JAXA-GISTDA RICE CROP MONITORING PROJECT BY ALOS AND THEOS DATA

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ABSTRACT: In 2011, GISTDA (Geo-Informatics and Space Technology Development Agency, Thailand) and Japan Aerospace Exploration Agency (JAXA) are collaborating in research projects to show the values of cooperative THEOS/ALOS data application including agriculture especially rice crop monitoring including, rice crop area estimation. This project mainly consists of paddy field mapping and rice yield estimation by crop model with earth observation satellite and ground observation data. This paper introduces the preliminary result of paddy filed mapping by using THEOS data and PALSAR data. The result implies that integration of these data for paddy field mapping improves the accuracy.

1. INTRODUCTION

On Jan 27, 2011, GISTDA and JAXA organized a workshop for Thailand Earth Observation Satellite (THEOS) series and ALOS series cooperation and formulated concrete plans for joint research and development on three topics: (1) rice crop monitoring, (2) flood monitoring, (3) coastal erosion monitoring. In Jun 2011, 2nd workshop has held at Bangkok, Thailand (GISTDA, 2011), and final workshop is scheduled in Dec 2011. In this project, GISTDA and JAXA are sharing knowledge, satellite data and in-situ data collected together, and jointly deal with same research topics.

Asian countries are responsible for approximately 90% of the world rice production and consumption (FAO, 2011). In particular, Thailand is one of the largest rice production countries and the largest rice exporting country. Hence, rice is important agricultural crop and deeply related to economy, food security and culture in Thailand. Rice related statistics or information such as growth conditions or yield estimation are imperative for policy makers to ensure economy or food security. However, collecting the data for rice related statistics or information is time and cost consuming task and improving the accuracy of the data requires enormous efforts.

In 2011, GISTDA and JAXA are collaborating in a research project of rice crop monitoring over Thailand. The ultimate goal of this project is to show values of THEOS/ALOS data application cooperation including agriculture, especially rice crop monitoring including, rice crop area estimation during rainy season and rice crop yield prediction demonstration. In this stage, we have just implemented paddy field mapping. Paddy filed map is fundamental information to estimate rice yield all over the study area.

2. PROJECT DESCRIPTION

2.1 Project Overview

Figure 1 illustrates framework of the project and this project mainly consists of paddy field mapping rice yield estimation of by model. First, paddy field are detected and mapped by using THEOS, ALOS AVNIR-2/PALSAR data. Optical sensors of THEOS and AVNIR-2 have higher spatial resolution and useful for detailed mapping. In contrast, although PALSAR does not have higher spatial resolution as THEOS or AVNIR2, PALSAR is microwave sensor and it can penetrate cloud and acquire land-surface information even if the area is covered by cloud. Therefore, PALSAR is suitable for monitoring cloudy area such as tropics including Thailand. By integrating these three sensors, the accuracy of paddy field mapping is improved. Because paddy field detection uses distinctive shape and seasonal characteristics of backscatter and the integration increases the frequency of data acquisition.

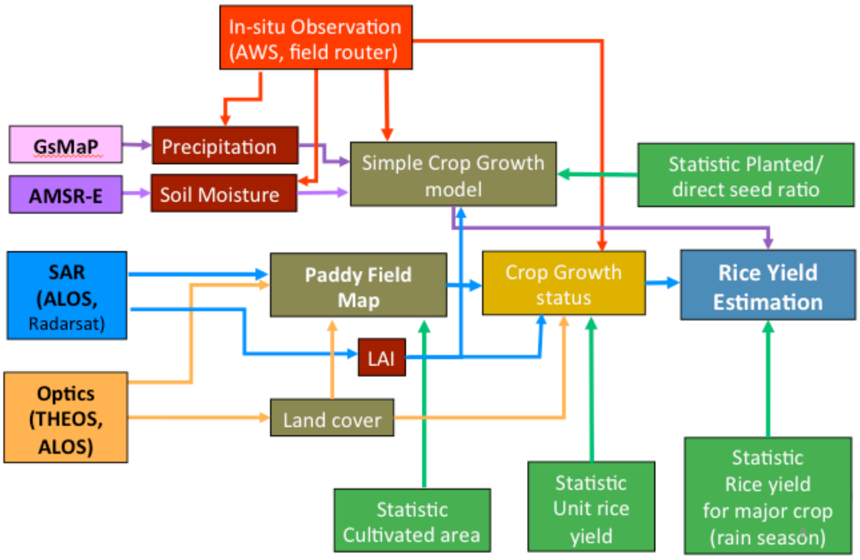

Figure 1. Framework for rice crop monitoring in GISTDA-JAXA joint research.

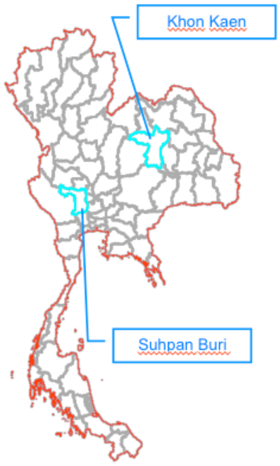

Figure 2. Study area.

Then, rice yield model is formulated with site-dependent parameters such as productivity or production per area by in-situ observation and meteorological data by automatic weather stations located at both study areas. Finally, rice yield over the study area is estimated based on the paddy field map and broad range of climatic data derived from satellite data.

2.2 Study Area

We selected two study areas, namely, Khon Kaen located northeast part and Suphan Buri central part of Thailand, and they have distinctive crop patterns. Rice crop in Suphan Buri is irrigated and major cropping pattern is direct seeding. In Khon Kaen, rice crop is rain-fed and the ratio of direct seeding and transplanting is depends on the rainfall in planting season. Thus, the yield in Khon Kaen is subject to amounts of precipitation. To ensure applicability of proposed method to other areas, different types of paddy crop areas were selected.

2.3 Used Data

Sensor specifications used for paddy field mapping is shown in Table 1. We will also use climatic products of such as Photosynthetic Active Radiation (PAR), soil moisture and Global Satellite Mapping of Precipitation (GSMaP) hourly data 4 hour after observation derived from Terra/Aqua MODIS, Aqua AMSR-E, TRMM TMI, PR and DMSP SSM/I for the numerical model for rice yield estimation.

In addition to satellite data, in-situ information of climatic data such as air temperature, soil temperature, precipitation and radiation are collected automatically by field router (Mizoguchi, 2011) and statistical production information are collected by Office of Agricultural Economics (OAE). And also, yield per area database of each study area is developed by sample method.

Table 1. Specifications of sensors onboard THEOS and ALOS

	THEOS		ALOS		
Sensor	Pancrhromatic	Multispectral	PRISM	AVNIR-2	PALSAR
Spatial Resolution	2.0m	15.0m	2.5m	10.0m	7.0-100m
Band (Polarization)	1 (panchromatic)	4 (RGB, NIR)	1 (panchromatic, 3-directions)	4 (RGB, NIR)	L-band (HH,HV,VH,VV)
Swath	22km	90km	35km/70km	70km	20-350km
Quantification	8-bit	8-bit	8-bit	8-bit	5-bit

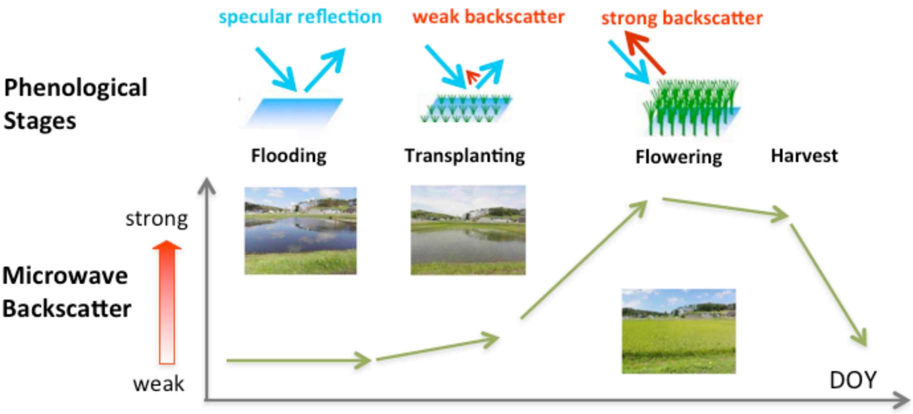

Figure 3. Seasonal characteristics of PALSAR backscatter in paddy field area.

3. PADDY FIELD MAPPING

3.1 Methodology for Paddy field Mapping

It is difficult to differentiate paddy rice area from other crop areas, because they have similar spectral and scattering signatures in flowering stage. Xiao *et al*. (2006) detected paddy field by using distinctive phenological stages, when the surface is flooded just before paddy rice is planted and when the surface is matured after planting by using MODIS data. In this research, seasonal characteristic of paddy field was retrieved from PALSAR data. In flooding season, backscatter is quite low, because the flooding surface is so smooth that it causes specular reflection. In matured season, backscatter indicates the highest, because the surface of vegetated paddy field is so rough that it causes strong backscatter (Inoue *et al*., 2002). Figure 3 is schematic illustration of Seasonal characteristics of PALSAR backscatter in paddy field area. And, PALSAR imagery enables us to detect the pixels that have flooded and flowering season easily, because even if the land-surface is covered by cloud, PALSAR can monitor seasonal changes of backscatter.

Additionally, paddy field is formed of distinctive shape of rectangle. Then, we also used AVNIR-2 and THEOS imagery to implement object-based image classification which is the algorithm utilizing shapes of the object.

3.2 Preliminary Result of Paddy Field Mapping by ALOS PALSAR Data

Paddy areas were detected by using time-series PALSAR data (17th Jul, 1st Sep, 17th Oct). By using simple thresholding method of detecting the pixel that has both flood and vegetated season. Figure 4 illustrates paddy field map derived from only PALSAR data over Khon Kaen in 2007. Now, we are validating the result with in-situ data or statistical data of Thailand. However, the paddy areas were heterogeneous and a lot of small patches were existing by visual interpretations. These mis-classifications are mainly due to speckle noise and pixel heterogeneity of PALSAR data. In order to reduce the effect of speckle noise, filtering method or object-based image classification with optical sensor data should be useful.

3.3 Preliminary Result of Paddy Field Mapping by THEOS Data

Figure 5 illustrates paddy field maps derived from THEOS multispectral data with object-based image classification and paddy filed map by Land Development Department (LDD), Thailand. THEOS data acquired on 3 Feb 2010 was processed by the software for object-based classification, namely e-cognition (Trimble). The accuracy of THEOS paddy filed map validated with LDD map was 91%. Since paddy field map of LDD was derived from airborne remote sensing, the difference of spatial resolutions mainly caused the disagreement between these paddy field maps. Futhermore, the date of acquisition between THEOS and LDD are different. Although the accuracy of derived paddy filed map is quite high, there is few other crops in this region and we can easily detect paddy filed area without seasonal characteristics from time-series satellite data. To identify paddy field area in the region mixing paddy field and other crops, seasonal characteristic is imperative. But, it is difficult to acquire clear-sky data by optical sensors in each season, because tropics including Thailand are frequently covered by cloud. Therefore, integration analysis of optical data (THEOS or AVNIR-2) and microwave data (PALSAR) is necessary to map

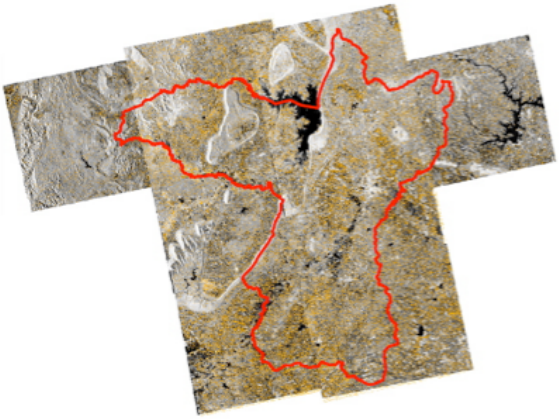

Figure 4. Paddy field map derived from ALOS PALSAR data over Khon Kaen in 2007. Yellow region means detected paddy field.

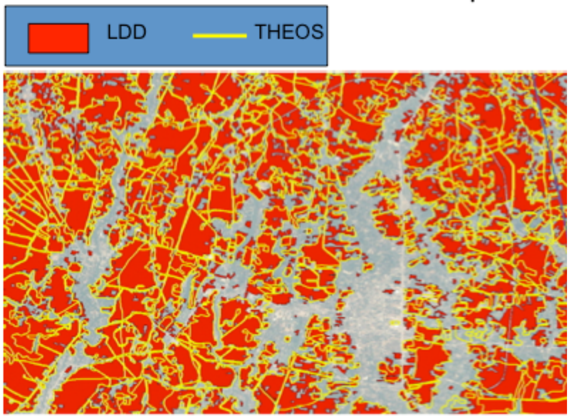

Figure 5. Paddy field map derived from THEOS data with object-based image analysis over Suphan Buri in 2010.

paddy field with high accuracy. Now, we are trying to develop the algorithm for paddy field mapping integrating optical and microwave data.

4. CONCLUSION

This paper reported preliminary results of rice crop monitoring under GISTDA and JAXA joint research. Paddy field maps have been derived from ALOS AVNIR-2 or THEOS. However, derived paddy field maps should be improved by integrating both data. After paddy filed map is developed with high accuracy, rice yield will be estimated by using numerical crop model with climatic data and derived paddy field map. The final outcomes will be presented at 3rd GISTDA-JAXA workshop in Dec 2011.

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