A COMPARISON OF RADARSAT-2 AND MODIS VEGETATION INDICES FOR RICE CROP PHENOLOGY IN THAILAND.

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ABSTRACT ... Rice is the staple food in Thailand. Thailand rice cultivation in can be divided into two classes, rain-fed rice and irrigated rice. Thailand, rice fields are located mostly in the central and north-east regions which are low-land and flat areas. Accurate paddy field monitoring is critical for yield estimating missions. Field survey is of limited utility to describe rice phenology across large areas. Remote sensing is probably the most reliable measurement tool for accurate rice monitoring over large areas. In this study, we compared time series MODIS and PROBA-V - normalized difference vegetation index (NDVI) and Radarsat-2 dual-polarization images that covered paddy area in Thailand. MODIS-derived NDVI derived from 8-day composite. Whereas, Radarsat-2 image were acquired every 24 days repeat cycle. From the result scatter plot, the MODIS and PROBA-V show the high result in R2 values (0.9027). This means that the characteristics of MODIS NDVI and PROBA-V NDVI are almost the same. For comparing the data with different sensor, PROBA-V NDVI with RADARSAT-2 HH Backscatter show the highest R2 values (0.7161) which show a good sign that both data from optical satellite and SAR satellite capable to fuse together.

KEY WORDS: MODIS, PROBA-V, Radarsat-2, Rice, Phenology

1. INTRODUCTION

Rice is an important industrial drop of Thailand. Ricecropping areas are huge and cover all regions in the country.In the past, rice cropping in Thailand has encountered manycritical problems due to limitation of water supply, flood,prices fall, etc. One important reason is that a mismatchbetween governmental policies and real rice cropping situation. For example, water supply or irrigation may not beprovided in the right cropping cycle so that rice croppingwas damaged in some area. Sometimes the problem occurredfrom farmers themselves. Rice sometimes has been croppedat any available time without prior notice which resulted inlack of sufficient supplies. Too much rice production alsoeffect pricing and storage.

The rice phonology estimation from remote sensing data is very useful information to evaluate damage from natural disaster as well as to develop business planning for price stabilization scheme.Suwannachatkul et al. [1] proposed to use MODIS data for the cultivation date estimation on the rice field. They used the Savitzky-Golay filter [2,3] to smooth the data. Then, they defined the rice stage are four stages including nothing, growing, mature, and harvest.

However, tropical regions are difficult to acquire optical image with all-weather to solve this problem due to the high cloud coverage in Tropical regions. The synthetic aperture radar due to its operation in the microwave regions can penetrate clouds, and can acquisition image all day and night.F. Ribbes et al. [4] use the RADARSAT data for rice field mapping and monitoring. The backscattering coefficient of rice field appears to have a significant temporal variation. The backscattering coefficient has highest correlation with age(day after sowing), plant high and plant biomass of rice

In this study, we compared time series MODIS and PROBA-V - normalized difference vegetation index (NDVI) and Radarsat-2 dual-polarization images that covered paddy area in Thailand. MODIS-derived NDVI derived from 8-day composite. Whereas, Radarsat-2 image were acquired every 24 days repeat cycle.

2. METHODOLOGY

Three main data used in this study, MODIS, PROBA-V and Radarsat-2, have its own approach in processing as shown in flowchart in Figure 1.

2.1 MODIS processing

2.1.1 Generating NDVI

The 8-day MODIS/Terra composite data (MOD09Q1) are obtained every 8 day in the red and near infrared (NIR) spectral bands. . The NDVI time-series data is derived from red and NIR bands of MOD09Q1 datasets as:

$$NDVI = \frac{NIR - RED}{NIR + RED} \qquad (1)$$

This operation is applied to every pixel of every available MODIS data. Then, the generated MODIS NDVI data are stacked together to create the time-series data.

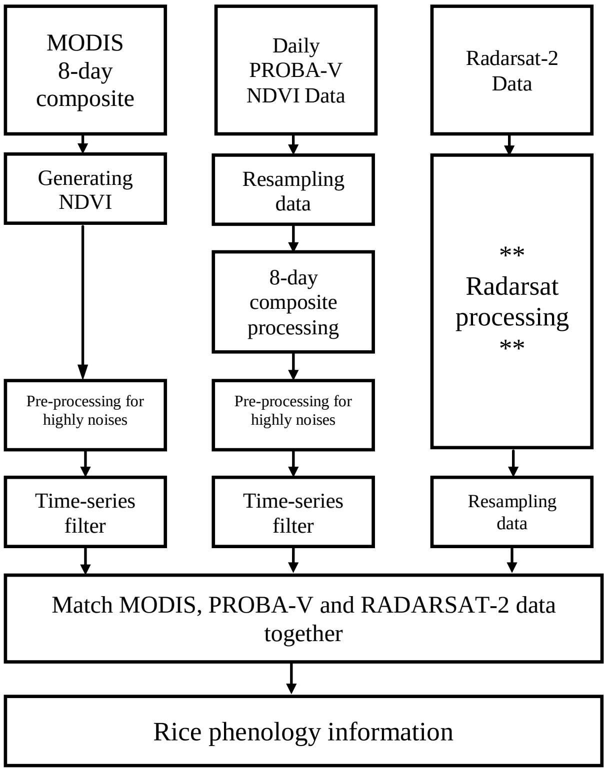


Figure 1.Flowchart of the overall processing.

2.1.2 Pre-processing for highly noises:

The NDVI generated MODIS NDVI time-series is usually not continuous and very noisy. The data qualities which were affected by cloud contamination and atmospheric variability are the major sources of noises. The distortion by cloud contamination causes the NDVI data drop drastically since cloud reflect both red and near-infrared spectrums in the similar level.

This severely drops NDVI data are detect and identified as the invalid noises data. These data would be eliminated, and the eliminated values would be linearly interpolated with its adjacent available pixel values. In this study, if the NDVI data is drops more than 0.4, this pixel will be classified as invalid pixel.

2.1.3 Time-series filter

Even though we eliminated the highly noises cause by cloud contamination from the NDVI data, numerous noise still exist in the NDVI data. For more reliable in data analysis, these noises need to be handled. In this study, the widely used Savitzky-Golay filter is take place to handle various noises exists in NDVI data for its simplicity and reliability.

The Savitzky-Golay filter **(Savitzky and Golay, 1964)** is a filter to move the window to cover the series, where each pixel smoothing is obtained by calculating the values of the polynomial and designed to preserve the form of the signal. The Savitzky-Golay filter can calculate with following equation

$$Y_j^* = \frac{\sum_{i=-m}^{m} C_i Y_{j+i}}{2m+1} \quad (2)$$

where Y is original NDVI value
Y_j^* is new NDVI value for jth
C_i is coefficient for ith for filter ($C_i = \frac{1}{2n+1}$)
n is number of smoothing windows

2.2 PROBA-V Processing

2.2.1 Resampling data

The PROBA-V data have 300m resolution which are different for 250m resolution of MODIS data. The daily PROBA-V NDVI data 300m resolution are then re-sampled using nearest neighbour technique in order to match with the MODIS 250m resolution.

2.2.2 8-day composite processing

With the purpose of matching with the 8-day composite data, every 8 day of NDVI daily PROBA-V data is extracted, then used to create the 8-day composite data. In this study, due to the characteristics of various noises usually causing the NDVI value to drops drastically, we assume that the higher NDVI value have more reliable quality. Therefore, these data are merging together and then comparing to identify the highest value among the 8 data. The operation is applied to every pixel of the image to create the PROBA-V 8-day composite NDVI data.

2.2.3 Pre-processing for highly noises and Time-series filter

Since, the noises in PROBA-V have the same characteristic as noises in MODIS data. We use same operation as in MODIS by eliminating the highly noises operation and then using Savitzky-Golay filter, respectively.

2.3 RADARSAT-2 Processing

The SAR data provided by Geo-Informatics and Space Technology Development Agency(GISTDA) consist of scanSAR narrow, RADARSAT-2 SAR images coverage the study area .The dates of data acquisition are 26 June 2013 to 27 November 2013. The RADARSAT-2 SGF images have resolution 3m and 50m respectively. The SAR data are provided by Geo-Infomatics Space Technology Development Agency (GISTDA).

Pre-processing the time-series image we used NEST ESA SAR for process the raw data image. The procedure of pre-process show in Fig. 2, the input of this process are SAR time-series image coverage the study area, the calibration are convert the digital number in raw data images to sigma naught (σ^0) in dB unit, terrain correction accounts for variations in the observed gravitational acceleration caused by variations in topography near each observation point, speckle filter to reduce salt and paper noise in raw data image, co-registration to make stacking images.

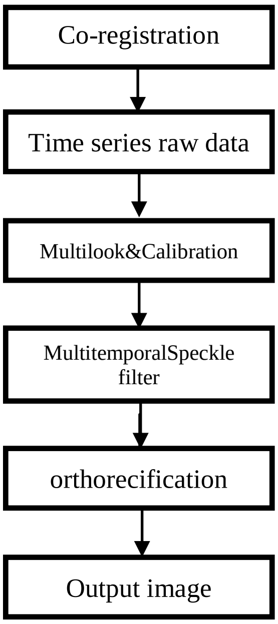


Figure 2.Flowchart of the overall processing.

2.4 Data comparision

The data used in this study, MODIS 8-day composite, daily PROBA-V data and RADARSAT-2, have different representative and resolution. For matching MODIS and PROBA-V, the MODIS will be used as the reference data. The 8-day composite PROBA-V 300m data are created and resampling to match with MODIS 250m data. Unlike the 8-day data in MODIS and PROBA-V data, the RADARSAT-2 data are discontinuity and have less coverage area. However, RADARSAT-2 data provide higher resolution and much more reliable data. Since, the optical satellite such as MODIS and PROBA-V suffered a lot from noises caused by cloud contamination which usually cover in most part of the optical image. But for SAR satellite like RADARSAT-2, they have an active sensor on board that does not need light to record the image and that can “see” through clouds with almost any interaction. However, SAR satellite might encounter the speckle noises which are a random and deterministic in an image. Still the noises cause by the speckle noises are a lot less comparing with the noises in optical satellite. Since the available RADARSAT-2 data are less than MODIS and PROBA-V data. The nearest date of MODIS and PROBA-V data are match with the available RADARSAT-2 data. The matching data are shown in Fig.3 and Fig.4

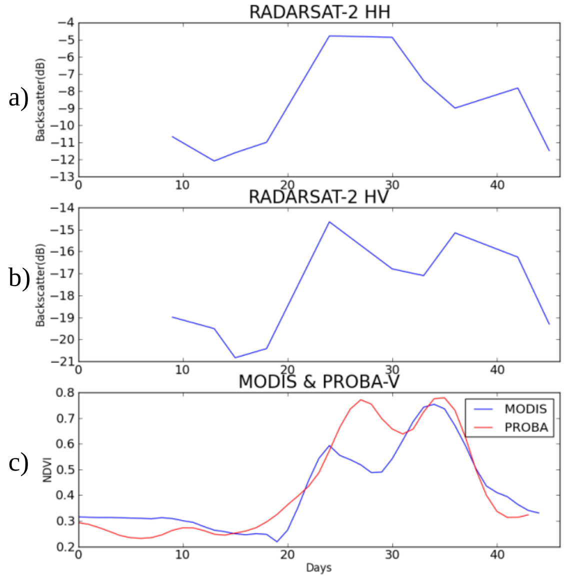


Figure 3.Data from Roi-et province, Thailand comparing between (a) RADARSAT-2 HH, (b) RADARSAT-2 HV, (c) PROBA and MODIS NDVI.

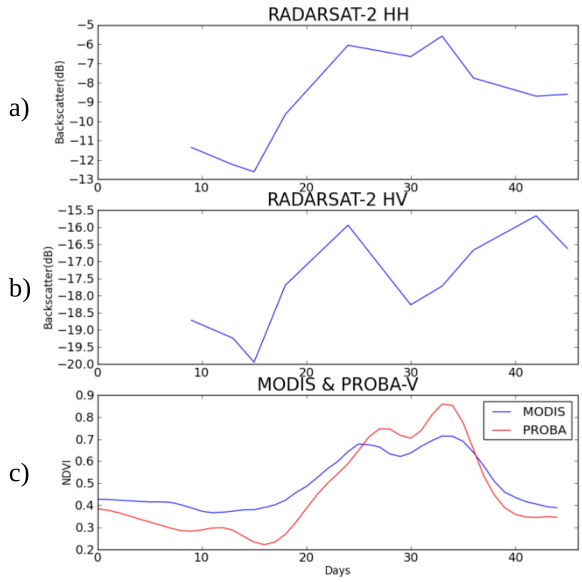
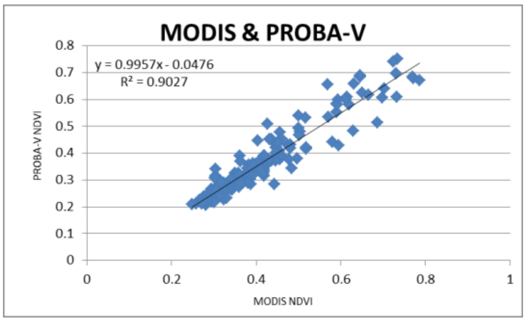


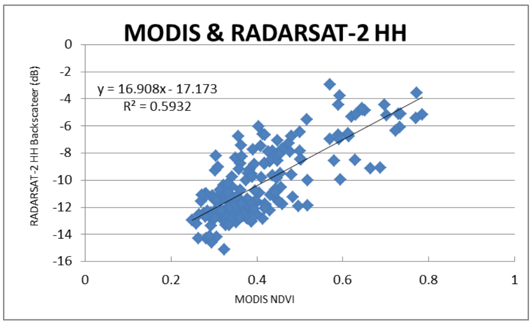
Figure 4.Data from Burirum province, Thailand comparing between (a) RADARSAT-2 HH, (b) RADARSAT-2 HV, (c) PROBA and MODIS NDVI.

3. EXPERIMENTALRESULTS

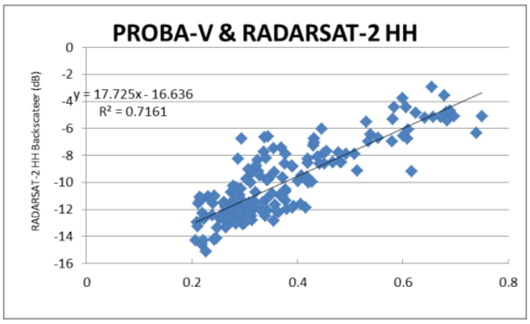
We present the result comparing between three different data. Figure.5 show the scatter plots for the five different comparisons, each data point corresponds to the data for each experimental site. For each plot, we also show the linear fit and the R^2 values for the fitted data.



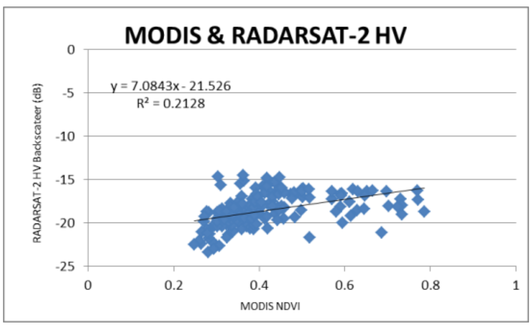
(a) MODIS vs PROBA-V NDVI



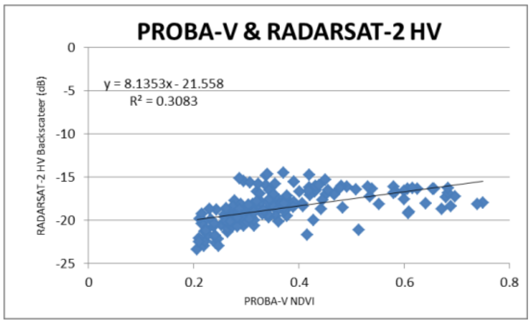
(b) MODIS NDVI vs RADARSAT-2 HH Backscatter



(c) PROBA-V NDVI vs RADARSAT-2 HH Backscatter



(d) MODIS NDVI vs RADARSAT-2 HV Backscatter



(e) PROBA-V NDVI vs RADARSAT-2 HV Backscatter

Figure 5. Scatter plot for comparison of each different data

From the result scatter plot, the MODIS and PROBA-V show the high result in R^2 values (0.9027). This means that the characteristics of MODIS NDVI and PROBA-V NDVI are almost the same. For comparing the data with different sensor, PROBA-V NDVI with RADARSAT-2 HH Backscatter show the highest R^2 values (0.7161) which show a good sign that both data from optical satellite and SAR satellite capable to fuse together. However, in comparison with the both MODIS and PROBA-V data with the RADARSAT-2 HV Backscatter show very low R^2 value. This can be concluding that SAR HV data are not appropriate to use together with the NDVI data.

4. REFERENCES

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