MONITORING OF PADDY FIELD PLANTING AREA WITH COMPLEX CROPPING PATTREN USING SATELLITE REMOTE SENING DATA : CASE STUDY IN CHIANG RAI PROVINCE

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ABSTRACT: In Chiang Rai province of Thailand, cultivation system of agriculture is complex during planting season. Mixed cultivations take difficulty to identify land use types such as paddy field and crop. Therefore this study is using Satellite Remote Sensing data solving the problem with two objectives: (1) to classify land use from Landsat5 image,(2) to develop band ratio indices from Aqua MODIS image and to perform correlation between band ratio indices and paddy planting areas(3) to be beneficial to predict seasonal production of rice. Firstly, the author used multi-date Landsat5 data (30 meters) to identify the characterize pattern of paddy field and mixed crops. Secondly, develops muti- temporal indices NDVI, NDWI and EVI values from Aqua MODIS (500 meter). The correlation values from Aqua MODIS and planting area was found that a maximum of NDWI identify transplanting stage and decreasing of NDWI inverse variable with NDVI or EVI remarkable the stage of heading. Third, This method was a key to discriminate stage of paddy planting to estimate of time of rice plantation from MODIS.

1.INTRODUCTION

1.1 Background

Rice is one of the principle grains in Thailand. It is not only a food staple, but also a key export commodity. Especially in Chiang rai province where the main physical feature of the land is a flat plain which is suitable for rice growing, rice production is still not sufficient for the increasing demand of the population. This study using Remote Sensing (RS), and Geographic Information System(GIS) to monitoring paddy field.

Cultivation of paddy field is constrained by the condition of availability of physical factors, such as solar radiation, temperature, and water. Cultivation system of agriculture is complex during planting season. Mixed cultivation take difficulty to identify land use types such as paddy field and crop. Therefore this study is using Satellite Remote Sensing data. For several time critical applications, optical sensors, such as LANDSAT 5 and a number of studied have been carried using temporal MODIS data to identify crop patterns and classify cropland areas. Surface Reflectance (MOD09A1) as the testing data. The data contains seven spectral at 500 –meter resolution in an 8 day period.

1.2 Objective

(1) To classify land use from Landsat-5 image,
(2) To develop band ratio indices from Aqua MODIS image and to perform correlation between band ratio indices and paddy planting areas.
(3) To be beneficial to predict seasonal production of rice

2. DATA AND METHOD

2.1 Study area

Chiang Rai province(see Figure 1) is test site representing the northern regions of Thailand, which is agriculture complex during planting season. Mixed cultivation take difficulty to identify land use types such as paddy field and crop.

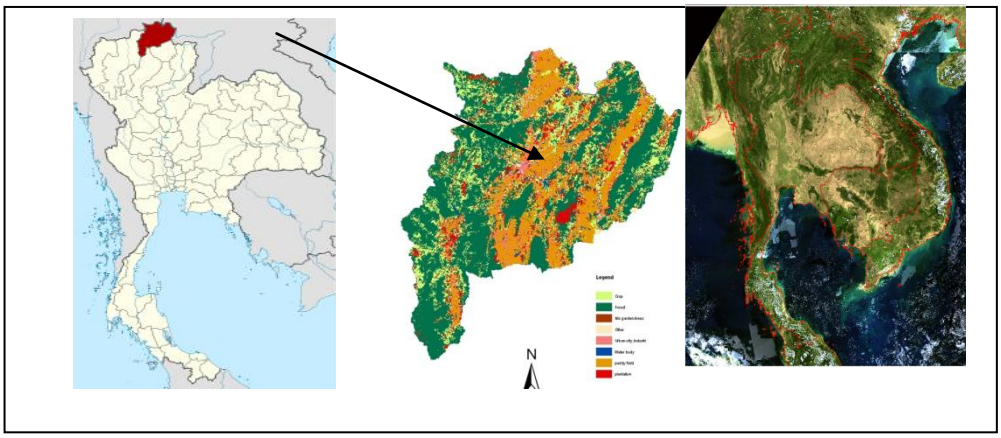

Figure 1 Cropping intensity of paddy field in Chiang Rai province

2.2 Data

As for the case using Landsat -5 during the period from 2009- 2010 of which 4 scene were taken in dry or transition period from rainy and dry season (May to December Methodology and MODIS data Surface Reflectance (MOD09A1) as the testing data. The data contains seven spectral at 500 –meter resolution in and 8 day period from 2008-2009.

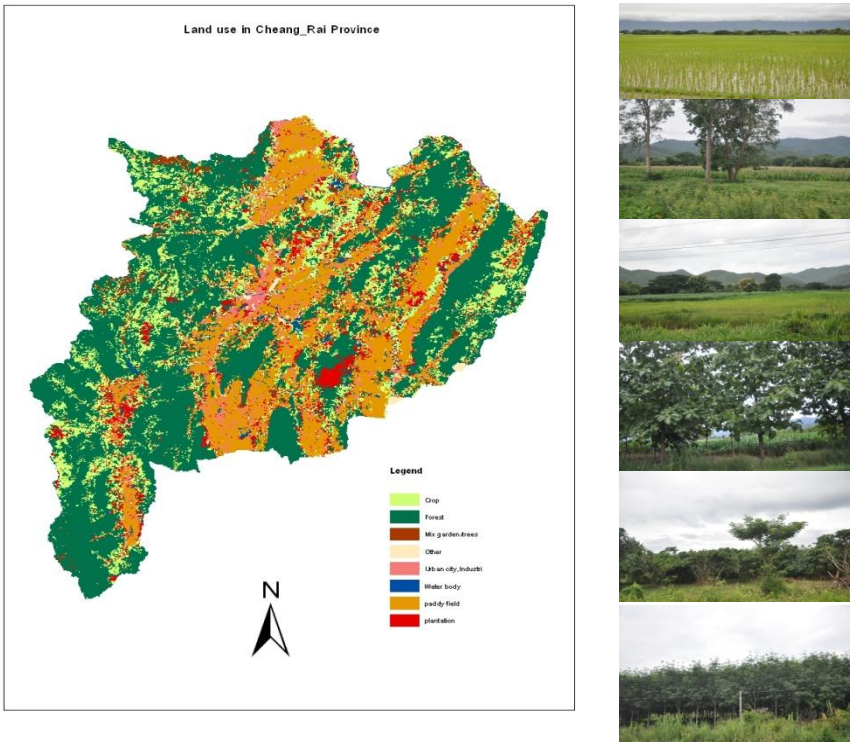

Figure 2 Land use map of Chiang Rai province

2.3 Method

In order to characterize the growing stage of paddy field, 2 indices NDVI and LSWI were calculating from Landsat data. Multi-temporal data of these indices was classifieds by ISODATA method and season changes of land color which could be associate with growing stage of paddy field, were estimated by examination of features of classes. Paddy field considered for the analysis was the area extracted from land use map mentioned above. The formula of NDVI and LSWI calculated from Landsat -5 are as follows:

$$NDVI = \frac{(B4 - B3)}{(B4 + B3)}, \qquad LSWI = \frac{(B4 - B5)}{(B4 + B5)}$$

The cultivation stage from preparation of transplanting to early growing rice was sequentially discriminated from Landsat data taken in December 2010. Then the relation between the discriminated classes and indices obtained from MODIS data was examined. Employed indices were NDVI and NDWI process and EVI calculation from reflectance data. The formula of NDVI , NDWI and EVI calculation from MODIS reflectance data as follow:

$$NDVI = \frac{(R2 - R1)}{(R2 + R1)} \qquad NDWI = \frac{(R1 - R6)}{(R1 + R6)}, \qquad EVI = 2.5 \times \frac{(R2 - R1)}{(1 + R2 + 6 \times R1 - 7.5 \times R3}$$

3.RESULT AND DISCUSSION

3.1 Seasonal changes of land cover paddy fields

Collected LANDSAT-5 data for the period from 2009 to 2010 were optimally distributed to season, in May, July and December. Spatial pattern of cropping could be generally depicted by producing color composite image of 3-tempora NDVI. Figure 3 represent an example of color composite image. (red:2009:04.08, green:2010:07.08, blue:2010.12.31), in Chiang Rai province. Left color composite image of 3-temporal NDVI and right color composite image of 3-temporal LSWI was the result of examination of changing pattern of land cover,Vegetation,Water surface or soil,over paddy field area.

Figure 3. Color composite image of 3 temporal NDVI

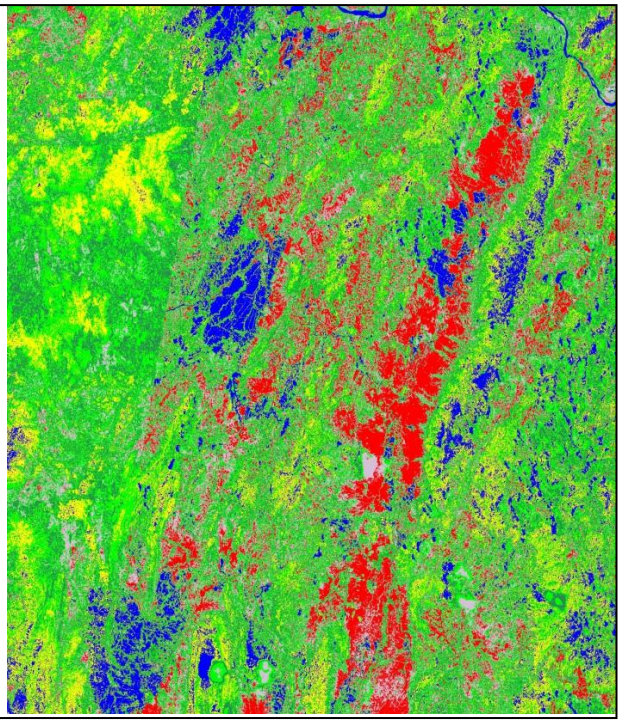

Figure 4.Color composite image of 3 temporal LSWI

3.2 Relation between indices derived from MODIS data and rice planting time

Paddy field is transplanting land is inundated with water and then vegetation activity starts to emerge .This transition stage was classified from class 1 (earlier planted) to class 5 by using Landsat from July 8 2010.Then the

relation between these class and indices derived from MODIS data was examined. Figure 5 shows temporal of these indices for each class. The figure indicated the evident maximum of NDWI at the time of transplanting and sharp increasing after the event. Inverted tendency is shown in both the case of NDVI and EVI. This phonological feature of rice was commonly indicted in the previous studies for the site location in other regions. It is noted that even for the area with complex cropping pattern MODIS data might extract the growing phase of the rice if appropriate method of estimate was developed.

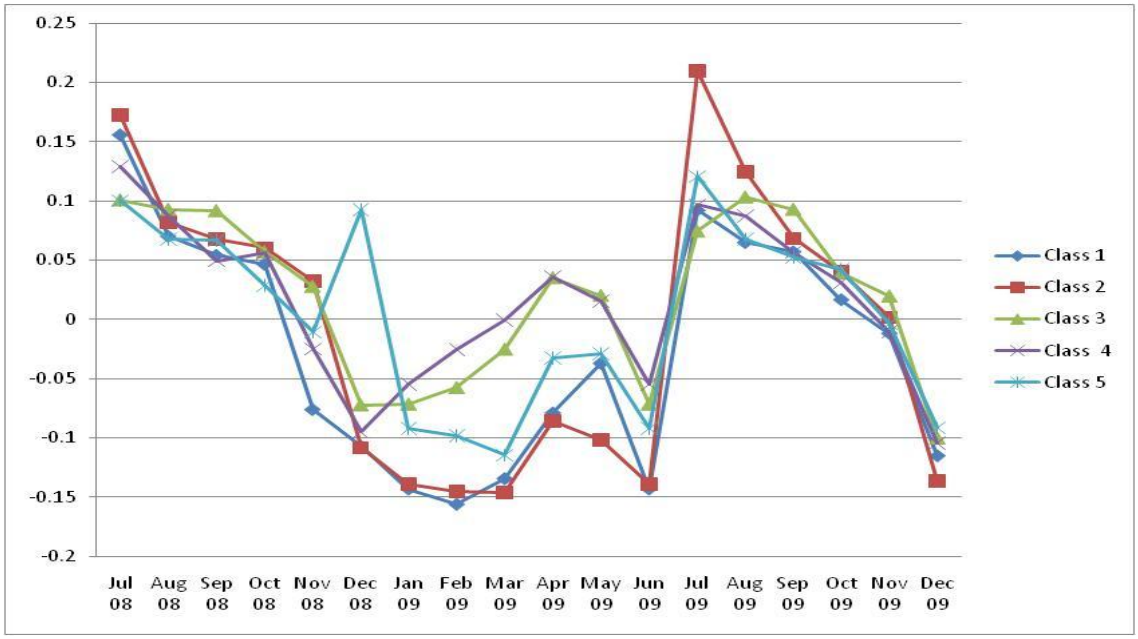

Figure 5 Temporal changes of indices derived NDWI class from MODIS data showing transitional stag of growth of rice around transplanting period

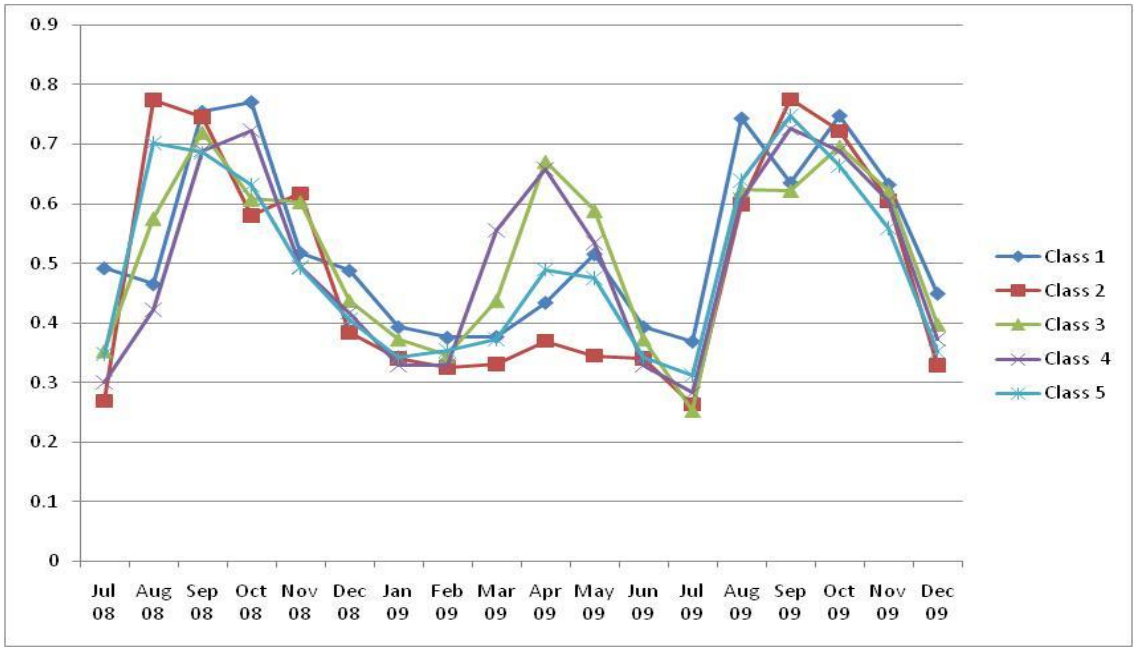

Figure 6 Temporal changes of indices derived NDVI class from MODIS data showing transitional stag of growth of rice around transplanting period

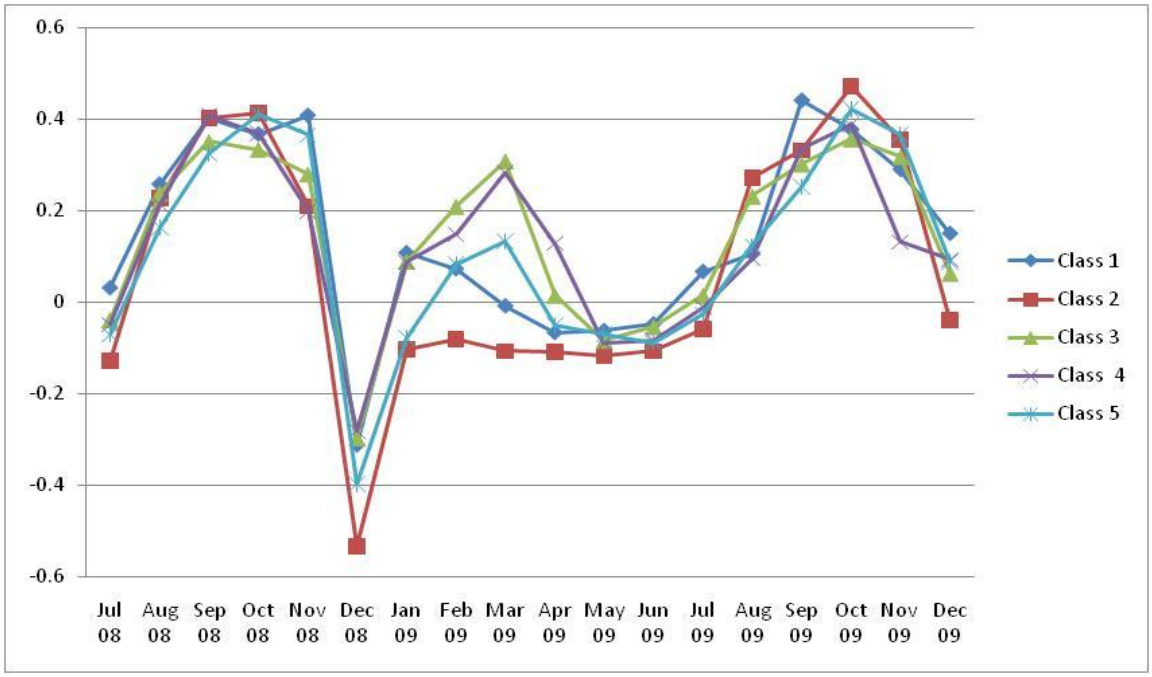

Figure 7 Temporal changes of indices derived EVI class from MODIS data showing transitional stag of growth of rice around transplanting period

3,3 Estimation of rice planting time Using MODIS data

For the purpose of estimating rice planting time, a model employed the following scheme was tentatively adopted. 1) value of NDWI is the highest in the period from one month before to one month 2) NDWI decrease more than 0.1 to two to three month later 3) NDVI and EVI increase more than 0.2 to two to three later/ This simple model generated the map of distribution of plant rice for Chiang rai province.

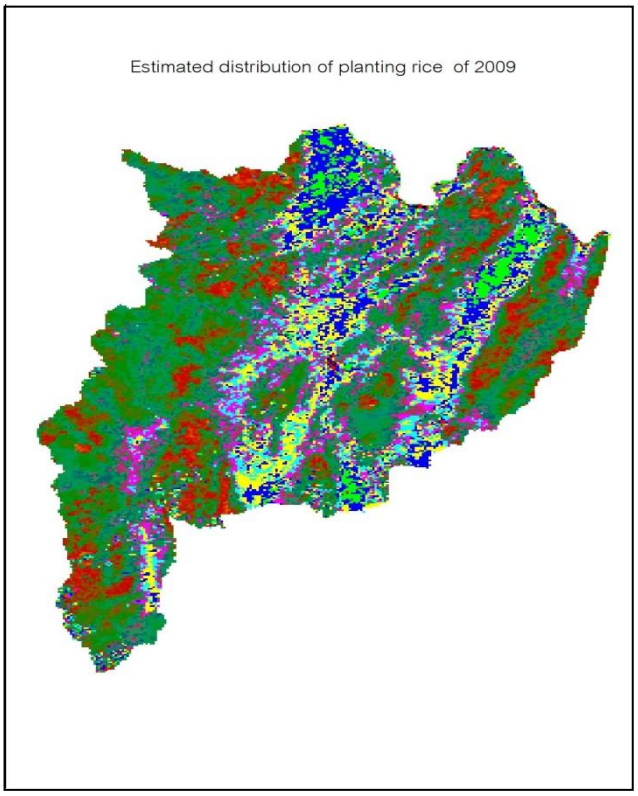

Figure 8 Estimated distribution of planting rice in August in 2009

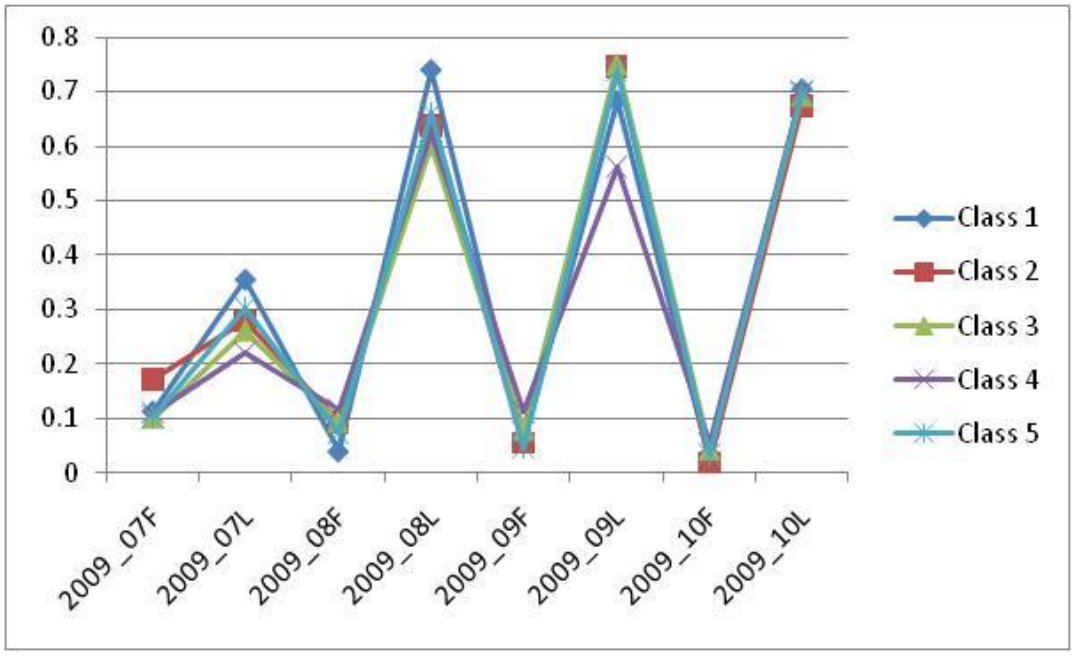

Figure 9 Ratio of estimated area of rice planting to the total area of specific class

Figure 9 represent the ratio of estimated area of rice planting to the total area of specific class mentioned in the previous section. class 1 was the area of planting rice in earliest among class then class 2 to series 5. It is recognize that this figure showed coincident pattern of order of planting rice.

4. CONCLUSIONS

Chiang rai province shows complex cropping patter of paddy field, which could be one of typical landscapes. This complexity by mix of different growing stage rice and also secondary crops was an obstacle to monitoring rice planting area using satellite remote sensing data. By the examination of spatial of planting rice using multi-temporal Landsat data.An attempt to estimate the time of paddy field planting using MODIS data was carried Out from the result of examination of relation between indices derived from MODIS data and rice planting. The land inundated by water at the transplanting stage of rice was the discriminative condition from other land use using NDWI. Then the combination of identification of sharp maximum NDWI and substantial increase of NDVI or EVI after the transplanting period proposed to be effective criteria to estimate the time of planting rice. Preliminary estimation showed promising result to the development of monitoring method of paddy field planting using MODIS data in Chiang Rai province where cropping patterns of rice complicatedly mixed.

REFERENCES

www.http://glovis.usgs.gov/

Xiangming Xiao.Stephen Boles,Steve Frolking,Changsheng Li,Jagadeesh Y Babu,William Salas,BerrienMoore III.Mapping paddy rice agriculture in South and Southeast Asia using multi-temporal Modis images.

Chi-Farn Chen.Qing Chen,Li-Yu Chang,Chu-Yen Chen.Mapping paddy rice using multi-temporal Modis image.

Sakamoto,T.,M. Yokozawa.H.Toritani,M. Shibayama, N.Ishitsuka and H.Ohno.2005.A crop phenology detection method using time-series MODIS data Remote Sensing of Environment.

Li Le; Li Chao;Zhu Xiufang;Pan Yaozhong.Consistency Analysis on paddy rice area survey with SPOT and TM images under the total restraint quantity.

Takeushi, W.,2007 Mapping of paddy field over Asian region using MODIS data In:Handbook od Agricalture Remote seng, edit by Akiyama, T et al., Jap. Agricaltureal Systems Society.