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Capacity Building of ALOS Satellite Data to Support Mapping and Monitoring Deforestation and Degradation in Indonesia

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ABSTRACT: RESTEC and partners designed a workshop in Indonesia and a training course in Japan with the aim to improve Indonesia's capability of forest monitoring, transferring Japanese technologies and knowledge of analysing satellite data, particularly ALOS/PALSAR, and contribute to decision-making in forestry and carbon emissions in Indonesia. A one-day workshop and two-week training course were completed where participants shared very useful information. Eight Indonesian GIS/RS experts learned the basic theory of Radar sensor, in particular ALOS/PALSAR, geometric and radiometric features of SAR and other basic knowledge. They also practised techniques and procedures using PALSAR observation data for forest monitoring and forest biomass estimation. With these techniques and knowledge, they can advance their research and operational forest-monitoring work more efficiently. Collaborators agreed that the training was useful and that these kinds of activities to improve Indonesian capacity should be continued.

KEYWORDS: *satellite, ALOS, PALSAR, forest, REDD+, Indonesia*

Introduction

Since the 1990's, forest monitoring using remote sensing in Indonesia has been carried out using Landsat images (optical images). Cloud cover is considered to be the main obstacle in obtaining consistent images that cover the whole area of the country and 10% of images are generally always cloud covered. This situation contrasts with the increasing need to obtain more rapid, reliable, and consistent information of the current status of land use and land cover as well as their dynamic changes over time.

Radar data has the capacity to penetrate cloud and is essential to overcome the cloud cover problem. Integrating data from the Phased Array type L-band Synthetic Aperture Radar (PALSAR) on the Advanced Land Observing Satellite (ALOS) into current forest monitoring systems will provide cloud free results. In addition to the capability of providing cloud cover-free information, ALOS/PALSAR data, specifically dual polarimetric data, also has the potential to discriminate between forest cover types and other major types of land cover. This implies that in the establishment of improved (new) reliable methods, solely for forest cover monitoring systems, detecting change and monitoring deforestation and degradation using ALOS/PALSAR data is promising.

Preparatory Phase

A workshop was held on 19 July 2011 in Bogor, Indonesia, and participated by Indonesian experts from ministries, agencies and universities. The participants shared information on research and capacity building activities related to forest monitoring by remote sensing in Indonesia, as well as needs of the Indonesian government. Based on the information shared, a training course was developed.

Figure 1. Participants of the workshop.

Before the training course, RESTEC developed a basic method of forest monitoring with PALSAR data, customising RESTEC's existing techniques, experiences and algorithms, which mainly focused on domestic forest areas in Japan. The existing techniques needed to be customised and adjusted to Indonesian forests because of the very different forest types between the two countries.

Figure 2 is a colour composite image analysed from PALSAR FBD data observing a forest area in Indonesia on 4 October 2008. FBD contains HH and HV polarisations. RESTEC generated the forest/non-forest map from PALSAR data observed on 25 February 2011. Figure 3 is the forest/non-forest map derived from Figure 1. RESTEC calculated the intensity of backscatter pixel by pixel, and settled the threshold at –13db in order to classify forest and non-forest. In the existing methodology, which we used to analyse forest areas in Japan, we set the threshold at –11.5db.

HIGHLIGHTS

- A workshop was held in Bogor, Indonesia, where participants shared useful information for satellite monitoring of forests.
- A two-week training course was conducted in Tokyo, Japan. Participants learned various techniques and procedures in using PALSAR observation data for forest monitoring and forest biomass estimation.

Training Implementation

Eight Indonesian GIS/RS experts who have basic knowledge and experience of GIS/RS were selected as trainees. They were from the Ministry of Forestry, Republic of Indonesia (MoF); the Agency for the Assessment and Application of Technology (BPPT) and the local government of Landak Regency (West Kalimantan Province).

Interferometry

Through the training course, the participants learned Interferometric SAR (InSAR) and Differential InSAR (DInSAR) techniques. Interferometry is used to analyse interference of phase information of two or more pairs of SAR data. In this technique, changes in surface condition can be detected, including areas of deforestation and degradation.

Polarimetery

Trainees learned about SAR Polarimetry, which is very important to classify forest and non-forest areas. ALOS/PALSAR full polarisation observation (PLR) mode can detect 4 pairs of polarisations (HH, HV, VV and VH). Trainees understood the features of polarisations and generated a colour composite image from different polarisation images. All participants obtained a series of techniques to generate colour composite images and forest/non-forest maps from PLR data.

Change Detection

Trainees learned the technique to detect deforestation and degradation using multi temporal sets of SAR data. Satellites can observe a certain area over and over again, particularly since radar sensors are not affected by weather. This is one of the advantages of satellite remote sensing and periodical observation and is very important in MRV for REDD+.

Above-Ground Biomass

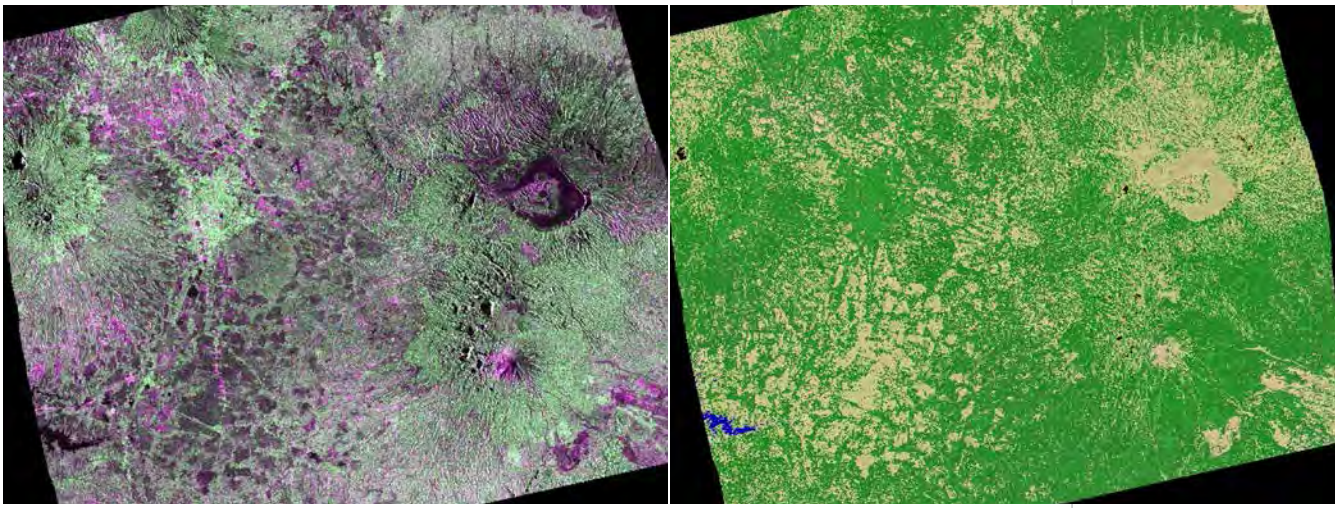
Trainees learned to estimate Above-Ground Biomass (AGB) directly from Radar backscattering or Sigma0. After applying radiometric terrain correction, they calculated the relationship between Sigma0 and AGB. Some research studies note that Radar backscattering is saturated around 100t/ha of AGB. Therefore, trainees understood that this technique should only be applied in low biomass areas in Indonesia, such as plantations with young trees.

Conclusions

The two-week training course was successfully completed and eight Indonesian GIS/RS experts learned the basic theory of Radar sensor, in particular ALOS/PALSAR, geometric and radiometric features of SAR and some other basic knowledge. They also practised the procedures of PALSAR Level 1.0 and 1.5 data analysis, InSAR and

Figure 2 (left). PALSAR FBD color composite image on 4 Oct 2008. Red color on HH, green on HV and blue on VV. Forest areas are shown as light green.

Figure 3 (right). Forest/non-foresty map derived from FBD data in Oct 2008. The forest area is shown in green, and non-forest area in yellow.



DInSAR analysis, forest area detection by dual polarisation, PALSAR Polarimetry analysis, and forest biomass estimation. The knowledge and techniques learned are essential in order to utilise radar satellite data for forest monitoring. With these techniques and knowledge, participants can advance their research and operational forest monitoring more efficiently than before.

All participants agreed that the training course was useful and these kinds of activities should continue in order to improve Indonesian capacity. As human resources in Indonesia are very limited and satellite data access — including financial aspects — is also an issue, we agreed that current and future forest and remote sensing-related projects should collaborate.

Future Directions

As ALOS completed its operation at the beginning of this project, we focused on the new satellite ALOS-2, which is to be launched in 2013, and prepared with ALOS archive data. ALOS-2 is expected to have greater capability and its observation data will provide more information to monitor forests. However, there is still a large gap between the requirements from the forest side and the capability of the satellite, in particular radar data. For example, the Ministry of Forestry has periodically generated their land classification map with 23 categories while PALSAR has provided the land classification map with only 10 categories so far.

The participants of this project agreed that we should continue capacity building activities to provide human resources, equipment, and the other environments to use ALOS-2 data. The project provided Indonesian GIS/RS experts with basic knowledge and techniques for ALOS-2 data. They are expected to assimilate, improve and expand their experience to other scientists in Indonesia and develop teams to use ALOS-2 data.

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PROJECT TITLE

Capacity Building of ALOS Satellite Data to Support Mapping and Monitoring of Deforestation and Degradation in Indonesia

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PROJECT LEADER

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