A PRELIMINARY STUDY ON DEFOREDTION MONITORING IN SUMATRA ISLAND BY PALSAR

Osamu Isoguchi[1)], Masanobu Shimada[1)], and Yumiko Uryu[2)]

[1)] Earth Observation Research Center, Japan Aerospace Exploration Agency (JAXA)
E-mail:isoguchi.osamu@jaxa.jp

[2)] World Wide Fund for Nature (WWF)

1. INTRODUCTION

Japan Aerospace Exploration Agency (JAXA) Earth Observation Research Center (EORC) launched an international collaborative project, the ALOS Kyoto & Carbon Initiative, to support explicit and implicit data and information needs raised by international environmental Conventions, Carbon Cycle Science and Conservation of the environment [1]. It forms the continuation of JAXA's JERS-1 SAR Global Rain Forest and Global Boreal Forest Mapping project (GRFM/GBFM) into the era of the Advanced Land Observation Satellite (ALOS). One of the most distinguishing aspects of the project is wall-to-wall observation by L-band SAR, the Phased Array L-band Synthetic Aperture Radar (PALSAR) on-board ALOS, based on the ALOS observation strategy. This observation enables us to create sub-continental scale mosaics semiannually. Some mosaics have already been provided through the JAXA KC web site (http://www.eorc.jaxa.jp/ALOS/kc_mosaic/kc_mosaic.htm) and used for scientific researches. For practical application, the JAXA is also providing the PASLSAR data, which include ScanSAR data, over Amazon rainforests to Ministry of the Environment in Brazil (IBAMA) for a near-real-time deforestation monitoring. A goal of this study is, by implementing the PALSAR data to rainforests in South East Asia, to develop a method to detect annual change in deforested area and for a near-real-time monitoring like done for Amazon rainforest. In this paper, as a feasibility study, we conducted the following investigations in Riau Province, Sumatra Island, where a land cover database is available: 1) the investigation of relationship between L-band normalized radar cross section (NRCS) and land cover type by comparing a K&C 50m dual-polarization (HH and HV) mosaic and WWF Riau GIS Land Cover Database, 2) a preliminary study on the detection of deforested area by using the 2007 and 2008 dual-polarization mosaics and time series of ScanSAR data.

2. L-BAND NRCS CHARACTERISTIC DEPENDING ON LAND COVER TYPE

We investigated the relation between L-band NRCS and land cover type by using the 50m dual-polarization mosaic in 2007 and the WWF Riau GIS Land Cover Database which was compiled based on ground observations and LANDSAT images in 2007. Fig.1 shows 2-D histograms (dB) for main 8 land cover classes as functions of HV and ratio of NRCS in HH over HV (HH/HV). Summary of the Statistics is as follows. The HH channel represented no significant difference among natural forest (-7.7dB), plantation (-8.2dB), and cleared (-8.7dB). Mangrove forest is 1.3dB lower than other swamp forests. Rubber plantation (-7.3dB) is the highest level among all classes. At HV channel, plantations except for Acacia and Rubber (-18.2dB) and cleared (-19dB) are 2-3 dB lower than natural forest (-15.8dB). There are no significant difference between Acacia (-16.6dB) and Rubber (-15.8dB) plantations and natural forest. Mangrove forest (-18.2dB) is 2.2dB lower than other swamp forests, being same level as plantations. Thus HV data is promising to distinguish forests from non-forests area except for some plantations (Acacia and Rubber). By using the HH and HV channels, we conducted a simple supervised classification by maximum likelihood method. 87.8% of natural forest based on the Land Cover Database was successfully classified. On the other hand, as expected the statistic results, many acacia plantations were misclassified into natural forest, which corresponds to 19% of the total classified forest.

3. CHANGE DETECTION FOR DEFORESTED AREA ESTIMATION

We also performed the classification of the 2008 dual-polarization (HH and HV) mosaic. Then newly deforested areas from 2007 to 2008 were roughly estimated as regions whose class changed from natural forest to non-forest in the natural forest area identified based on the 2007 WWF Riau GIS Land Cover Database. The detected area corresponds to 3.8% of the Land

Cover-based natural forest in 2007. It should be noted that the classification still had many noise-like miss-classifications over mountainous area probably due to increased backscattering caused by foreshortening. In order to provide more accurate estimation, slope correction process should be implemented in the future. We selected 6 major deforested areas to investigate actual HH and HV signal changes. Fig. 2 shows an example of the color composite images of the HH and HV channels and classification result. The NRCS in the HV channel decreased by 3±0.57 dB for the all 6 areas. The actual values reached down to -19 dB in some areas, which indeed equivalent level as the cleared in the above-mentioned NRCS statistics. On the other hand, the HH NRCS represented slight decrease (0.13±0.49 dB drop) but no significant change, some of which increased by 0.8dB. The result corroborates the availability of the HV channel for the detection of newly deforested area. Next question is how the HH NRCS change for deforestations. In order to clarify it, we calculated the HH NRCS time series over the 6 selected areas by using the 44-day interval ScanSAR data from Jan 2007 to June 2008. Unlike fine-beam observations, dual-polarized observation is not allowed for ScanSAR. For reference, we also calculated them for natural forest, which shows an annual cycle with the local maximum of 0.28dB amplitude in rainy season. This seasonal feature is considered to be attributed to change in dielectric constant [2]. The NRCS time series of all the 6 areas departed upward from the annual cycle. Fig.3 shows an example corresponding to the area in Fig. 2. In this case, the departure started from Oct. 2007, reached a peak of 1.3dB in March 2008, and came close to the annual cycle again in June 2008. The same type of the temporal increase of HH signal just after deforestation has been reported in Amazon forest. Felled trees are usually left alone for a while, which is considered to contribute to the HH increase and HV decrease. After being carried away, the HH NRCS decreases than normal. It is expected that similar process is just as valid for the deforestation in Sumatra, although grand truth should be needed to confirm it. Thus the results imply the feasibility of single-polarized ScanSAR data to the near-real-time monitoring of deforested area in Sumatra Island.

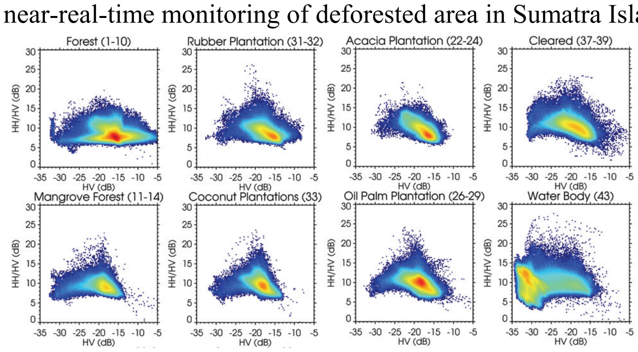

Fig. 1 2-D histograms (dB) for 8 land cover classes as functions of HV and ration of NRCS in HH over HV (HH/HV).

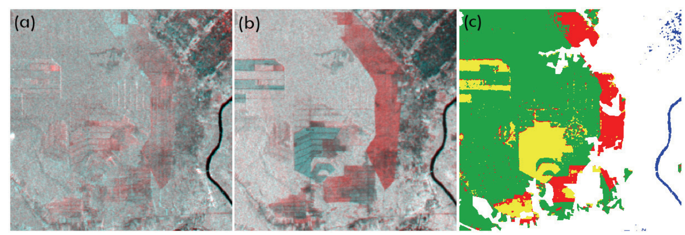

Fig.2 Deforested area example. Color composite images of (a)HH and (b) HV channels and (c) classification result. Red area represents estimated deforested area during 2007-2008.

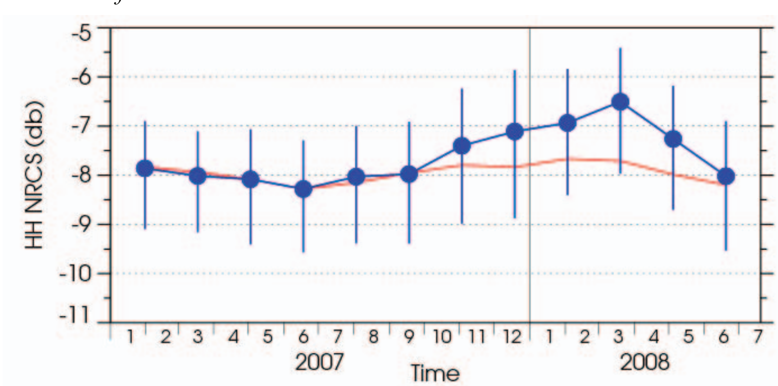

Fig. 3 HH NRCS time series in (blue) the estimated deforested area shown in Fig.2 and (red) typical natural forest.

REFERENCES

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