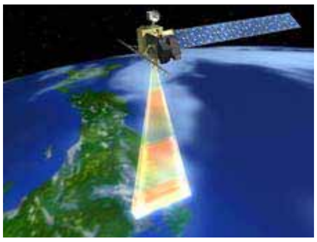
- ✓ **Launch:**
  - Jan. 24, 2006 by H-2A Rocket #8
  - **> exceed 4 years celebration**
- ✓ **Objectives:**
  - Cartography (1/25,000 scale)
  - Regional environmental monitoring
  - Disaster monitoring, *etc.*
- ✓ **Three mission instruments:**
  - PRISM, AVNIR-2, PALSAR


***PRISM***
Panchromatic Remote sensing Instrument for Stereo Mapping



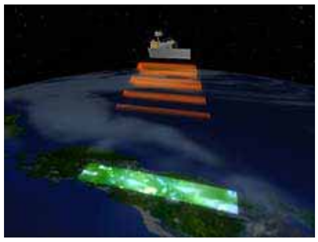
PRISM can acquire triplet stereo imageries by nadir-, forward, and backward-radiometers with 2.5m spatial resolution in 35km wide swath.

***AVNIR-2***
Advanced Visible and Near-Infrared Radiometer type 2



AVNIR-2 can observe with 10m resolution in 70km swath, and it can be changed the observation area by pointing capability within +/-44 degrees in across track.

***PALSAR***
Phased Array type L-band Synthetic Aperture Radar



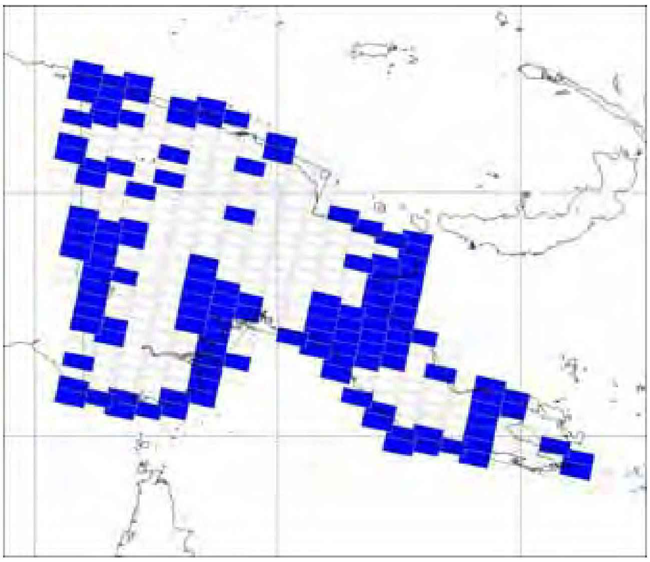
PALSAR can acquire the data in not only daytime but also nighttime as well as cloudy and rainy whether conditions.

Ref. JAXA Web

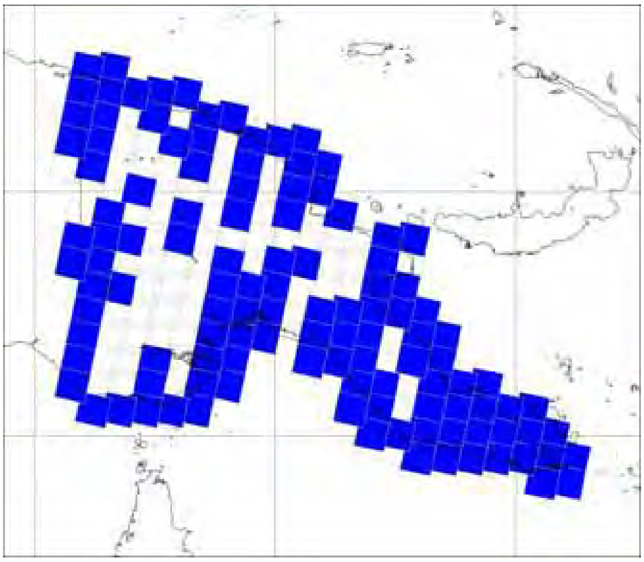


# ALOS Archive Situation

**ALOS/PRISM 2006-2009**



**ALOS/AVNIR-2 2006-2009**

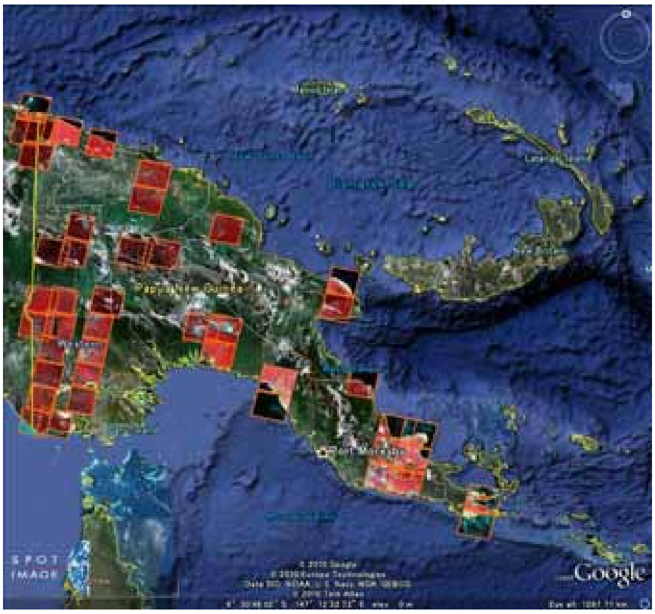


■ Collected with less than 20 % of cloud cover

ALOS optical sensors (PRISM & AVNIR-2) cannot cover whole country of PNG with good quality imagery even for several years

## SPOT Archive Situation

**SPOT4 2002**

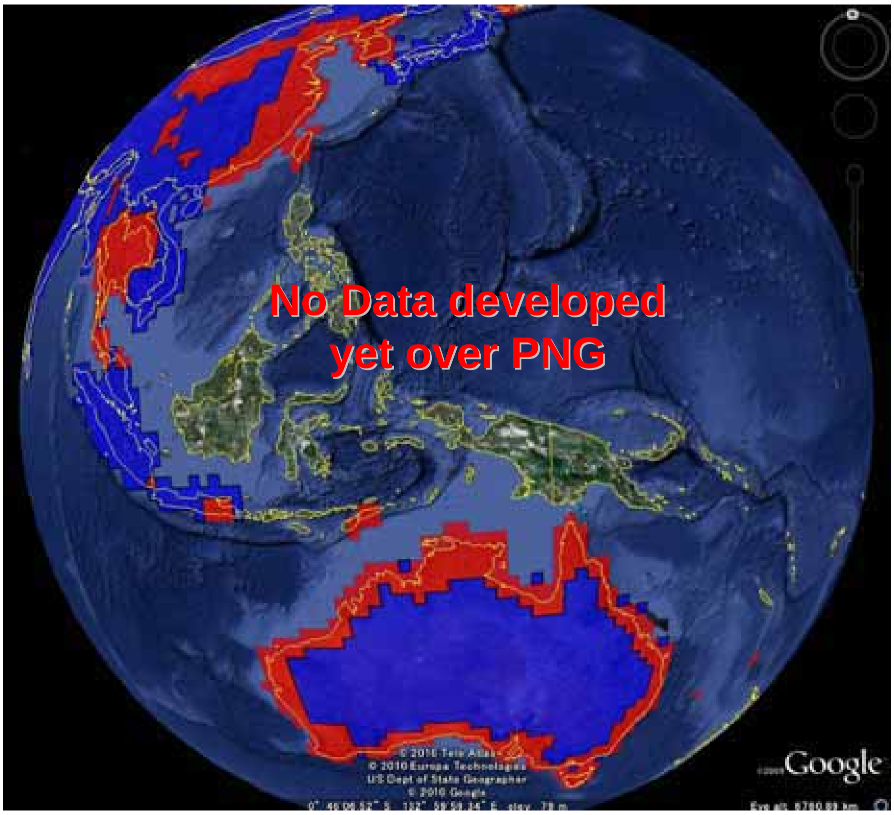



**SPOT5 2008**

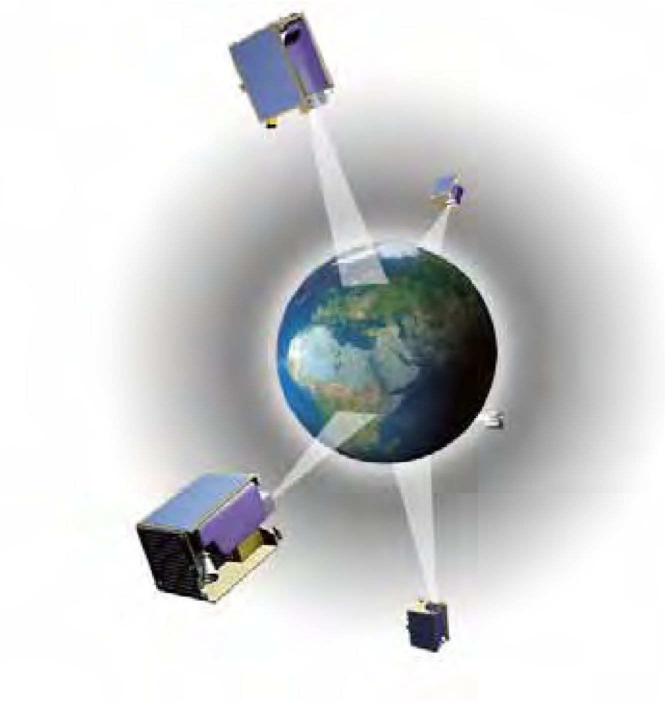

Even SPOT cannot cover whole country of PNG well and they cannot assure to collect good quality imagery within a year



## SPOT Reference3D (SPOT DEM) Situation



# RapidEye Information



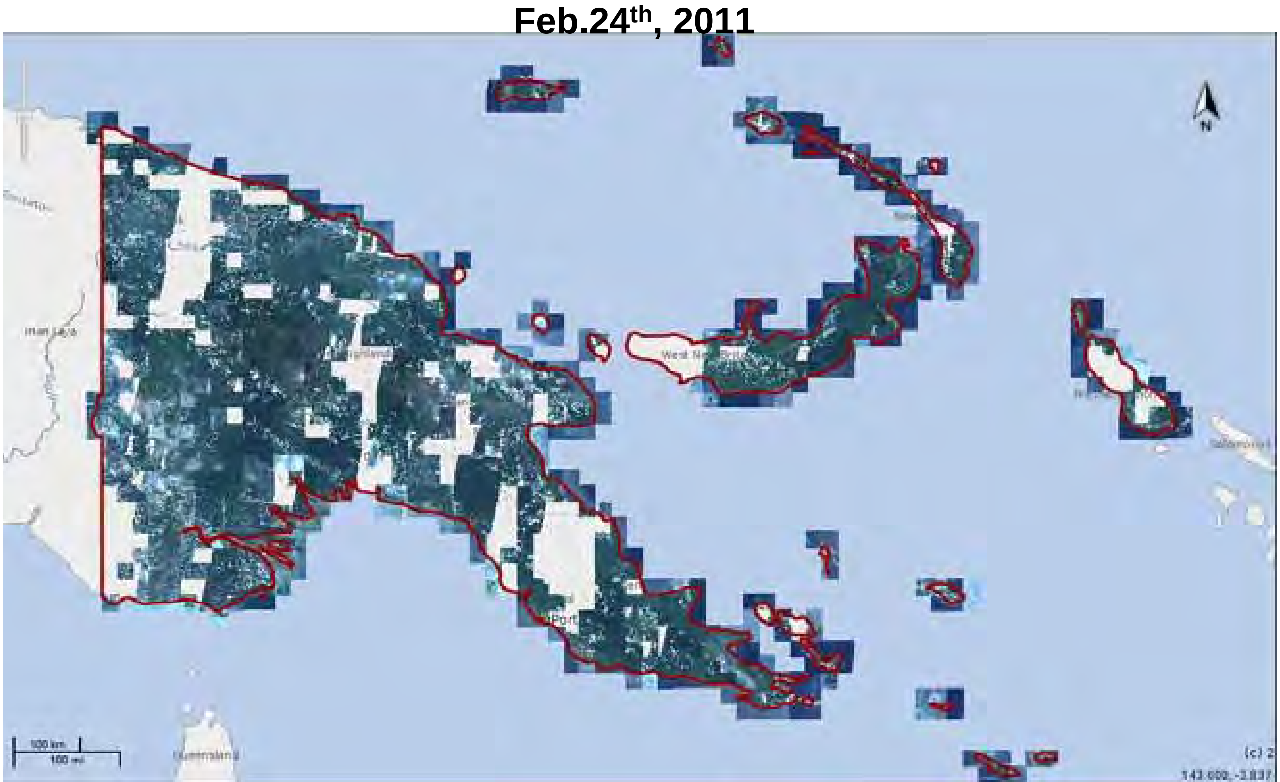
| | |
|---|---|
| Orbit | **620 km, sun synchronous** |
| Number of Satellites | **5** |
| Spacecraft Mass | **150 kg each** |
| Image Data Downlink | **>60 Mbps** |
| Onboard Data Storage | **>1500 km of image data** |
| Max. Spacecraft Roll Angle | **± 25 degrees** |
| Payload Type | **Push broom Optical Imager 5 Optical bands** |
| Swath | **78 km** |
| Nadir Pixel Ground Sampling Distance | **6.5 m** |
| Global Revisit Time | **1 day** |
| Average Repeat Period (Europe and North America) | **<5 days** |
| DEM Generation Capability | **Yes** |
| Mission Life | **7 Years** |

Ref. MDA Web



# RapidEye Archive Situation

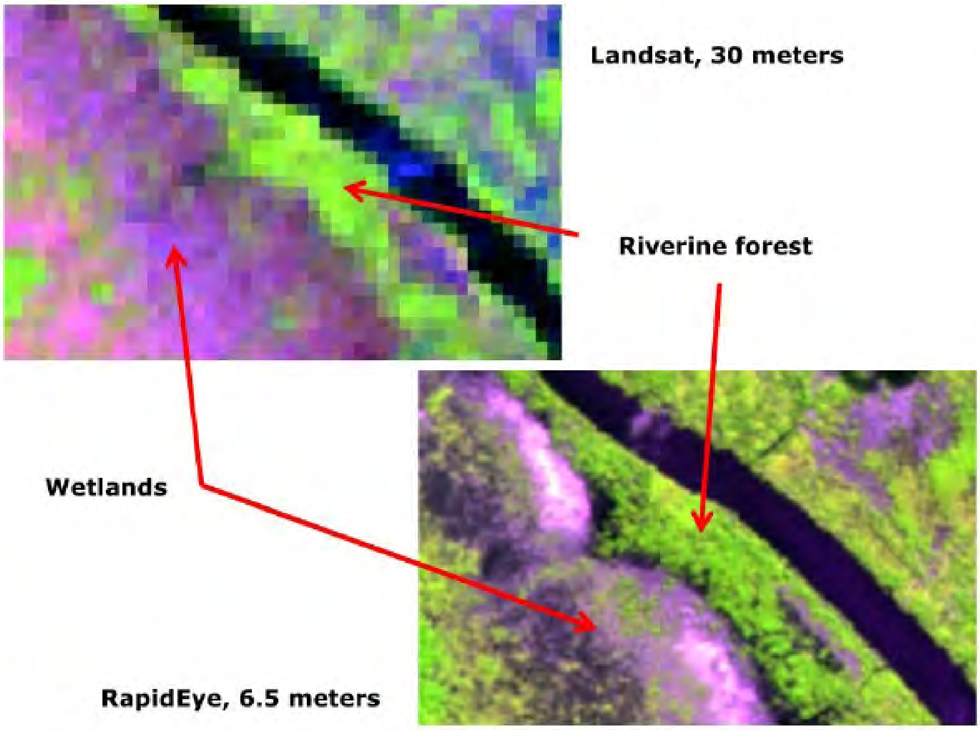
**Feb.24th, 2011**



RapidEye (5 constellation satellites) is showing the ability to cover whole country of PNG within a year

# RapidEye Ability/Performance 1

## Forest types, canopy cover



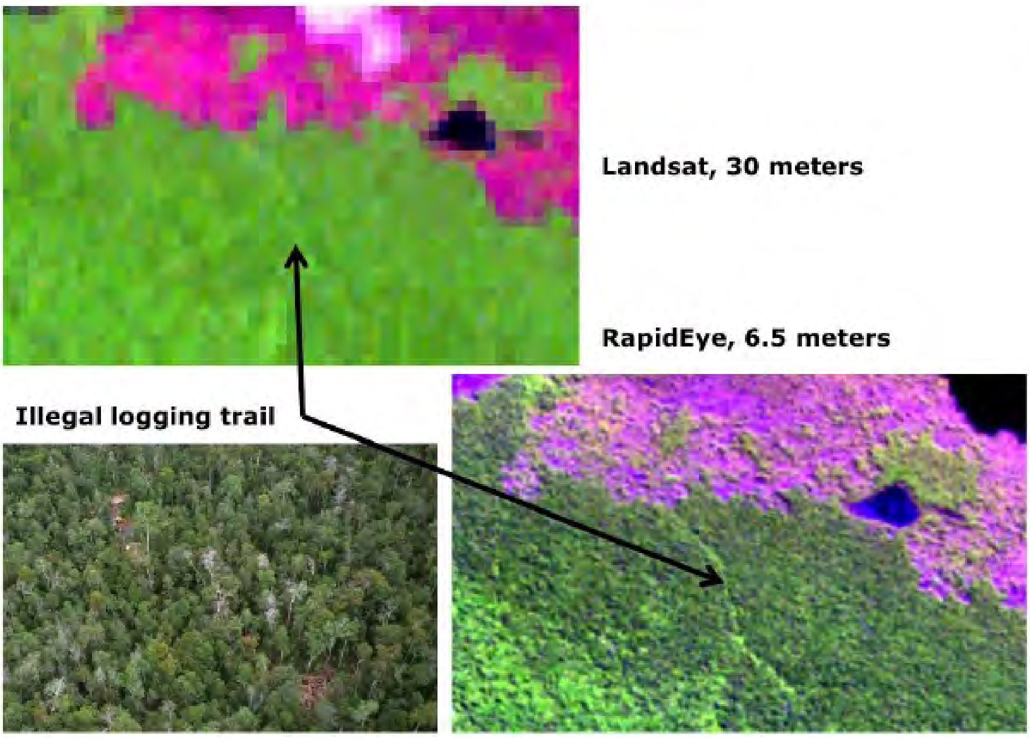

RapidEye
geo facts
turned into knowledge





# RapidEye Ability/Performance 2

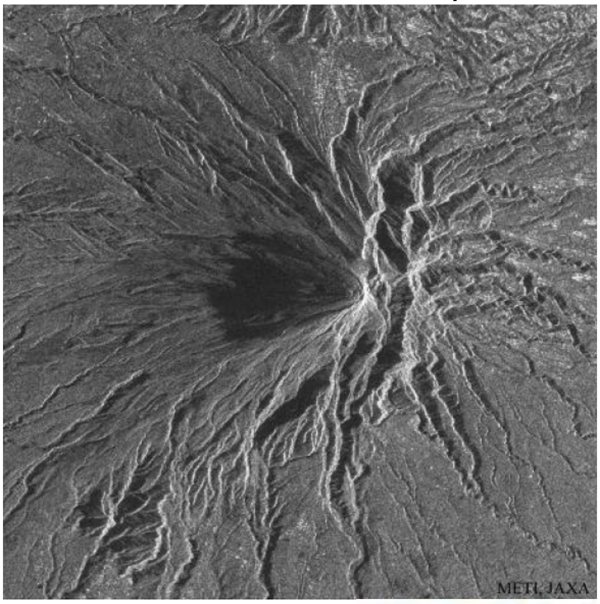
## Illegal logging



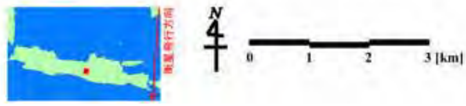

RapidEye
geo facts
turned into knowledge

## Radar Satellite: Weather Independent

**Volcano MERAPI, Indonesia (2006/4/29) with Clouds**




**PALSAR**



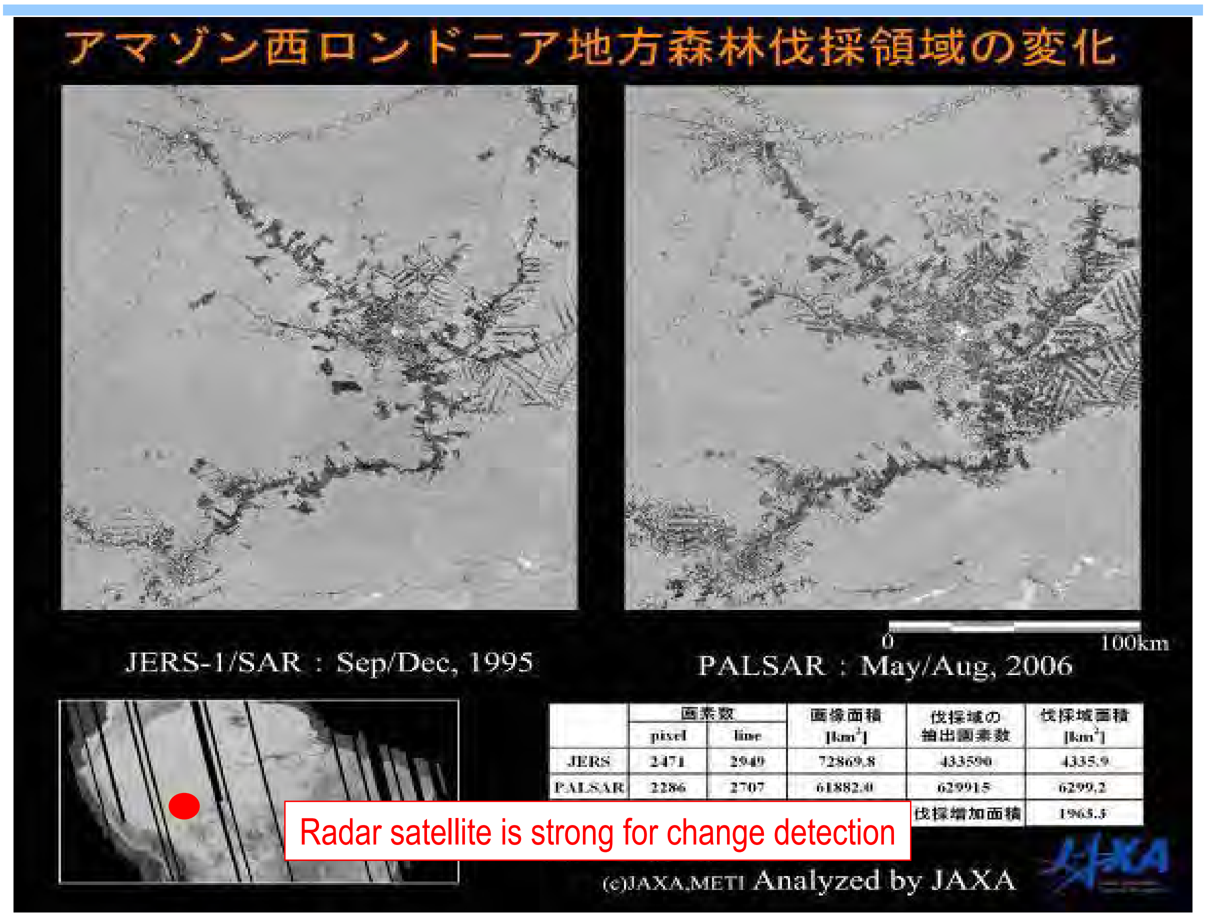

**AVNIR-2**

Radar satellite can monitor in any weather

Ref. JAXA Web



## Radar Satellite: Change Detection




| | 画素数 | | 画像面積 [km²] | 伐採域の抽出画素数 | 伐採域面積 [km²] |
|---|---|---|---|---|---|
| | pixel | line | | | |
| JERS | 2471 | 2949 | 72869.8 | 433590 | 4335.9 |
| PALSAR | 2286 | 2707 | 61882.0 | 629915 | 6299.2 |
| | | | | 伐採増加面積 | 1963.3 |

Radar satellite is strong for change detection

# ALOS-2 and ALOS-3 Information

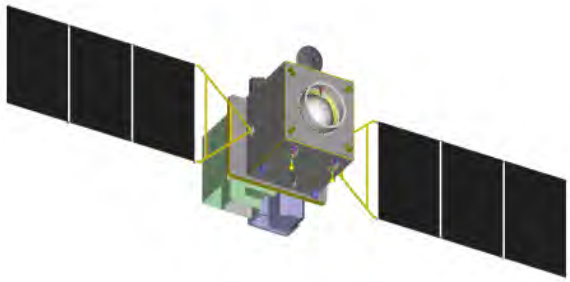
## ALOS F/O Mission: ALOS-2 (SAR) and ALOS-3 (Optical)

- National land monitoring and managements
- Resources managements
- Disaster monitoring
- ALOS-2 is planed to be launch in 2012-13, and ALOS-3 is hoped in 2014-15 (TBD)

Current System Concept (under investigation)

- Monitoring disaster area affected by earthquake, volcano, flood, etc.
- Observing the disaster affected area within 3 hr (6 hr in night)
- A satellite constellation of two optical sensor satellites and two SAR satellites
- ALOS-2: 3m resolution (3x1m in spotlight mode) with 50km swath (SAR)
- ALOS-3: Panchromatic - 0.8m resolution in 50km swath; multi - 5m in 90km swath; and hyper-spectral 30m in 30km swath (TBD)

ALOS-2: SAR Satellite



ALOS-3: Optical Sensor Satellite



# Forest Monitoring Practice for REDD+

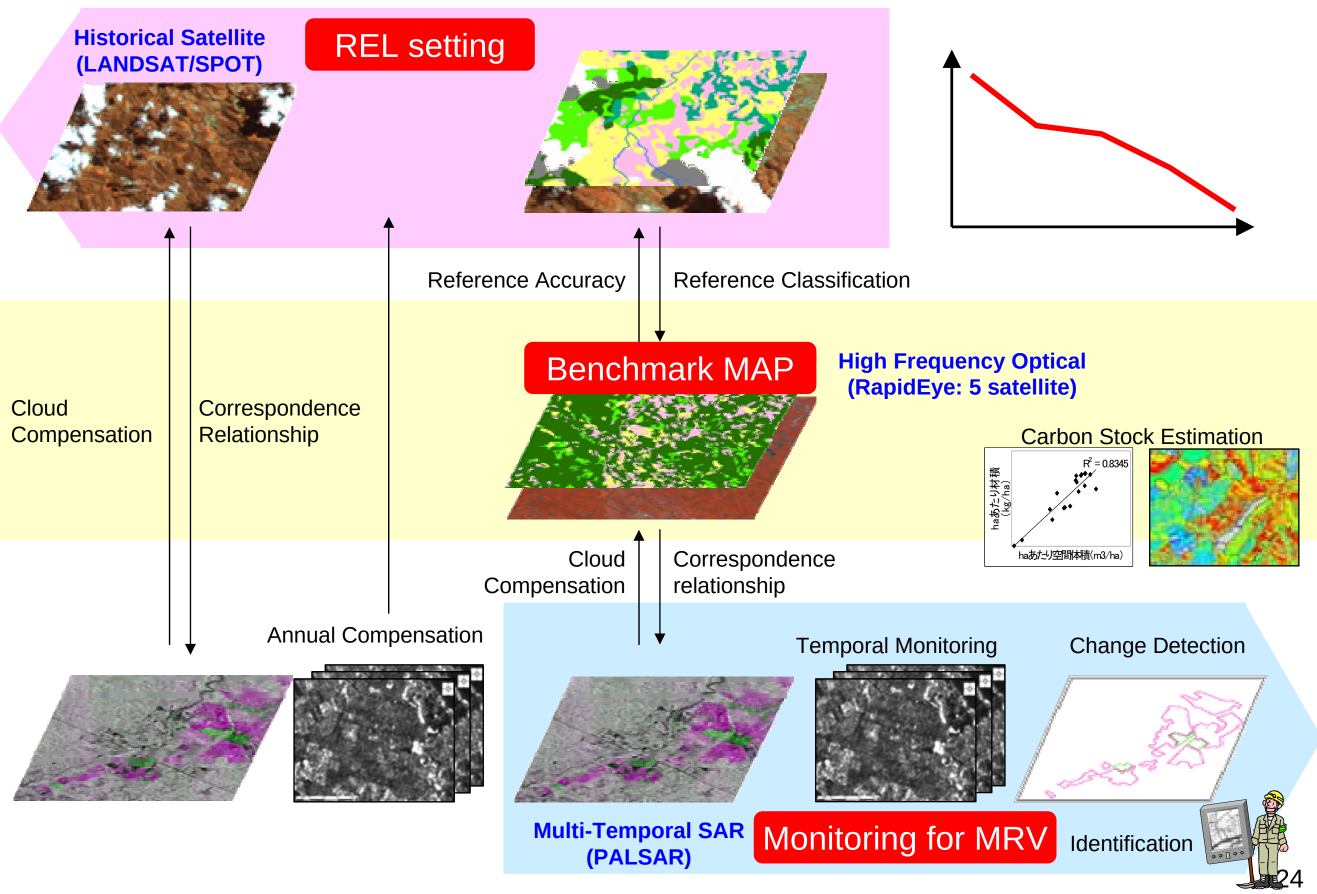


Image processing manual using RapidEye and PALSAR around Milne Bay

1. General procedure of using ERDAS Imagine

1-1. Menu

Execute ERDAS Imagine click this icon (But this version is not latest).


This menu icon appears.

Viewer : to view import/create image

Import : to Import/Export from many type of formats

Data Perp : to make/subset image, mosaic and geocode

Composer : to prepare layout legend, title and so on for printing.

Interpreter : Most of analysis function are included in this menu.

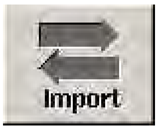
Classifier : For executing Unsupervised/Supervised classification.

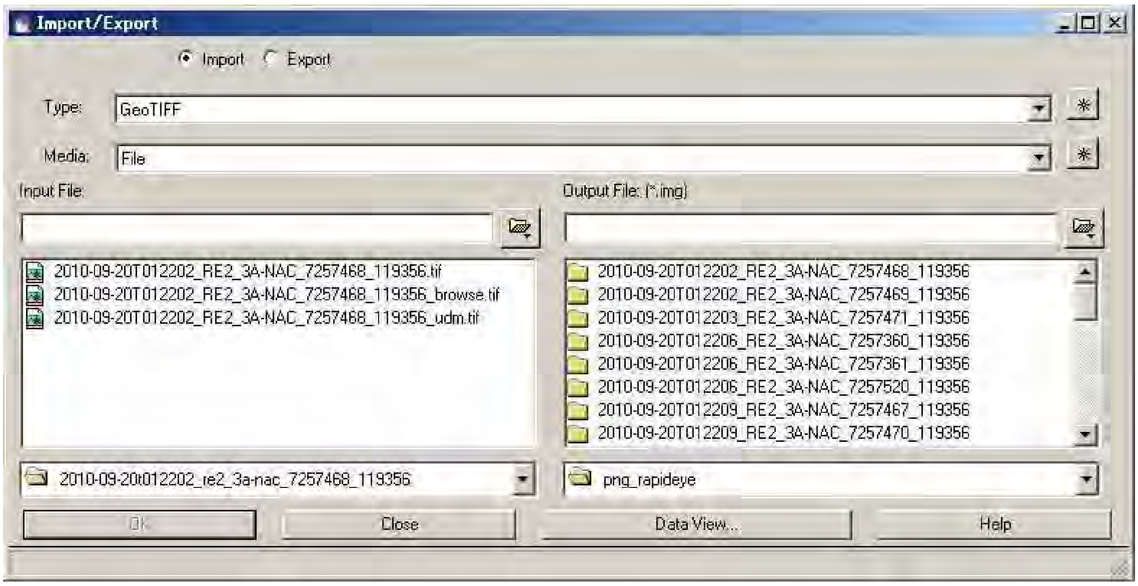
Modeler : to write a flowchart of commands for processing.

2. RapidEye data processing

2-1. Importing of Geotiff file

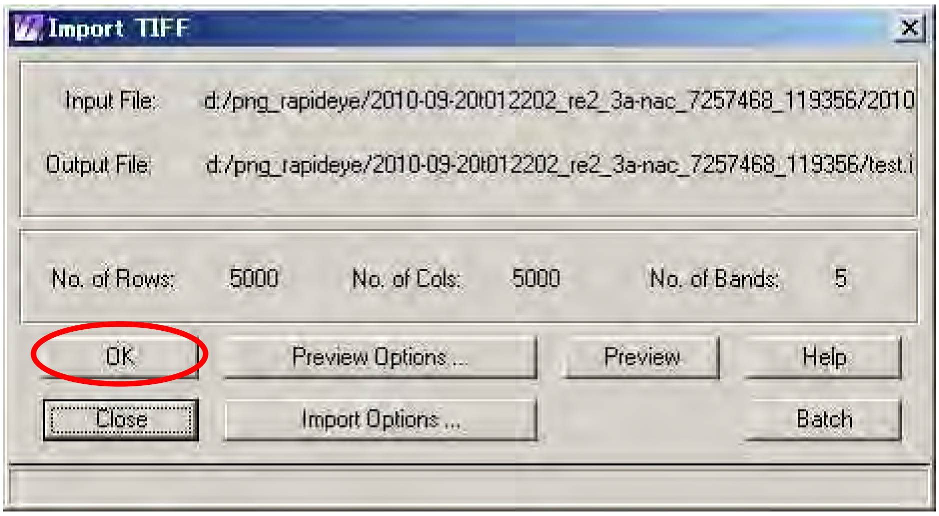
Open a Geotiff file in directory using Import menu



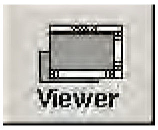

In Import/export select Geotiff file as input file. In Output file create new file with file extension "*.img" for using in ERDAS Imagine

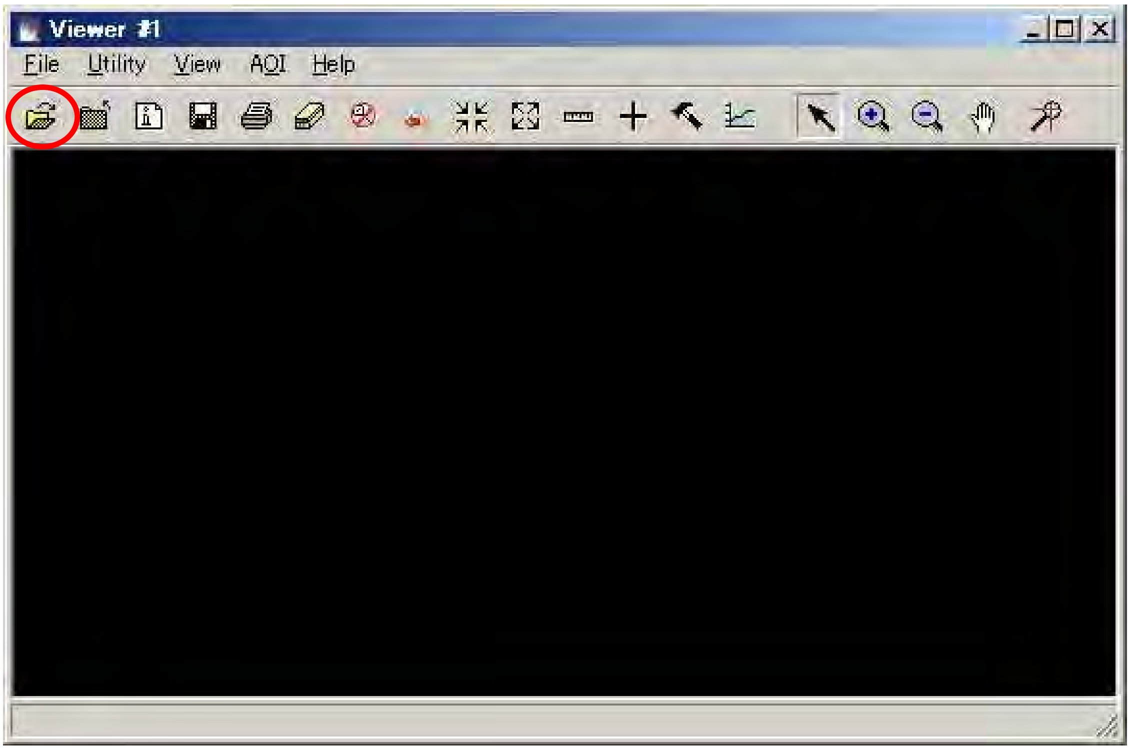
NB: For input TIFF dialogue options, accept the default settings.



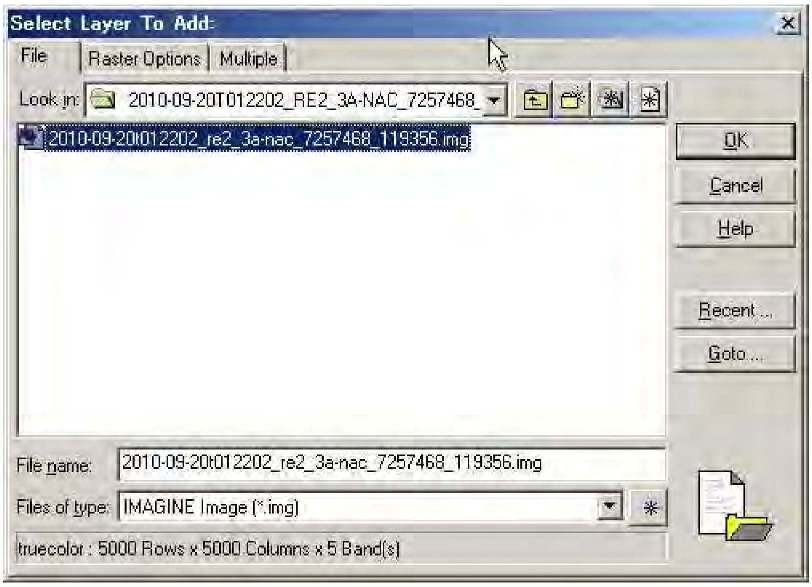

The process creates two (2) files with extensions "*.img" and "*.rrd".

To display the imported image click Viewer menu and select file and open.

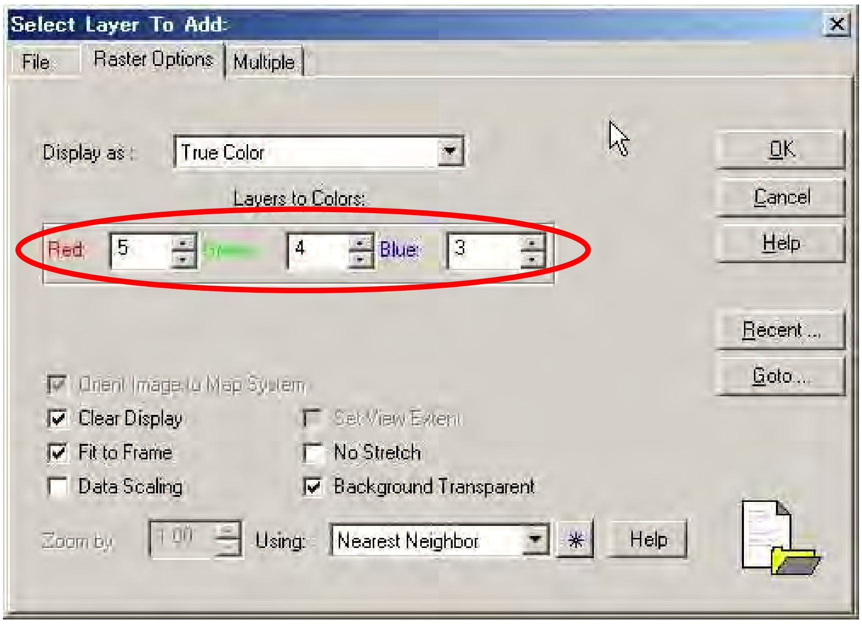


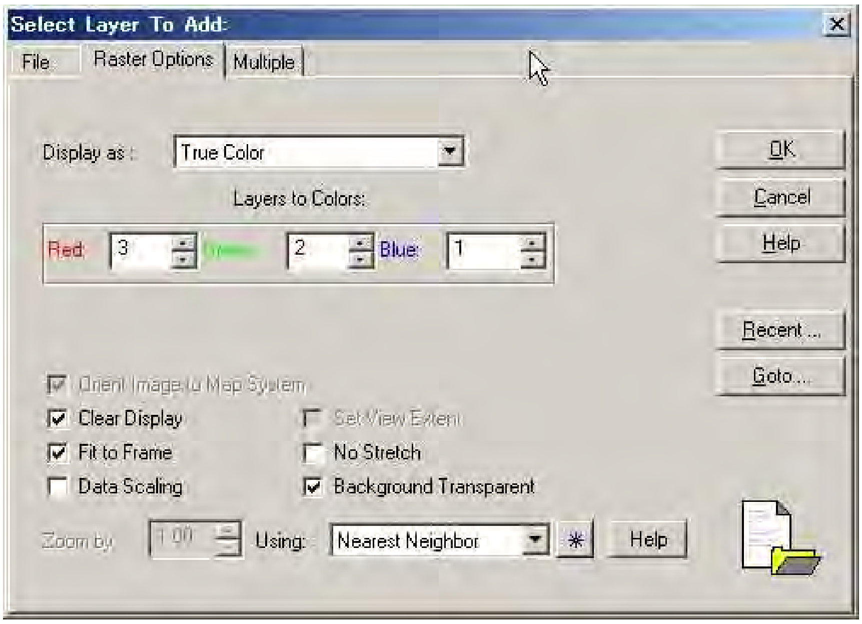

In [Select layer to add] choose imported image




In [Raster Options] display as True Color and set color combination as indicated below.



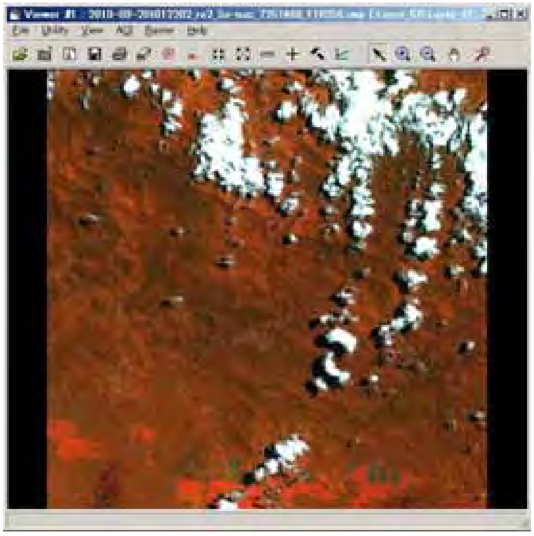

To display an image in photogrammetric (natural color) set color combination as below

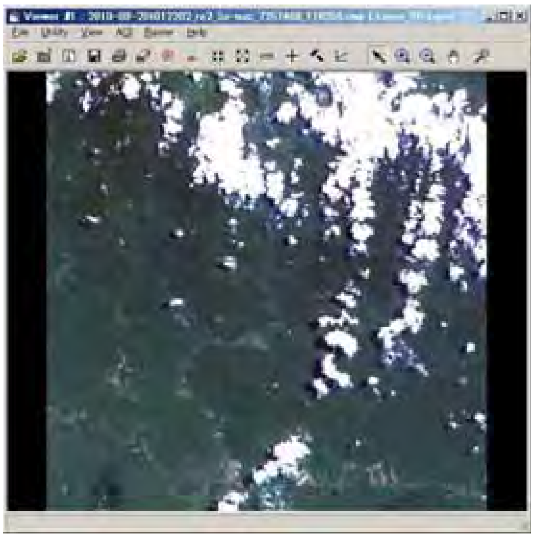



To display entire image tick the Fit to frame option

To view no data area (in black) tick Background Transparent option to make the image transparent

To compare visible (natural color) image and infrared image select Viewer to open second viewer to compare the two images. In second Viewer click file and open. In Select layer to add, select the same imported file. In Raster options, display as True color with color combination as above. (The two images are displayed as below)

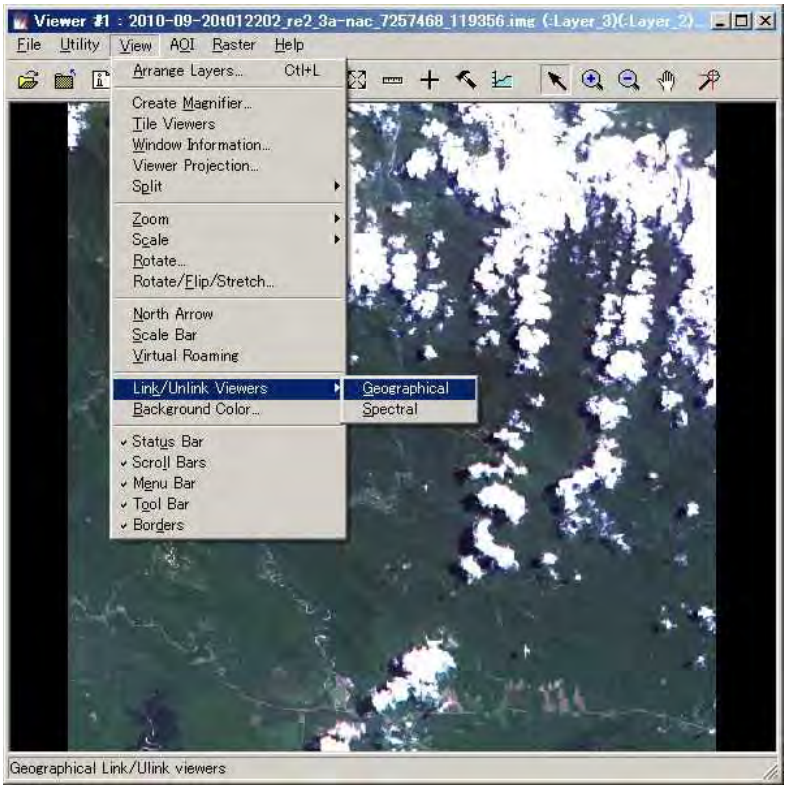




The left image shows difference of forest area.

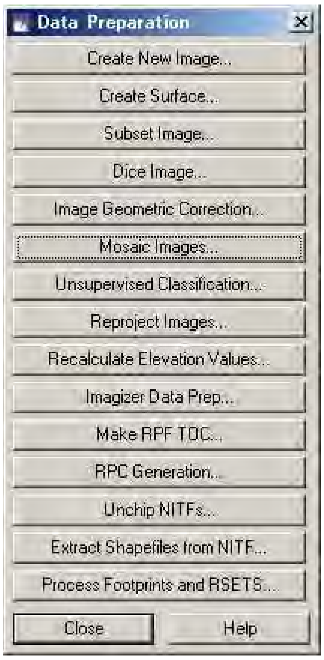
The right images shows natural color (using for mapping.)

To view two (2) images at same time (simultaneously) in Viewer menu, select view option and click link/unlink viewers and choose geographical.

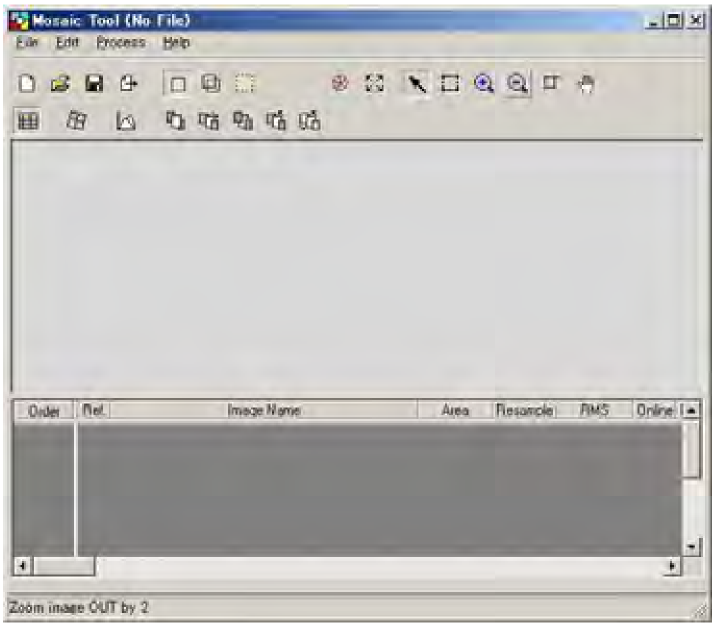


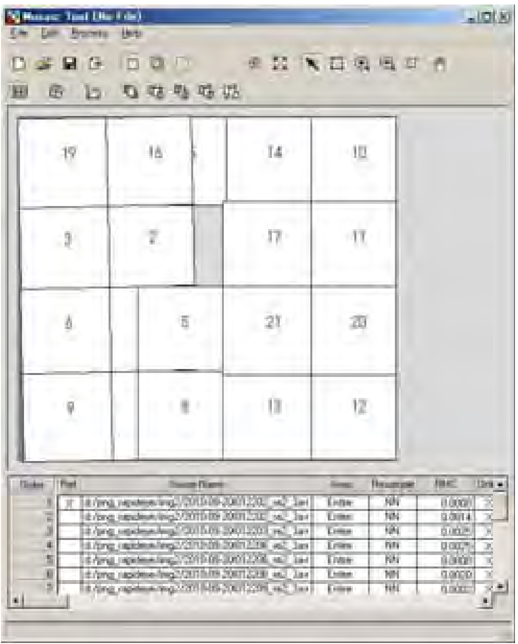

## 2-5. Mosaicing Of RapidEye Image by ERDAS Imagine

Select Data Prep menu and click Mosaic images and Mosaic tool. In Edit option select Add images and choose the imported images (*.img) of interest that will join each other.(The images are assigned Id numbers for reference). In process menu select Preview mosaic to check before mosaicing or select Run mosaic to continue Mosaic process. If Run mosaic then save the Output file in *.img format and wait for mosaic process to complete. Check the final mosaic by selecting Viewer menu and Open file and and choose saved mosaic file in *.img format.

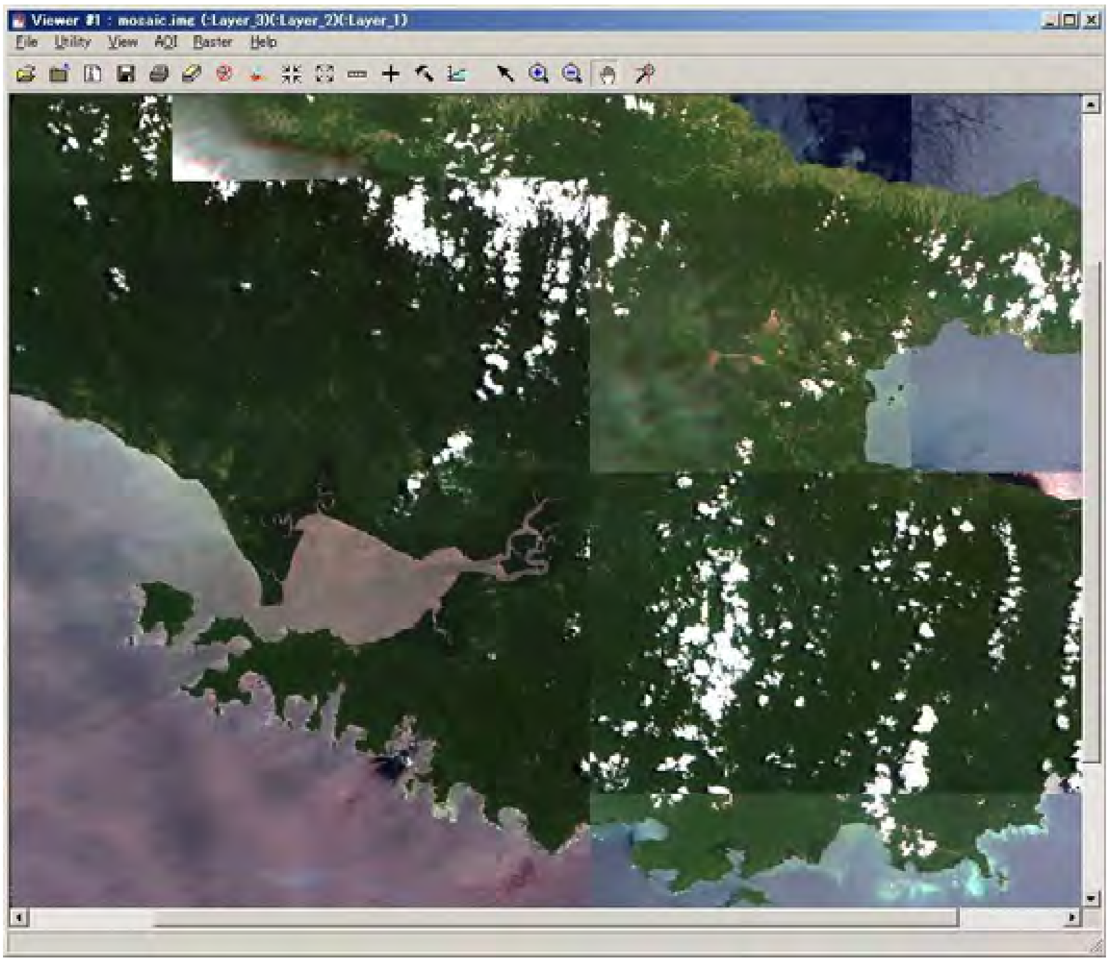









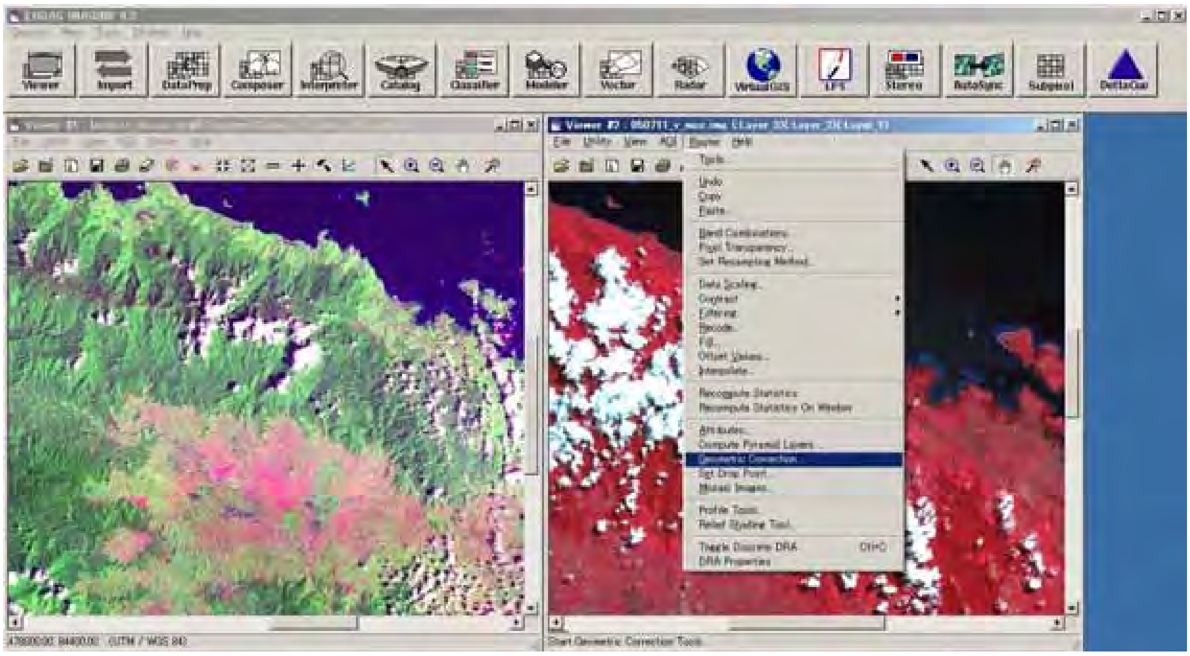
Mosaic index information



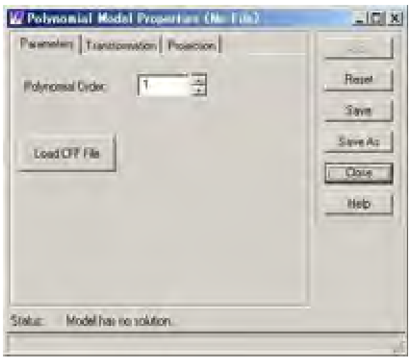

Bottom view is final/complete mosaic image.

2-4. Geometric Correction (Pre-processing)

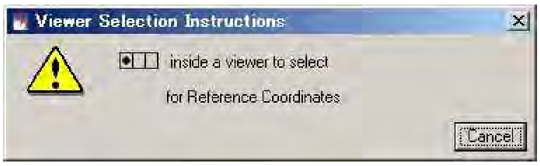
Prepare two imported images as;
Viewer 1: Show orthorectified image
Viewer 2: Show not orthorectified image
In Viewer 2 select Raster menu and choose Geometric Correction. Set Geometric Model and apply Polynomial. In Polynomial Model Properties accept the default values.
In GCP Tool Reference Setup select Existing viewer. In Viewer Selection Instructions click on a point in Viewer 1 and the Reference Map Information appears for information.
Select a minimum of nine (9) or ten (10) GCPs. Check RMS Error and Control Point Error. Both errors should be less than pixel size (normally 100) in Viewer 1.

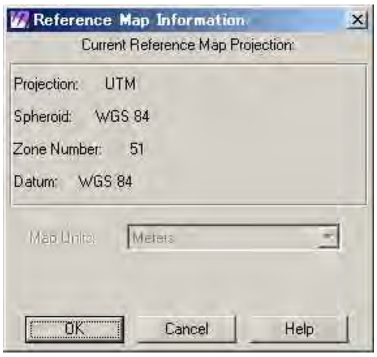


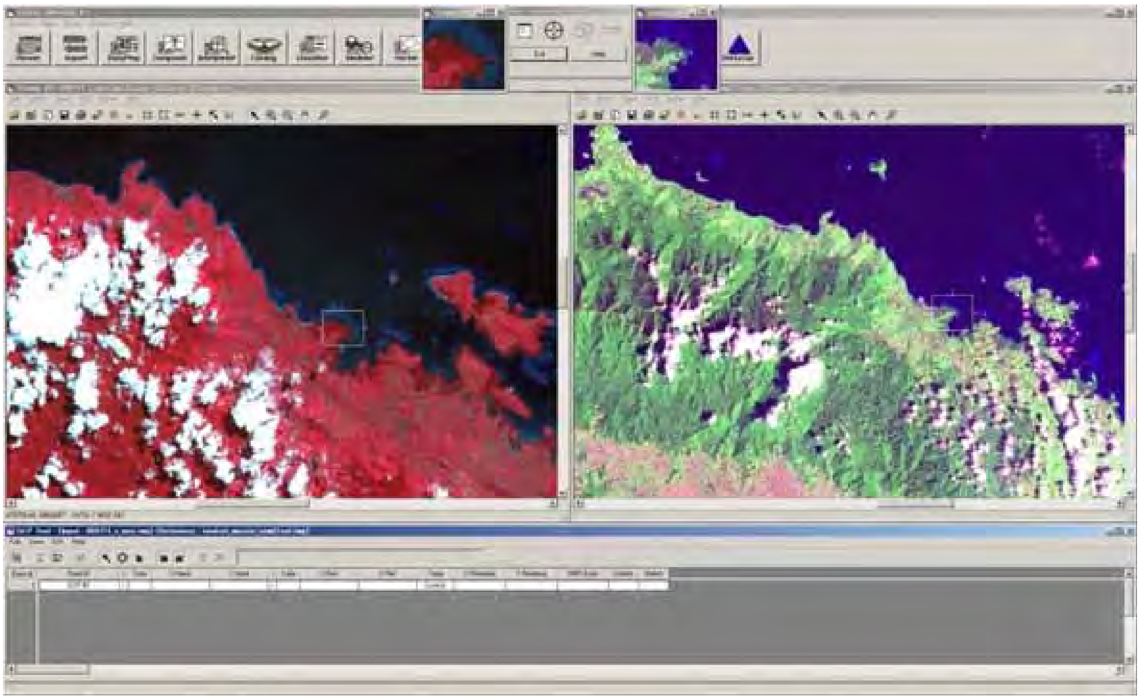




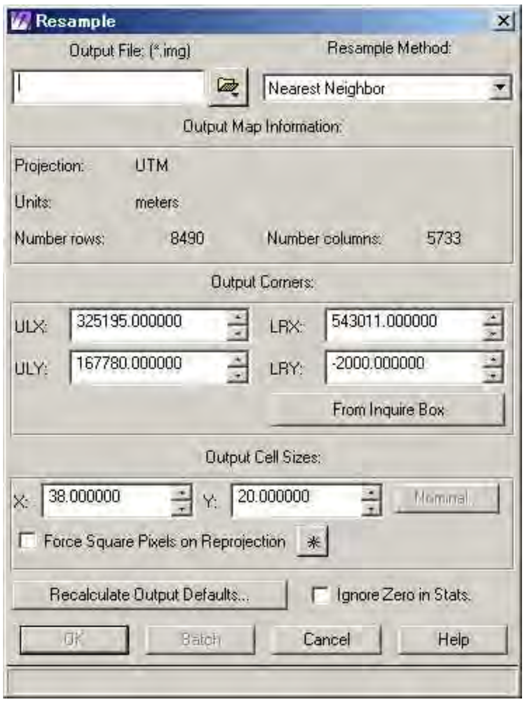

GCP Tool Reference Setup
Collect Reference Points From:
Existing Viewer
Image Layer (New Viewer)
Vector Layer (New Viewer)
Annotation Layer (New Viewer)
GCP File (.gcc)
ASCII File
Digitizing Tablet (Current Configuration)
Digitizing Tablet (New Configuration)
Keyboard Only
OK
Cancel
Help


Viewer Selection Instructions
inside a viewer to select
for Reference Coordinates
Cancel

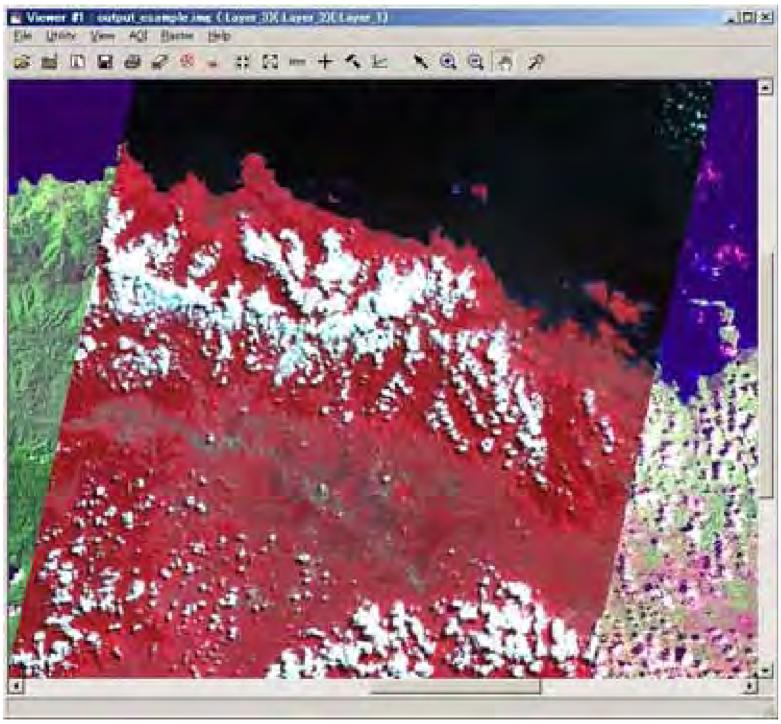

Reference Map Information
Current Reference Map Projection:
Projection: UTM
Spheroid: WGS 84
Zone Number: 51
Datum: WGS 84
Map Units: Meters
OK
Cancel
Help



In Geometric Tools select Display Resample Image dialogue. Then enter Output File name and choose Nearest Neighbor in Resample Method. Click OK to let resample process run.

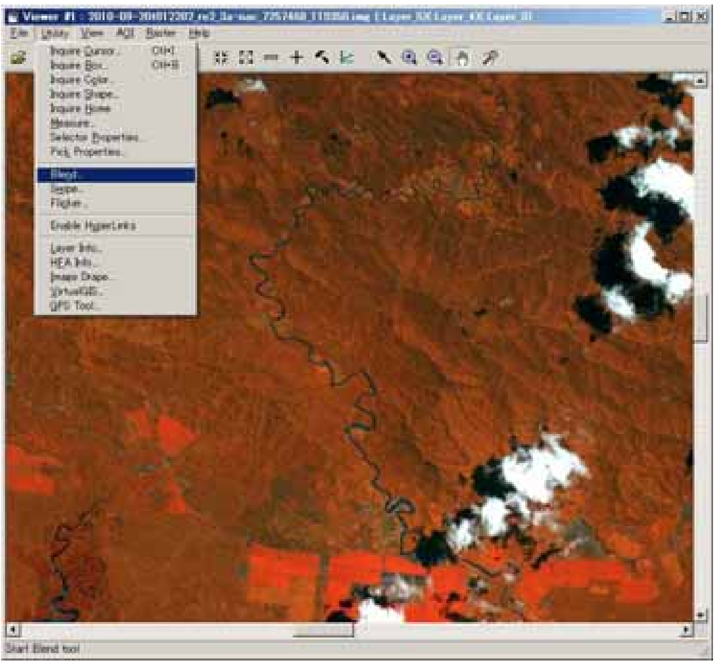


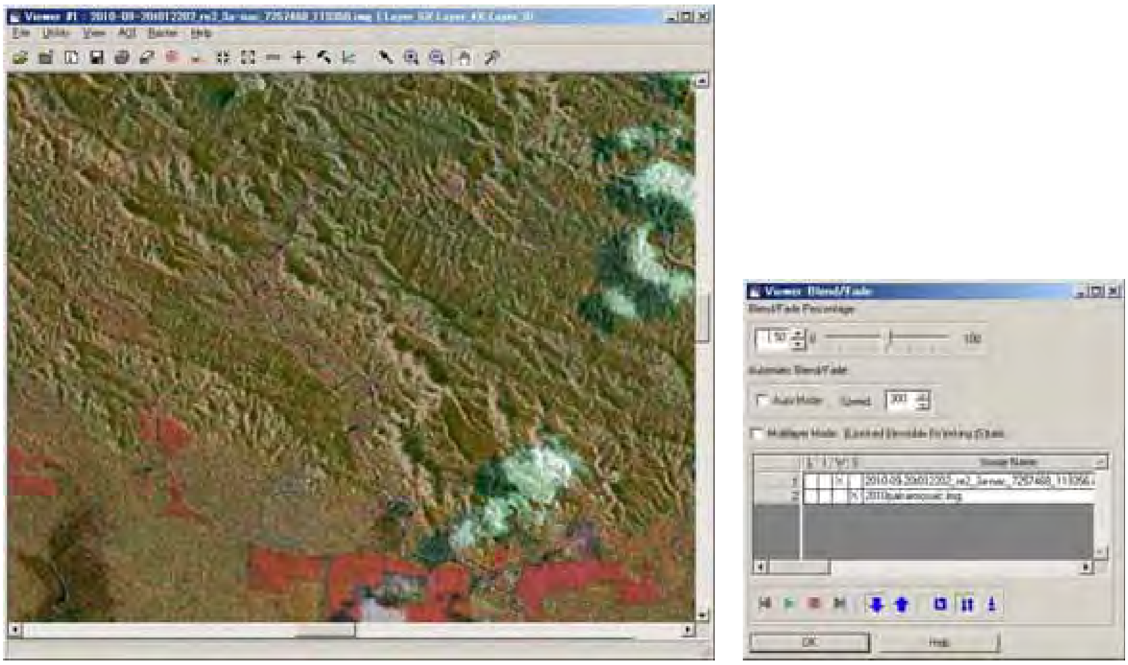

Create new Viwer to display geocoded (orthorectified) image. Open two images in same Viewer reference image and output resample image.




NB: When opening Output image untick Clear Display, tick Background Transparent and reset color combination to Red:3, Green:2 and Blue:1 depending on the Output image.

In Utility option select Blend or Flicker to view changes/difference in the two images.

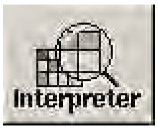




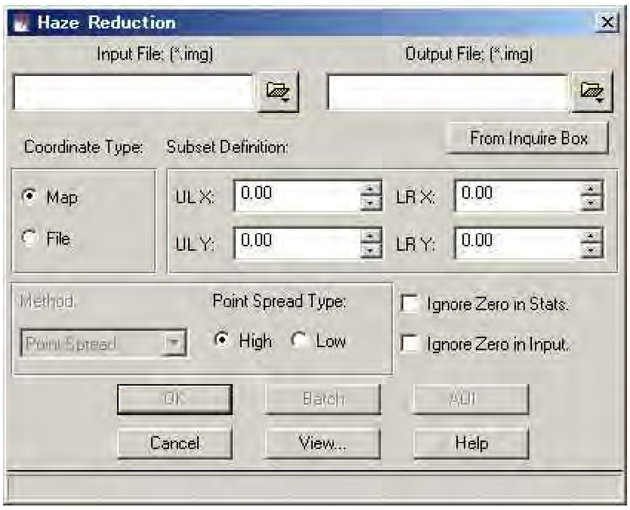
Comparing RapidEye image and PALSAR image using Blend/Fade.

2-2. Atmospheric Correction (Pre-processing/Radiometric Correction)

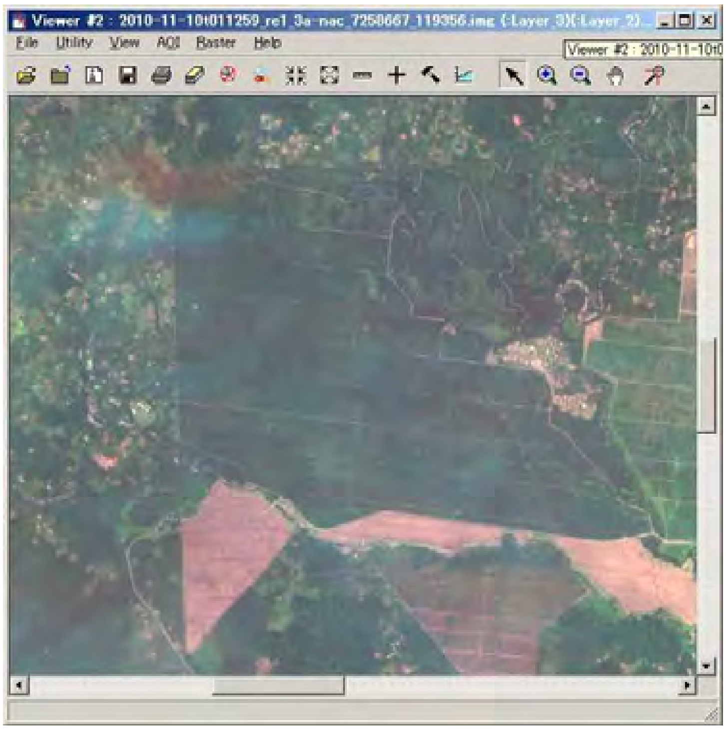
Select Interpreter menu and choose Radiometric Enhancement and select Haze Reduction or Noise Reduction. If Haze Reduction then open Input file (original) and create Output file (rename file). For Point Speed Type click High and rename Output file (eg, haze_reduction_high.img) and click OK to run.

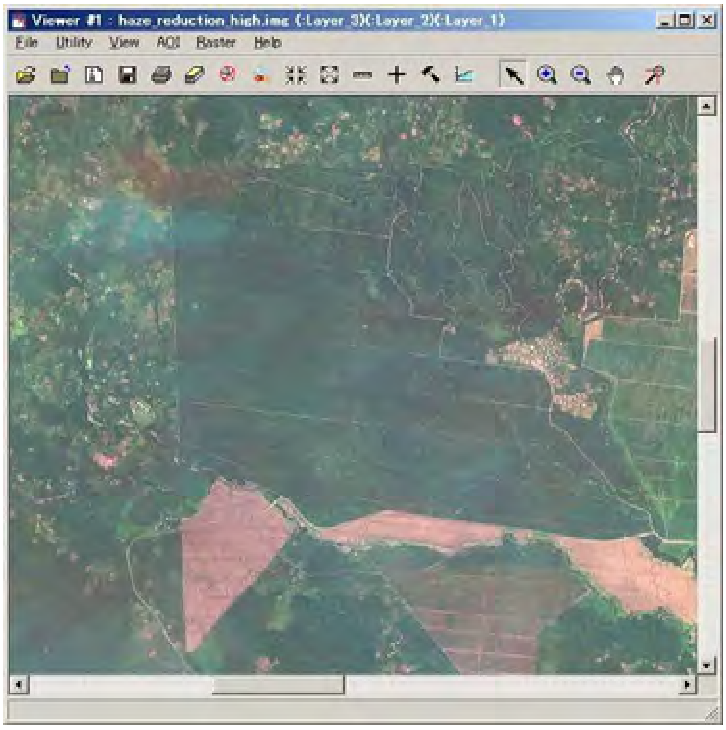





To compare, repeat above process then click Low and rename Output file (eg, haze_reduction_low.img) and click OK to run.



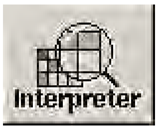



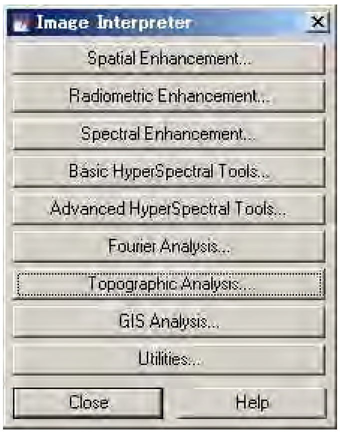

Top view is original RapidEye image.

Bottom view is applied Haze Reduction.

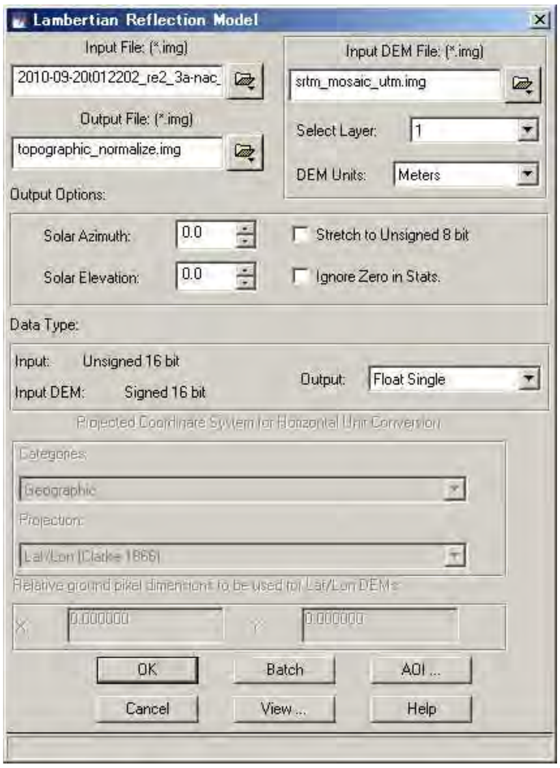
2-3. Topographic Analysis (Pre-processing/Radiometric Correction)(Optional)

In Interpreter menu select Topographic Analysis and choose Topographic Normalize. In Lambertian Reflection Model specify target image (working image file) as below








Input DEM file (already created) and set layer number as 1 and DEM units in Meters. Then create Output file (eg, topographic_normalize.img). Set Solar Azimuth (eg, 34) and Solar Elevation (eg 76) and click OK to run. (NB: Solar azimuth and elevation values are obtained from respective metadata files or can be calculated from meteorological information from observation/acquired date)

## 2-6. Applications of Optical Image (RapidEye)

The Optical image has a range of applications in analysis of geographical features. For applications in forest cover analysis optical image has merits in observing status of vegetation areas/types in forest and monitoring its changes. Landuse changes such as plantations can also be monitored among the forest cover. The forest cover and landuse change can be analysed using NIR(Near Infrared) band (especially RapidEye has NIR band as band #5). Other features such as roads, rivers (inundated areas), settlements, natural and man-made disasters can also be effectively monitored using optical images.

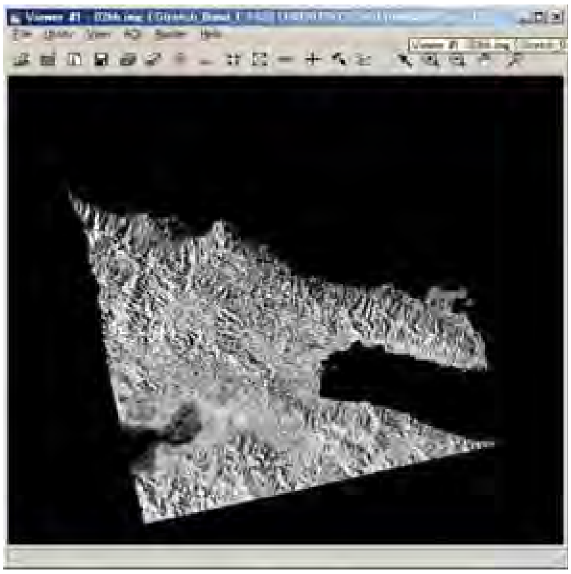
3. PALSAR data processing

3-1. Import PALSAR data

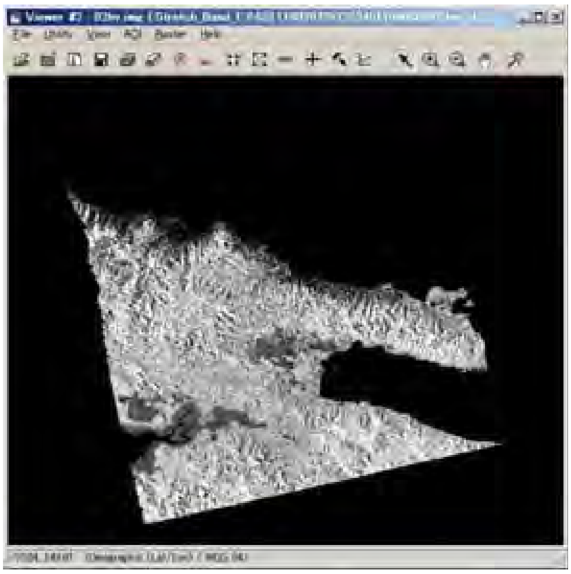
ERSDAC(A PALSAR provider) provides geocoded and orthorectified image as Geotiff file format, so it can be imported as geotiff image using Import tool. (See 2-1. How to import images.)

3-2. Combine HH-polarization image and HV-polarization image

In this programme, PALSAR FBD (Fine Beam Dual polarization) images are applied. FBD data are separated as HH data and HV data. Layer Stacking tool is used to combine the two images (HH data and HV data).



HH polarization image

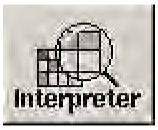
 HV polarization image

Note : What is HH polarization? and HV polarization?

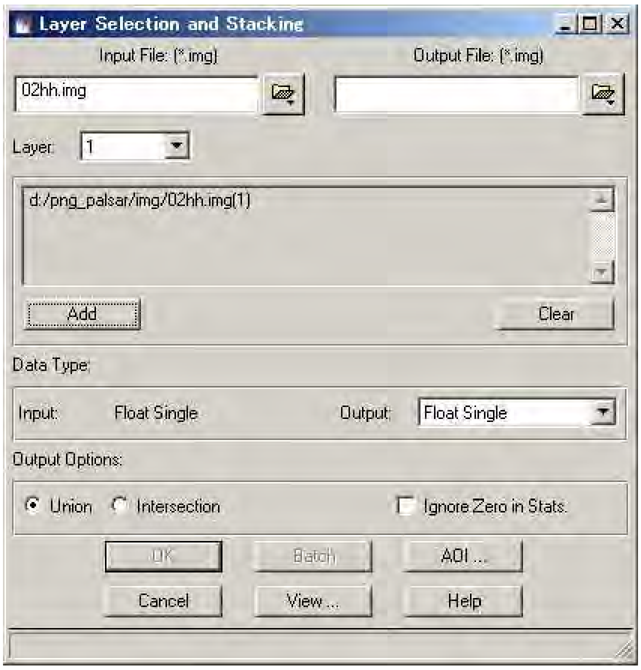
The radar sensor is an active sensor apart from Optical sensor which is passive. Thus, the radar sensor (space-borne) transmits signals to the target (on ground) and receives backscatter signals from the target. The signal transmitted by radar sensor is referred to as H (horizontal signal). The signal received by radar sensor is backscatter signal and referred to as; (1) H (horizontal signal) and (2) V (Vertical signal).
If the target(surface) is smooth, the backscatter signal is H. If the target(surface) is rough or the target is forest crown, the backscatter signal is V because the signal polarization is rotated.

Insert a diagram showing HH and HV here.

In ERDAS Imagine software select Interpreter menu and choose Utilities. Then select Layer Stack and choose Stacking. In Stacking open the Input file (*.hh.img) and click Add to add 'hh' file. Also open input file (*hv.img) and click Add to add 'hv' file.

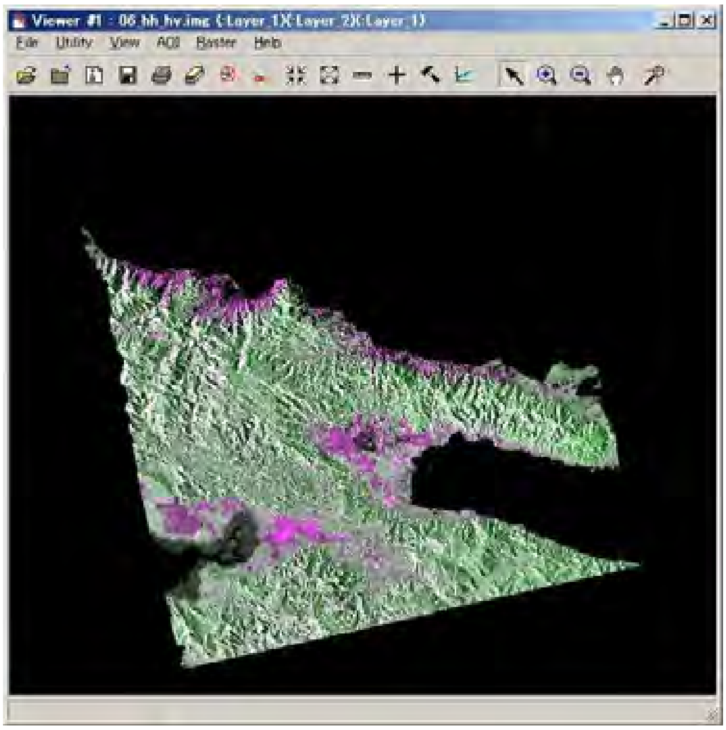




Create an Output file as (*hh_hv.img) which combines the two images and click OK to run the stacking process.


To display the processed image select File/Open in Viewer menu and in Select Layer To Add choose Raster option to set color combination as; Red: Band 1 (HH), Green: Band 2 (HV) and Blue: Band 1 (HH).

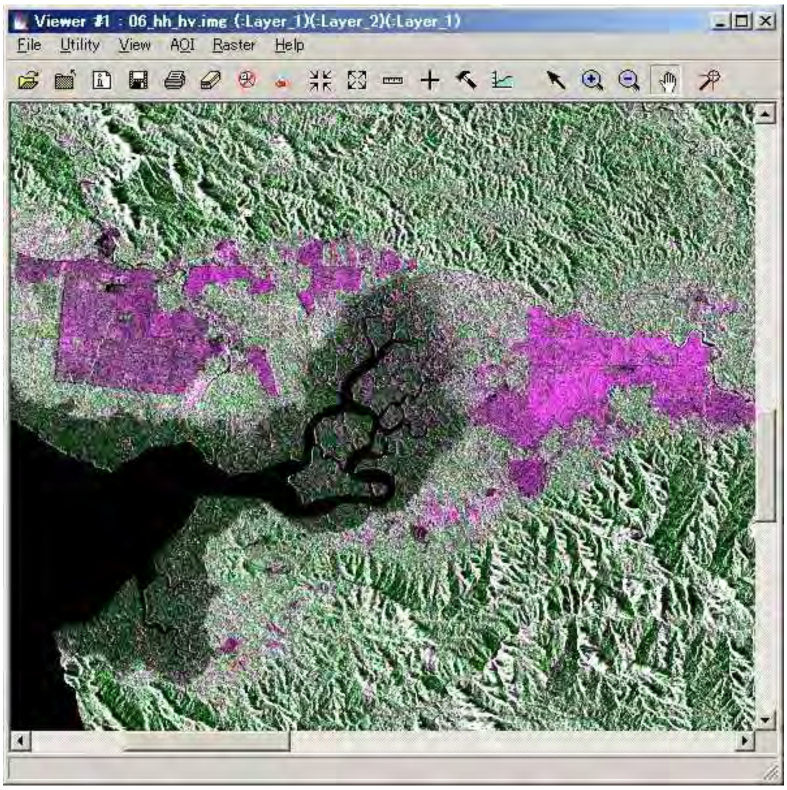


Viewer #1 : 06 hh hv.img (:Layer_1)(:Layer_2)(:Layer_1)
File Utility View AOI Raster Help

3-3. Comparing HH image and HV image

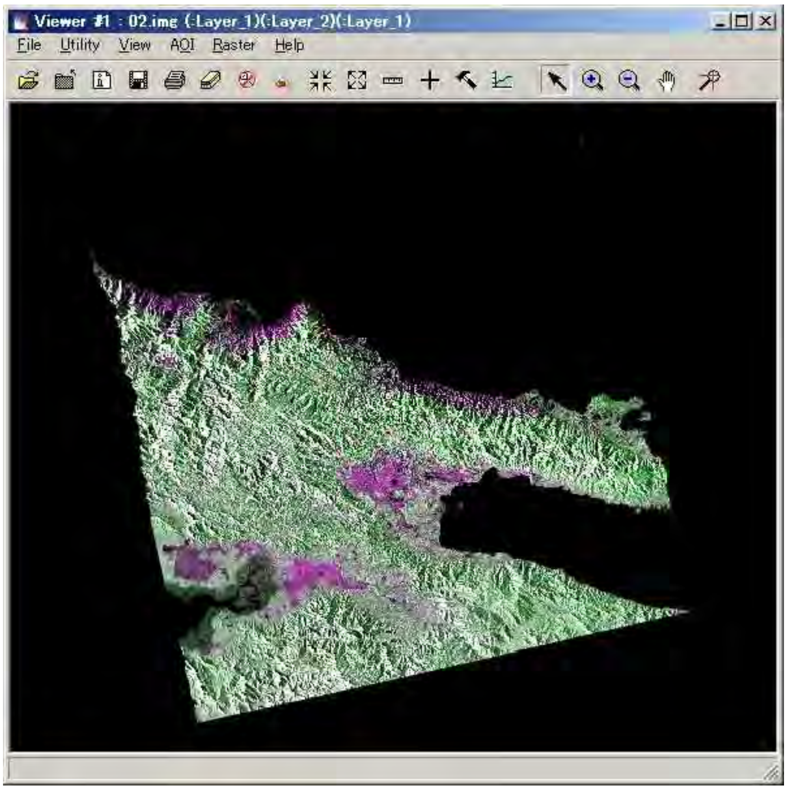
In figure ……. the processed image display false color of the image and so it depicts a profile of vegetation cover in area of interest (AOI). The HH signal received with bright/strong backscatter shows features such as buildings, settlements due to its double-bounce effect. The HV signal received with bright/strong backscatter shows vegetation areas or relief areas (rough areas) due to volume scattering.

In figure below, mangrove area is shown as dark green but due to water cover it also indicates grey color among mangrove areas. (HV signal received with dark/weak backscatter)

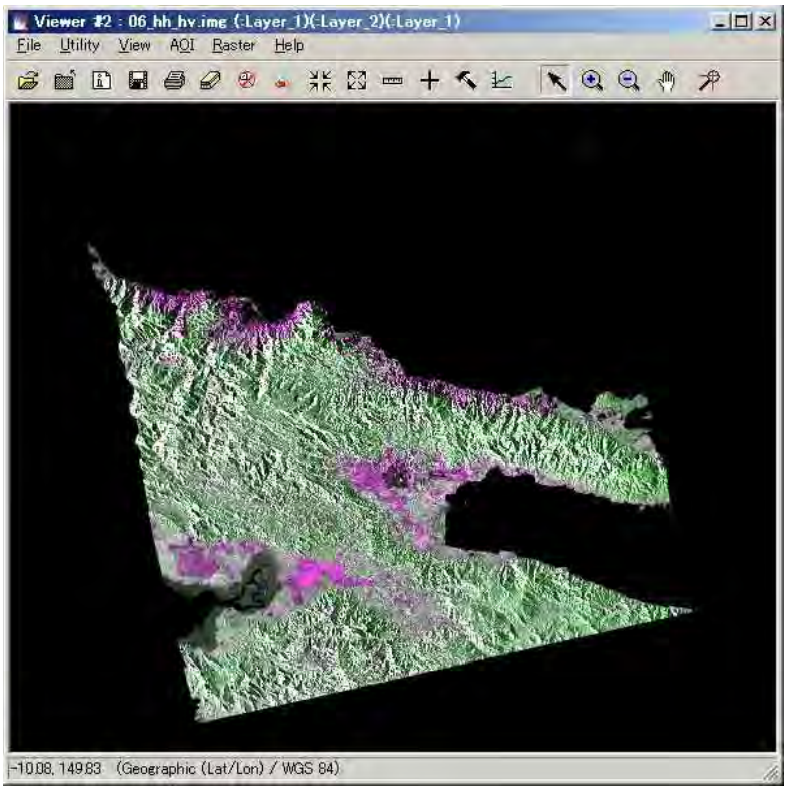


3-4. Comparing PALSAR image in 2007 and 2010

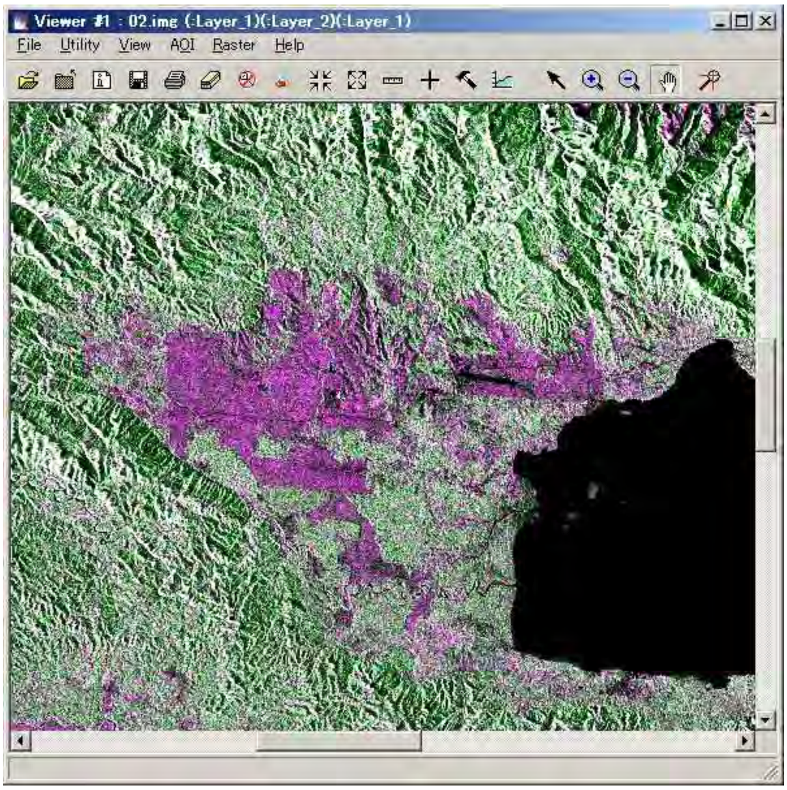
Physical/Geographical changes can be observed over certain period of interest and thus the PALSAR image can be used as such in comparing images of 2007 and 2010. The two images can be compared to monitor or detect changes in vegetation/forest cover over time period. If the image (HV signal as backscatter effect with color Green: band 2) shows bright/strong effect in year 2010 than in 2007, it indicates afforestation, or re-growth/regeneration. If the image (HV signal as backscatter effect with color Green: band 2) shows dark/weak effect in year 2010 than in 2007, it indicates deforestation/logged area or burning/clearing area of forest/vegetation cover. If the image (HH signal as backscatter effect with color Magenta: band 1) shows bright/strong effect in year 2010 than in 2007, it indicates building constructions or new planting areas (agriculture). If the image (HH signal as backscatter effect with color Magenta: band 1) shows dark/weak effect in year 2010 than in 2007, it indicates clearing/removal of .buildings, roads, surface areas with water cover or flooding areas.



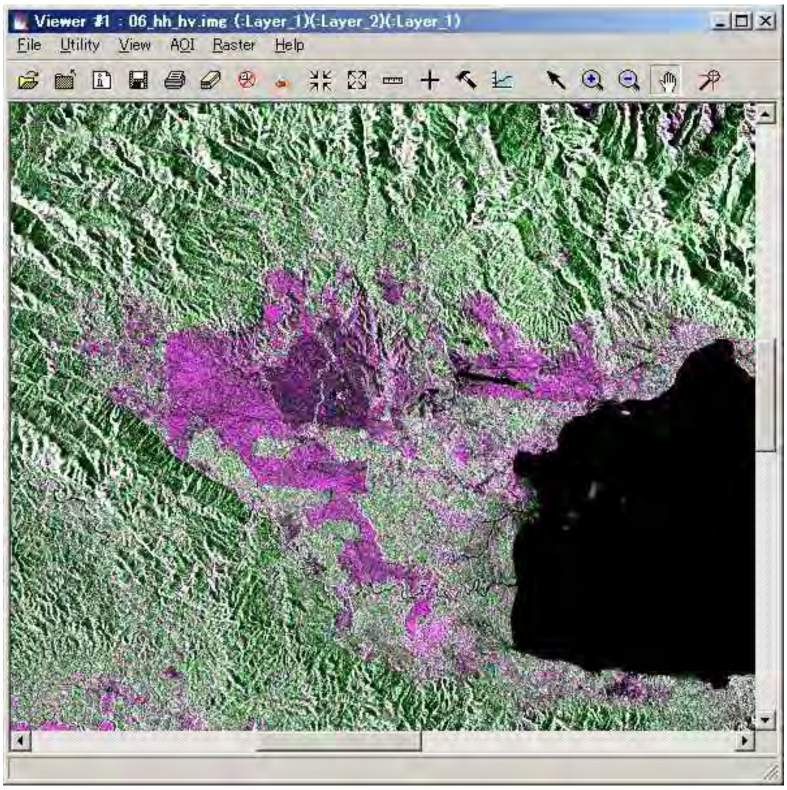
PALSAR image in 2007



PALSAR image in 2010



PALSAR image in 2007



PALSAR image in 2010

4. Applications of RapidEye, PALSAR and GeoSAR

The table below summarizes the applications and its merits and demerits.

| RapidEye | PALSAR | GeoSAR |
|---|---|---|
| **Applications**<br>Forest/Vegetation Types<br>Plantation<br>Land-use<br>Roads<br>Rivers<br>Settlements<br>Natural/Man-made disaster | **Applications**<br>Forest/Vegetation Change detection<br>Geological structure<br>Natural/man-made disaster<br>Plantations | **Applications**<br>Forest cover detection<br>Tree height |
| **Demerits**<br>Cloud cover<br>Expensive | **Demerits**<br>Difficult to interpret/understand | **Demerits**<br>More expensive<br>One time observation<br>Limited area of observation (Cannot cover whole of PNG) |

## Presentation on JICA Training Program

**JICA PROGRAM**

CAPACITY DEVELOPMENT ON FOREST RESOURCE MONITORING FOR ADDRESSING CLIMATE CHANGE IN PAPUA NEW GUINEA (PNG)

**PROGRAM OBJECTIVE:**

1. TO UNDERSTAND THE WHOLE PICTURE OF FUTURE ACTIVITIES THROUGH THE INTRODUCTION OF CASE EXAMPLE OF JAPANESE REDD & RELATED SUPPORT
2. TO BE ABLE TO PREPARE AND ORGANISE BASIC INFORMATION FOR IMPLEMENTATION OF THE FUTURE PROJECT THROUGH PRACTICAL WORK OF FOREST COVER CLASSIFICATIONS USING REMOTE SENSING TECHNOLOGY AND ACTUAL DATA OF PNG.

## PO 1. (A) CASE EXAMPLE OF JAPANESE REDD & RELATED SUPPORT:

(ERSDAC) EARTH REMOTE SENSING DATA ANALYSIS CENTRE

**PALSAR Project**

PHASE ARRAY TYPE L – BAND SYNTHETIC APERTURE RADAR IS ONE OF THE IMAGING SENSORS ON BOARD THE ALOS (ADVANCED LAND OBSERVING SATELLITE) LAUNCHED IN JANUARY 24,2006.

## CHARACTERISTICS OF PALSAR

- ALL WEATHER SENSOR (RAIN/NIGHT/CLOUD)
- L BAND (1.27 GHZ/23.6CM)
- HIGH RESOLUTION (GROUND RES.10M)/ SWATH 70KM
- MULTI-POLARIZATION: HH, VV, HH + HV, VV + VH, HH + HV + VH + VV. FOR VEGETATION, SOIL AND GEOLOGIC CLASSISFICATION

## Japan Aerospace Exploration Agency (JAXA)

REDD AND FOREST MONITORING USING ALOS/PALSAR

- GLOBAL TIME SERIES HIGH RESOLUTION (10M AND 25M) L – BAND SAR DATASET USING JERS-1(1992 – 1998) AND PALSAR (2007 – 2010) ARE BEING GENERATED AND USED FOR REDD+, i.e, MONITORING THE FOREST CHANGE, FOREST CLASSIFICATION AND IN FUTURE CONVERTING TO BIOMASS
- SEVERAL CLASSIFICATION METHODS ARE EVALUATED FROM THE MAIN (AUTHOMATIC OPERATION) DRIVER FOR REDD. JAXA IS KEEN TO SHARE THE REDD+ACTIVITY JOINTLY USING THE SATELLITE DATA, GROUND TRUTH DATA, EXPERIMENT, EVALUATION WITH INTERESTED PARTIES.

## Forestry & Forest Products Research Institute

### ONE OF THE ROLES OF REDD R & D CENTRE OF FFPRI IN FFPRI– REDD PROGRAM IS TO;

- DEVELOP REMOTE SENSING METHODOLOGIES AND ANALYTICAL TECHNIQUES IN ORDER TO MONITOR DEFORESTATION AND FOREST DEGRADATION IN DEVELOPING COUNTRIES.
- FFPRI DEVELOPS METHODS TO INTEGRATE REMOTE SENSING TECHNIQUIES WITH GROUND MEASUREMENTS FOR FOREST MONITORING. REMOTE SENSING BY SATELITE IS A PARTICULARLY USEFUL TECHNIQUE FOR MONITORING FORESTS OVER LARGE AREAS.  IT IS ESPECIALY EFFECTIVE WHEN MONITORING DEFORESTATION. AND FOREST DEGRADATION IN DEVELOPING COUNTRIES.

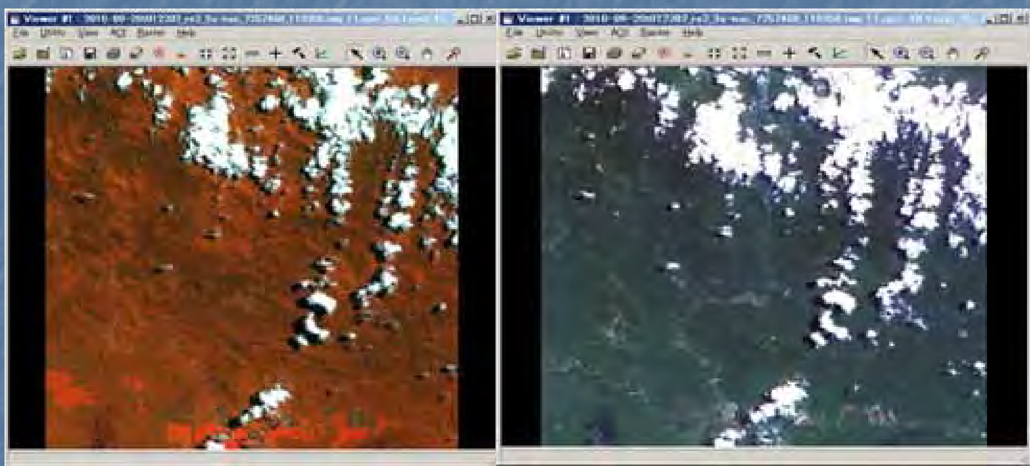
- METHODS ARE CURRENTLY DEVELOPED TO ESTIMATE CHANGES IN CARBON STOCK LEVELS AND TO IDENTIFY THE VARIOUS CAUSES OF FOREST DEGRADATION BY USING MULTI TEMPORAL OR HIGH RESOLUTION SATELLITE DATA IN COMBINATION WITH GROUND MEASUREMENTS.

- ALSO RESEARCHING WAYS OF USING THE SAR CARRIED ON THE JAPAN ALOS SATELLITE AND EXHIBITING ITS ABILITY TO PENETRATE CLOUD COVER IN ORDER TO IDENTIFY DEFORESTATION AND FOREST DEGRADRADATION IN CLOUD COVERED TROPICAL RAIN FORESTS.

**PO (2): PRACTICAL WORK OF FOREST COVER CLASSIFICATION USING REMOTE SENSING TECHNOLOGY AND ACTUAL DATA OF PNG**

**(2.1) Image processing of RapidEye by ERDAS Imagine for Milne Bay Province (PNG)**

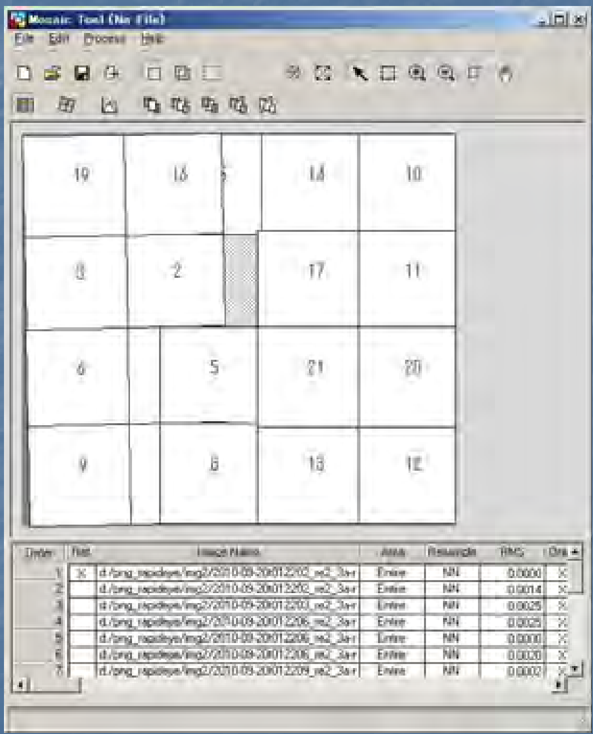
Comparing visible (natural color) image and infrared image

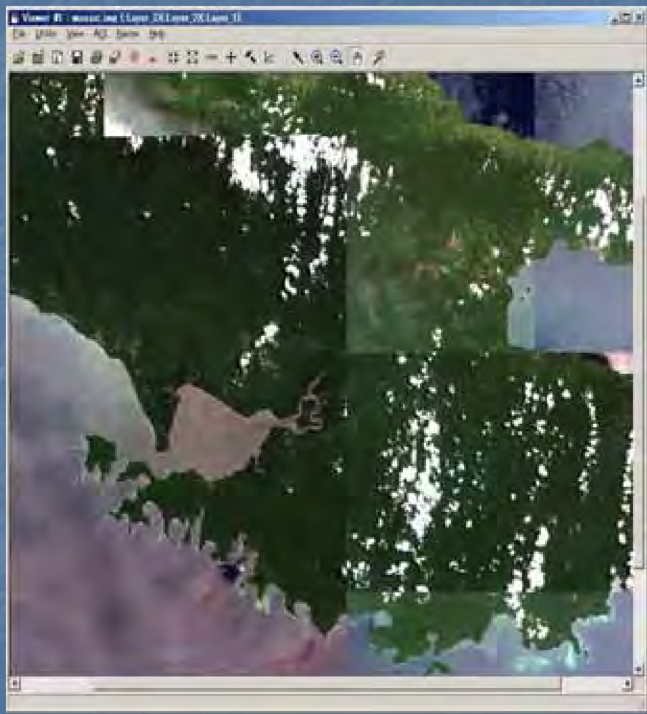


**The left image in Infrared color (false) shows difference of forest and land-use area.**
**The right images shows natural color (useful in mapping )**

## Mosaic Of RapidEye Images by ERDAS

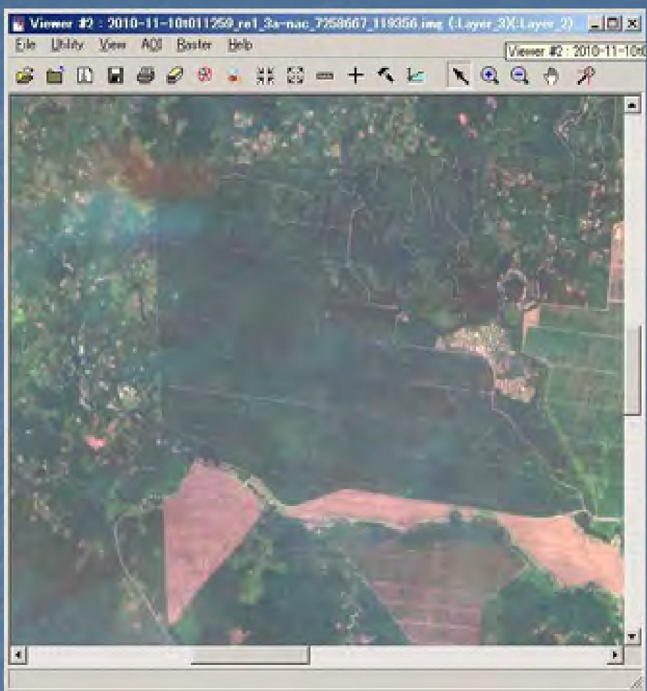
Mosaic index information

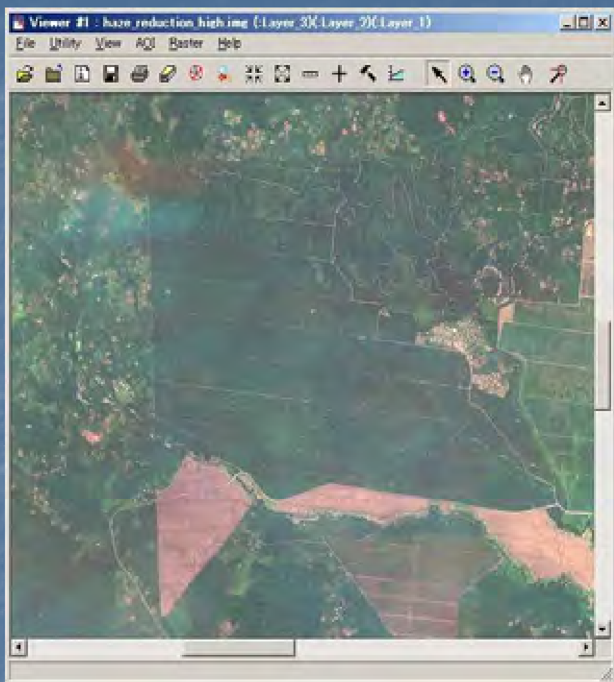


View of final/complete mosaic image.

## Atmospheric Correction (Pre-processing/Radiometric Correction)

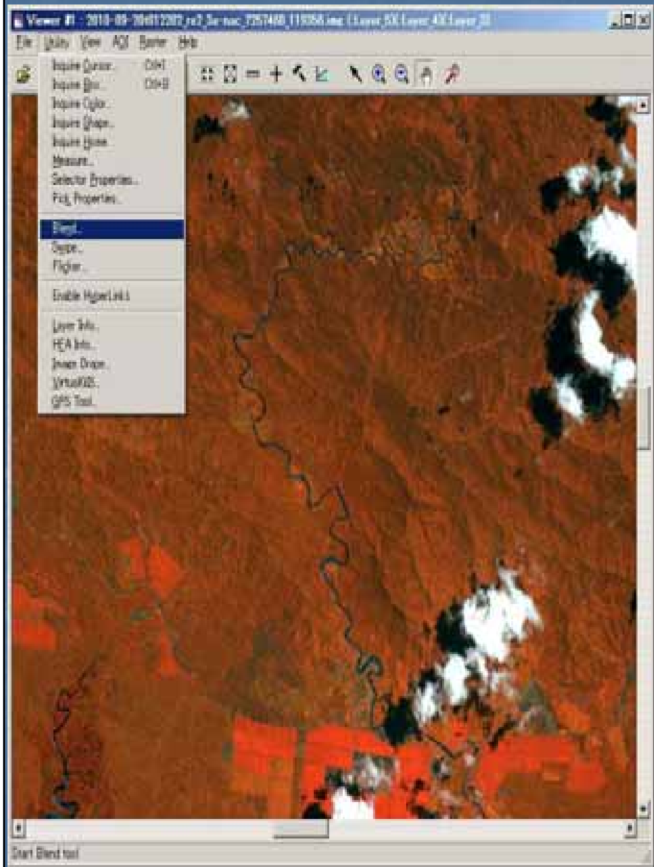


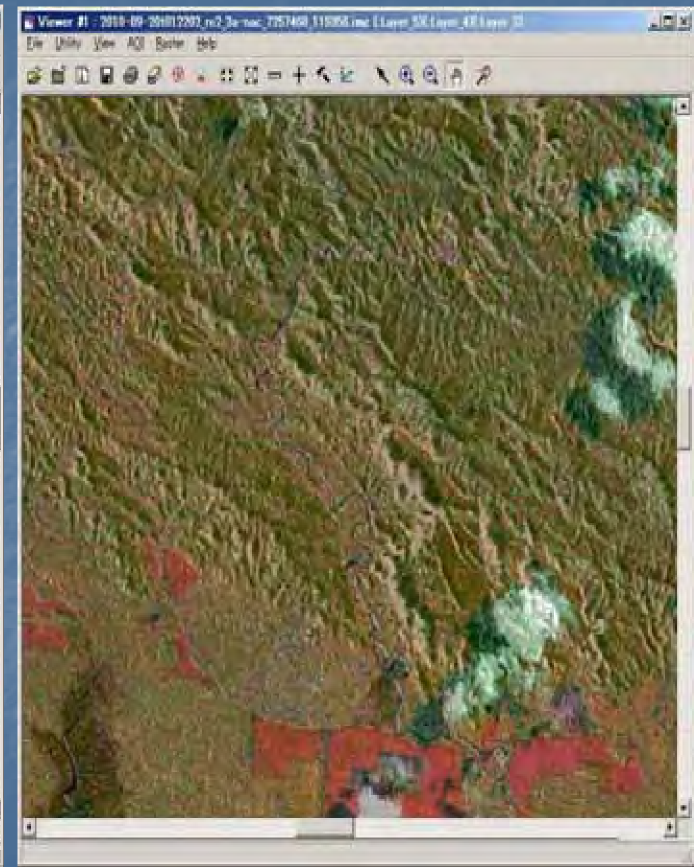

Left view is original RapidEye image.

Right view is applied Haze Reduction.

## Comparing/merging RapidEye image and PALSAR image using Blend/Fade



RapidEye/PALSAR Image

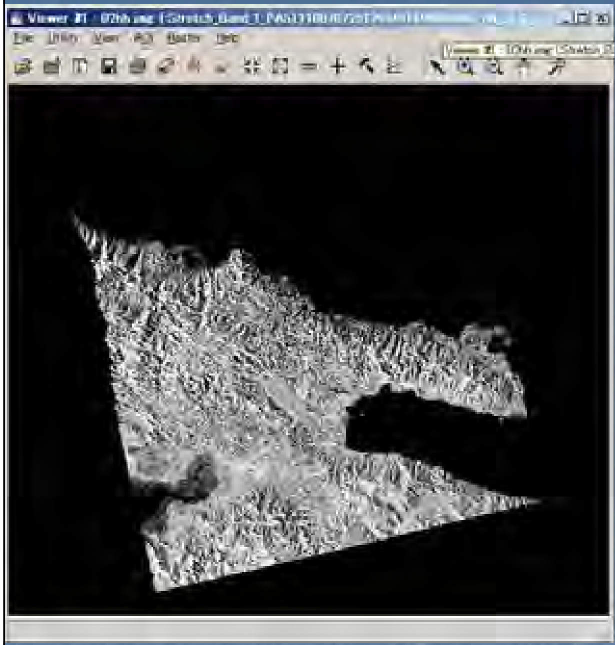


PALSAR/RapidEye Image

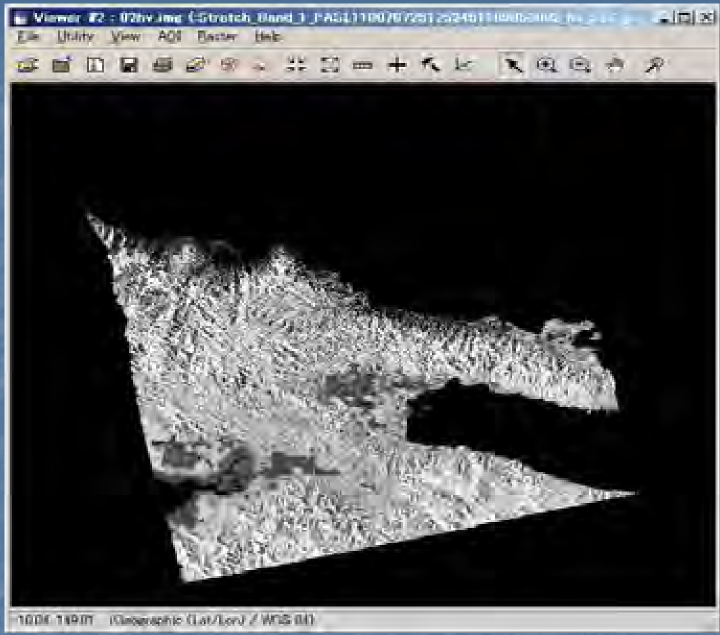
## Applications of Optical Image (RapidEye)

The Optical image has a range of applications in analysis of geographical features. For applications in forest cover analysis optical image has merits in observing status of vegetation areas/types in forest and monitoring its changes. Landuse changes such as Logged and Landuse features can also be monitored among the forest cover. The forest cover and its changes can be analysed using NIR(Near Infrared) band (especially RapidEye has NIR band as band #5). Other features such as roads, rivers (inundated areas), settlements, natural and man-made disasters can also be effectively monitored using optical images.

## 2.2 PALSAR Data Processing



HH polarization image



HV polarization image

## What is HH polarization? and HV polarization?

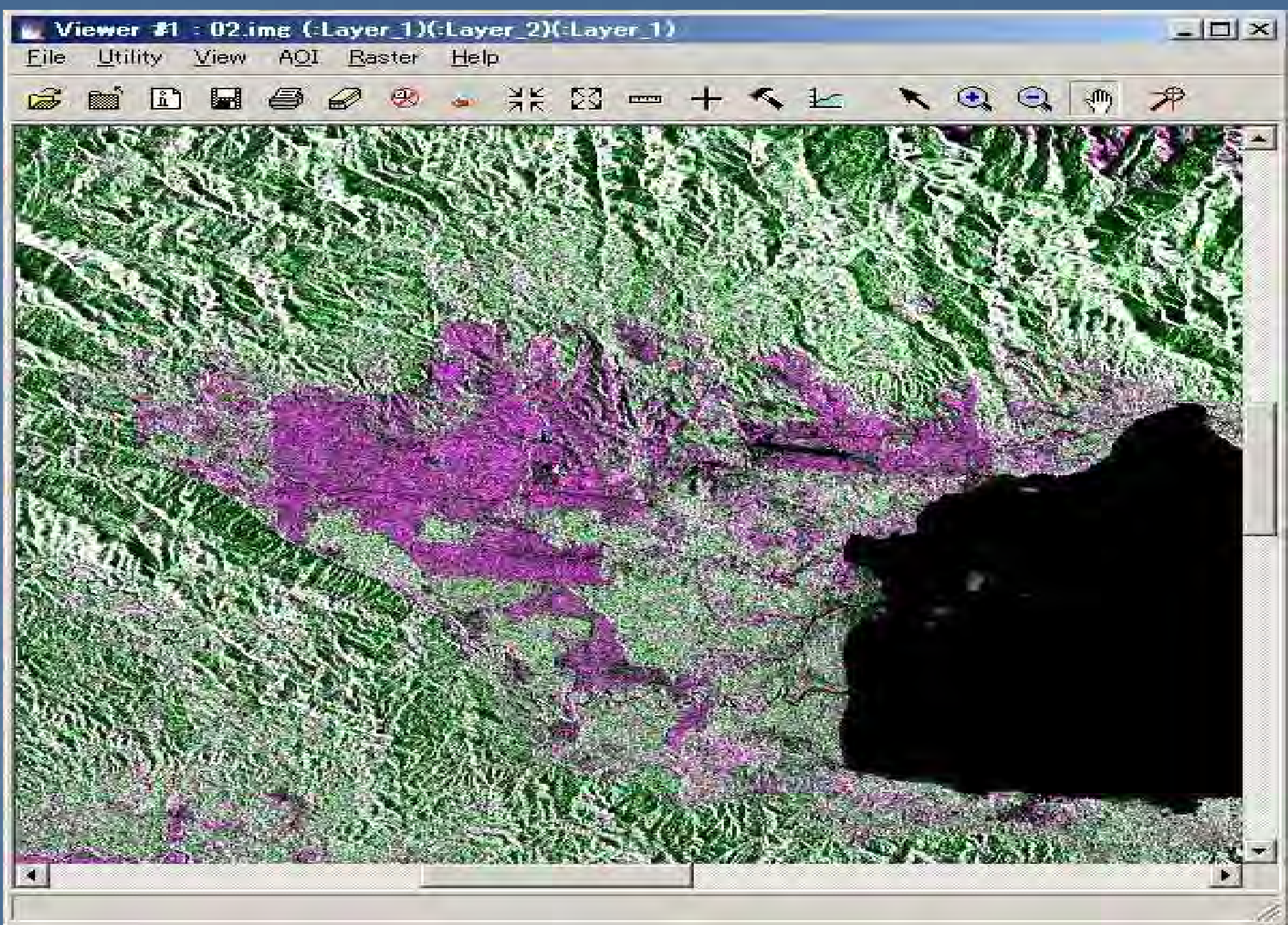
- The radar sensor is an active sensor apart from Optical sensor which is passive. Thus, the radar sensor (space-borne) transmits signals to the target (on ground) and receives backscatter signals from the target. The signal transmitted by radar sensor is referred to as H (horizontal signal). The signal received by radar sensor is backscatter signal and referred to as; (1) H (horizontal signal) and (2) V (Vertical signal).

- If the target (surface) is smooth, the backscatter signal is H. If the target (surface) is rough, eg; forest crown , the backscatter signal is V because the signal polarization is rotated. (Illustrate)

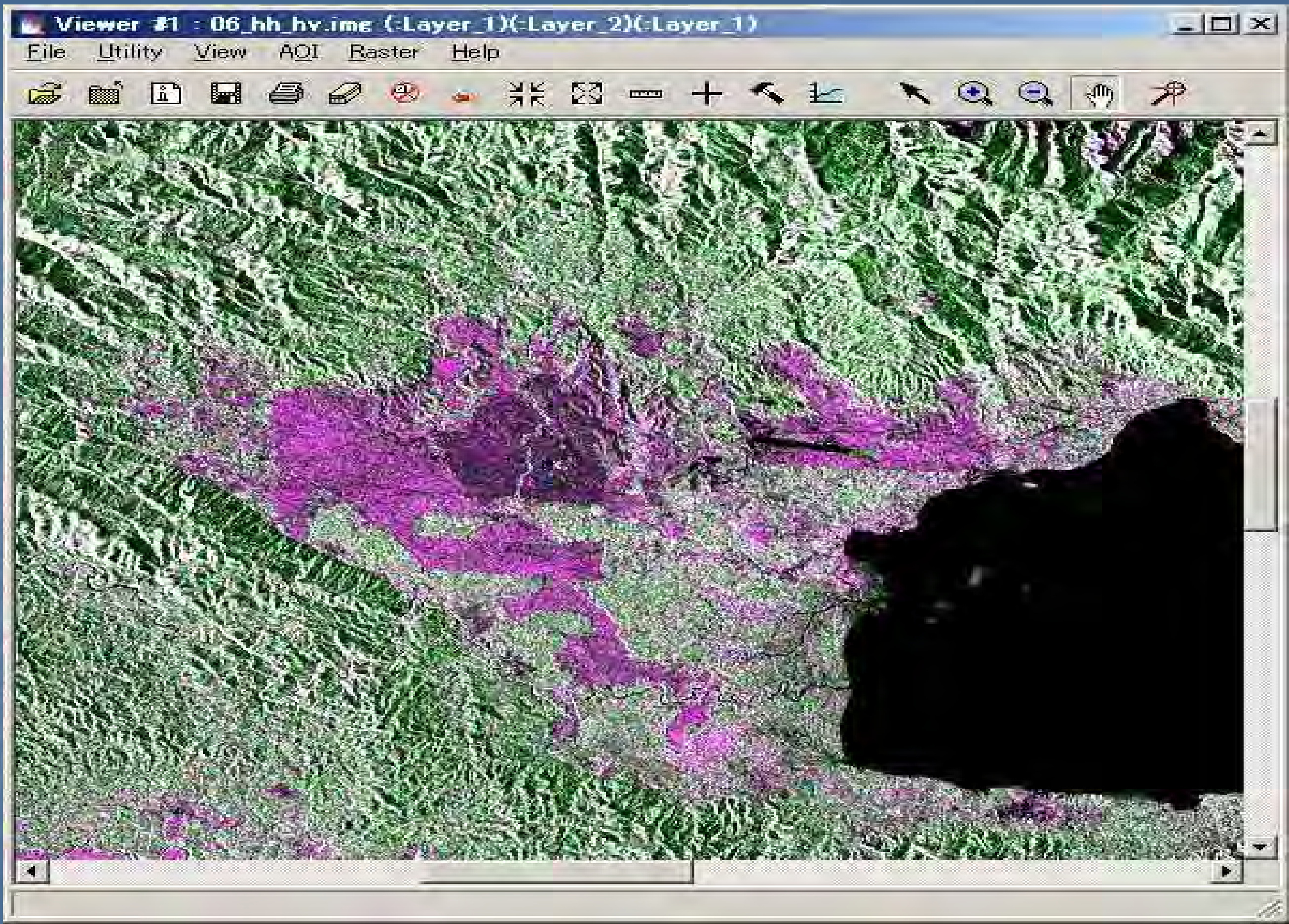
## Comparing PALSAR image of 2007 and 2010

- Physical/Geographical changes can be observed over certain period of interest and thus the PALSAR image can be used as such in comparing images of 2007 and 2010. The two images can be compared to monitor or detect changes in vegetation/forest cover over time period.

- If the image (HV signal as backscatter effect with color Green: band 2) shows bright/strong effect in year 2010 than in 2007, it indicates afforestation, or re-growth/regeneration.
- If the image (HV signal as backscatter effect with color Green: band 2) shows dark/weak effect in year 2010 than in 2007, it indicates deforestation/logged area or burning/clearing area of forest/vegetation cover.
- If the image (HH signal as backscatter effect with color Magenta: band 1) shows bright/strong effect in year 2010 than in 2007, it indicates building constructions or new planting areas (agriculture).
- If the image (HH signal as backscatter effect with color Magenta: band 1) shows dark/weak effect in year 2010 than in 2007, it indicates clearing/removal of .buildings, roads, surface areas with water cover or flooding areas.




**PALSAR image in 2007**

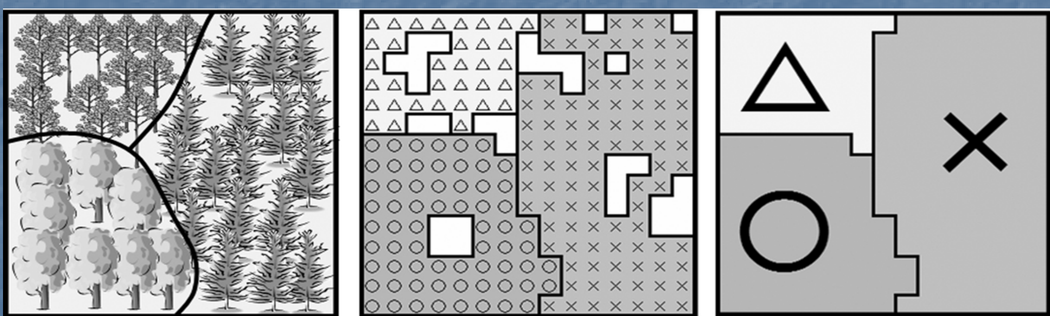



PALSAR image in 2010

## 2.3 Forest Cover Classification

- **Object based classification (eCognition Software)**

  **Object-Based Classification is a method of image analysis to conduct classification based on image objects. This method to partition a comparatively homogeneous domain on an image is similar to image interpretation by human eyes (Figure 1 (a)). It is difficult to partition homogeneous domain on the existing pixel-based classification without the difference of the minute domain, because it does not consider relations with neighboring pixels (Figure 1 (b)). Therefore, in many applications, the object-based classification can be more effective for high resolution image analysis than pixel-based classification (Figure 1 (c)).**



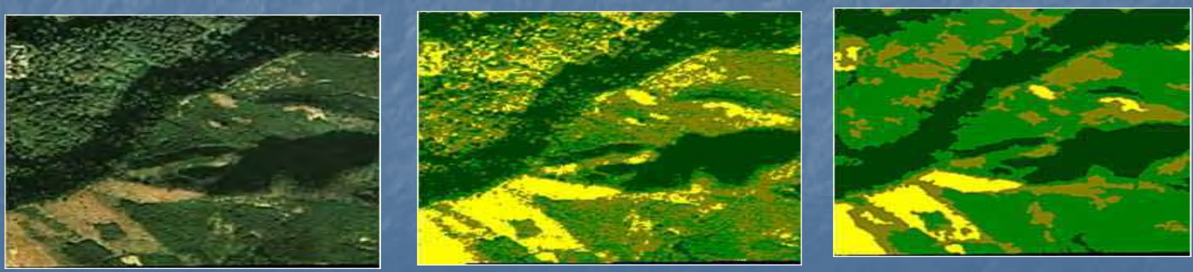
(a) (b) (c)

Figure 1: Differences between Object-based Classification and Pixel-based Classification

## Classification

- (a) Human eyes' interpretation (Boundaries of different vegetation types can be extracted.)
- (b) Pixel-based classification (The difference of the minute domain is extracted unnecessarily)
- (c) Object-based classification (Results can be close to those of human interpretation.)
- Regarding pixel-based classification, because one class of domain may contain many minute domains of other classes, it is often hard to interpret a resulting classification map. Regarding object-based classification, on the other hand, because this method segments a whole image into small domains (image objects), a resulting classification map can be similar to a map that can be created based on human eyes' interpretation (Figure 2).

Figure 2: Comparison of Pixel-based Classification and Object-based Classification



**Original Image** **Pixel-Based Classification** **Object-Based Classification**

## 2.4 Applications of RapidEye, PALSAR and GeoSAR

The table below summarizes the applications and its merits and demerits.

| RapidEye | PALSAR | GeoSAR |
|---|---|---|
| **Applications**<br>Forest/Vegetation types<br>Plantation<br>Land-use<br>Roads<br>Rivers<br>Settlements<br>Natural/Man-made disaster | **Applications**<br>Forest/Vegetation<br>Change detection<br>Geological structure<br>Natural/man-made disaster<br>Land-use | **Applications**<br>Forest cover detection<br>Tree height |
| **Demerits**<br>Cloud cover<br>Expensive | **Demerits**<br>Difficult to interpret/understand | **Demerits**<br>More expensive<br>One time observation<br>Limited area of observation<br>(Cannot cover whole of PNG) |


Arigato Gozaimasu
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JAXA
(Acknowledgements)