MULTITEMPORAL LANDSAT DATA TO QUICK MAPPING OF PADDY FIELD BASED ON STATISTICAL PARAMETERS OF VEGETATION INDEX (CASE STUDY: TANGGAMUS, LAMPUNG)

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Abstract. Paddy field has unique characteristics that distinguish it from other plants. Before it planting, paddy field is always flooded so that the appearance is dominated by water (aqueous phase). Within the growth of rice, field conditions will be increasingly dominated by greenish rice plants. While at the end, the rice plants will turn yellow indicating for harvesting. During flooding stage, the normalized difference vegetation index (NDVI) of pady field is negative. The negative value of NDVI of paddy field will ultimately increase to the maximum value at the maximum vegetative growth. The NDVI of paddy field will decrease from generative phase until harvest and after harvest. The objective of this study was to perform the vegetation index analyses for multitemporal Landsat imagery of paddy field. The results showed that the difference of vegetation index values (maximum - minimum) of paddy field were greater than the difference of vegetation index values of other land uses. Such differences values can be used as indicator to map land for rice. The evaluation results with reference data showed that the mapping accuracy (overall accuracy) was of 87.4 percent.

Keywords: *NDVI, Landsat, paddy field, maximum and minimum vegetation index, Lampung*

1 INTRODUCTION

The availability of a complete national spatial data is still limited to the scale of 1:250,000. However, very limited data are available within the scale of 1:50,000 and 1:100,000 (Geospatial Information Agency, 2012).

Many techniques have been applied to map the paddy field based on multi temporal satellite images such as digital classification techniques (supervised classification) and visual interpretation. These techniques are usually time consuming, whereas the need for spatial information of paddy field especially for outside regions of Java, Bali, and Nusa Tenggara is very urgent. Unique paddy field characteristics distinguishing it from other land uses, has the potential for further analysis of faster mapping.

Vegetation index or NDVI is an index that describes the level of greenness of plants. NDVI values are obtained from the calculation of the ratio between the reflectance value of near infrared channel and visible from MODIS, NOOA, Landsat, and SPOT data. In theory, the NDVI values range between -1 and 1, where the value of minus to zero reflects the absence of vegetation, while the higher value reflects the higher level of greenness of plants, and vice versa (Affan, 2002).

Yang and Su (1998) examined patterns of plant growth based on NDVI current growing season in 1996 and 1997. Spectral irradiance measured by Spectroradiometer instrument mounted at 1 m above the surface of the rice plant. The measurement results showed the value of NDVI rice reached a peak of about 70 days after planting, then NDVI decreases with increasing age of the plant.

Monitoring the growth of rice plants with SPOT imagery conducted by Frederik *et al*. (2010) showed that the rice vegetation index ranged from 0.1 to 0.9. Panuju *et al*. (2009) showed that paddy vegetation index ranged from 0.1 to 0.8. Using ASTER iamges, Nugroho *et al*. (2008) found that NDVI values of rice in relationships with its age were as follows: age of 43-55 days with NDVI ranged of 0.77- 0.82; age of 77 days with NDVI value of 0.74; age of 91 and age 98 days with NDVI of 0.59 and 0.49. Meanwhile, Dirgahayu (1999) was able to map paddy field based on the age of rice plants. This objective of this study was to analyze the value of NDVI multitemporal Landsat imagery based on the statistical parameters for the identification and mapping of paddy field. This technique was expected for a quicker mapping of paddy field.

2 MATERIALS AND METHOD

This study was conducted in the district Tanggamus, Lampung using multitemporal Landsat data of 2000, 2001, 2002, 2004, 2006, 2008, and 2009. The Landsat has a standard requirement before further processing such as ortho correction with a maximum RMS error of 1 pixel, terrain corrections using SRTM 90 meters, and cloud correction/removal. In addition to Landsat data, the Quickbird 2005 data were also used in this study. In this study, it was assumed that during the period of 2000-2009 the land use changes or paddy field conversion in research area was very low.

Several steps on the data analyses were conducted as follows:

1. Extraction of vegetation index values of multitemporal Landsat imagery and produced of four-channel NDVI composite images i.e., maximum NDVI, minimum NDVI, mean NDVI, and difference between maximum NDVI with minimum NDVI.
2. Producing training samples and statistical analysis to determine the distribution of multitemporal NDVI values at the study site and on the rice field.
3. Image enhancement by providing value limit minimum, maximum, and average NDVI using a specific reference to the location of the suspected fields. This will appear in contrast with non paddy field location. Each channel using a threshold (threshold value) was determined based on the extracted value of NDVI in paddy fields (step two). The threshold values for each channel were as follows:
   a. Maximum NDVI >= 0.537 and <= 0.811
   b. Minimum NDVI >= -0.228 and <= 0168
   c. Mean NDVI : >= 0.255 and <= 0.557
   d. The difference of NDVI (NDVI maximum - NDVI minimum) >= 0.447)

   The values obtained from the training sample (bare land, vegetation, and water) were taken on multitemporal Landsat data.
4. Identify some NDVI indices include maximum NDVI, minimum NDVI, mean NDVI and difference (maximum-minimum) NDVI in the study location.
5. Paddy field interpretation of Quickbird image as a reference with multitemporal Landsat imagery guidance.
6. Evaluation of mapping results with reference paddy field maps and calculate mapping accuracy using confusion matrix formula.

The complete steps of the data processing and analyses is described in Figure 1.

3 RESULTS AND DISCUSSION

Analysis of multitemporal NDVI values in the study area showed that in general, the minimum NDVI values ranged of -0.783 to 0.305 and maximum values ranged of 0.426 to 0.960. Meanwhile, in rice cultivation, minimum NDVI values ranged of -0.228 to 0.168, maximum values ranged of 0.537 to 0.811. The results indicated that the minimum and maximum value of NDVI in rice fields was lower than all other study sites because other sites were inundated by water permanently (sea, lakes, rivers, reservoirs, and ponds). The maximum NDVI values in other locations were higher than in the study site with rice cultivation due to forest cover at most sites.

Paddy field can be detected by the appearance of green color contrast in RGB color composite image made up of multitemporal Landsat NDVI statistical value, as shown in Figure 2.

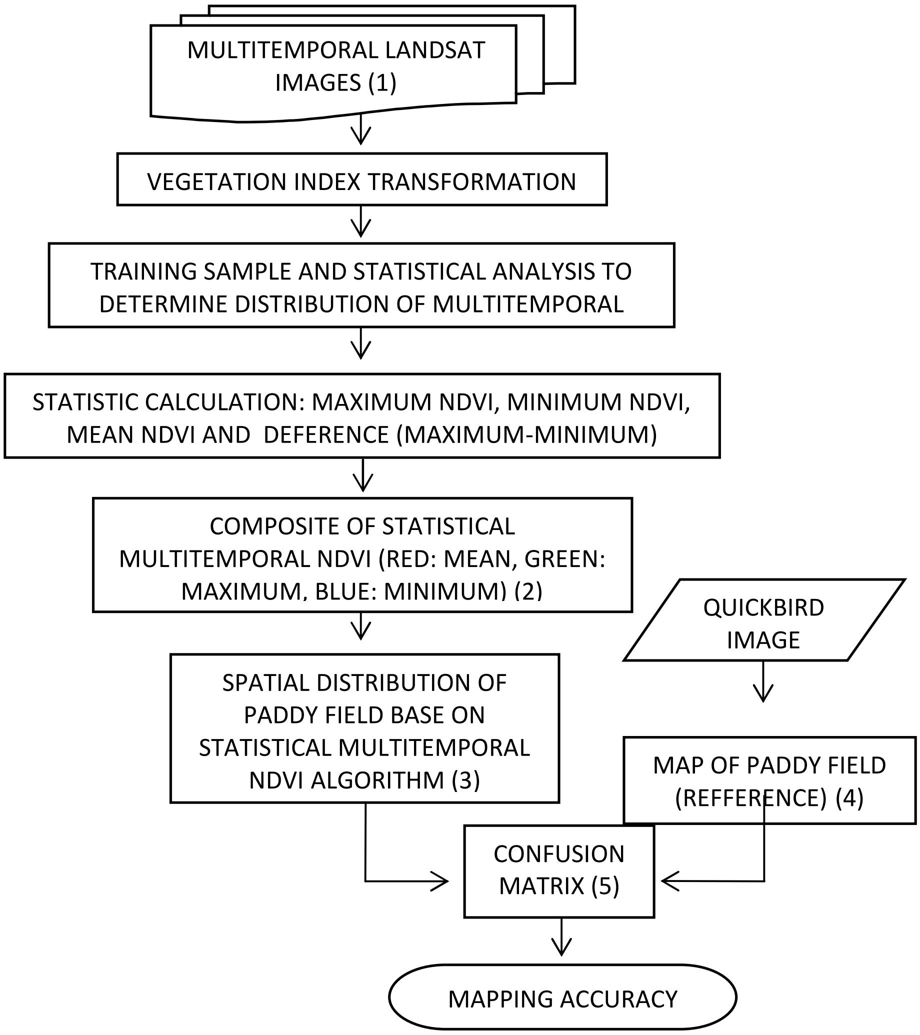

Figure 1. Flow diagram of research

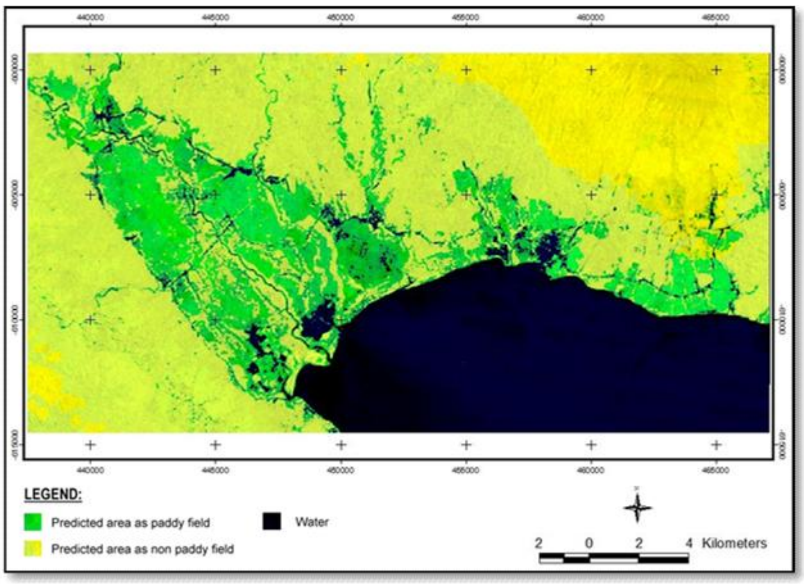

Figure 2. RGB composites of multitemporal Landsat statistical NDVI at Tanggamus, Lampung.

The image was produced using mean value of red layer, maximum value of green layer, and minimum value of blue layer. Based on the composite image, the paddy fields look very different than non paddy field area as a result of the real effect of the difference between the maximum and minimum NDVI values. NDVI values in rice fields followed the phase change of rice (fallow, water, and vegetation). In the aqueous phase, the NDVI values were the lowest (as low as -0.228). In the fallow phase, the NDVI values were relatively low, while in the vegetative phase, the NDVI ranged from low to high (0.3 to 0.811). This leads to a wide difference between the maximum and minimum in NDVI values.

The identification results showed that the index values of the four criteria exhibited the most obvious influence to mapping paddy field than the other three indices. Merging of the four statistic value criteria, multitemporal NDVI can be further used to map quantitative rapid paddy field (Figure 3).

To test mapping accuracy, we used paddy field map from Quickbird image as the reference and produced the accuracy of 87.47% (Figure 4; Table 1). Results overlaying paddy field into the paddy field reference from Quickbird image is presented in Figure 5.

In terms of processing time, this method requires a qualitatively relatively faster compared with the conventional method (supervised classification or visual interpretation).

Table 1. Statistic of mapping accuracy

Landuse	Area (ha)		Total	Accuracy (%)		Total
	Paddy fields	Non-paddy fields		Paddy fields	Non-paddy fields	
Paddy fields	5,159	575	5,733	90.0	10.0	87.4
Non-paddy fields	4,643	26,059	30,702	15.1	84.9	

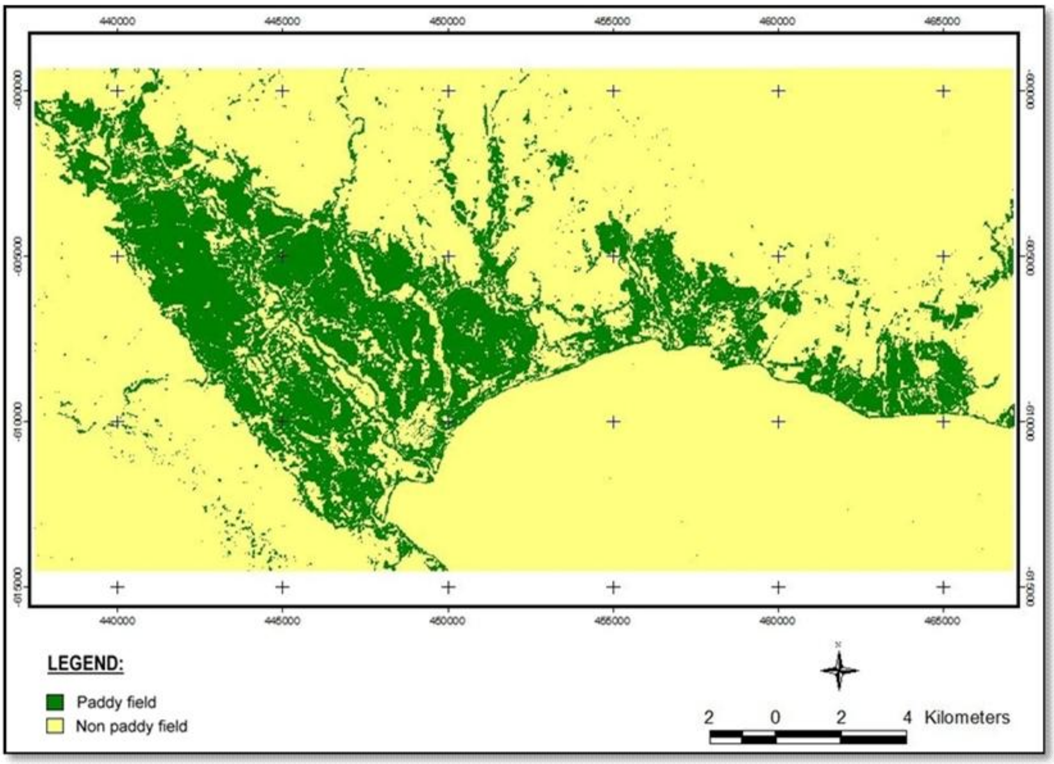

Figure 3. Paddy field mapping based on statistical NDVI multitemporal algorithm

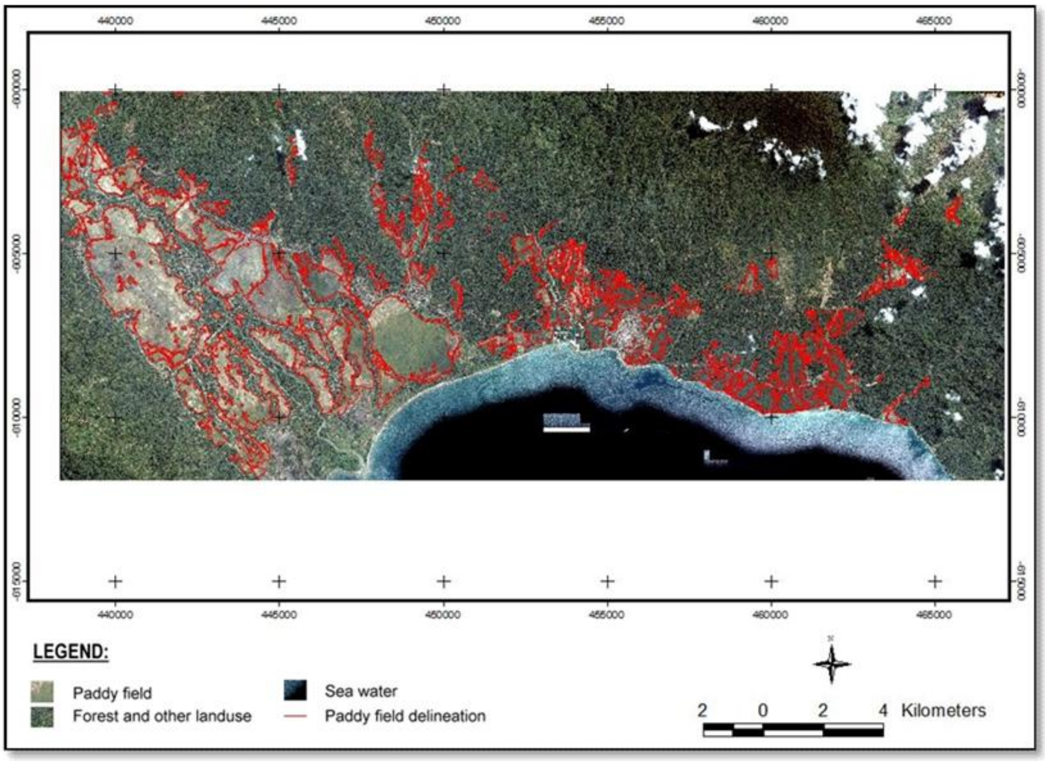

Figure 4. Paddy field spatial information (refference) of Quickbird image, Agustus 15 2005

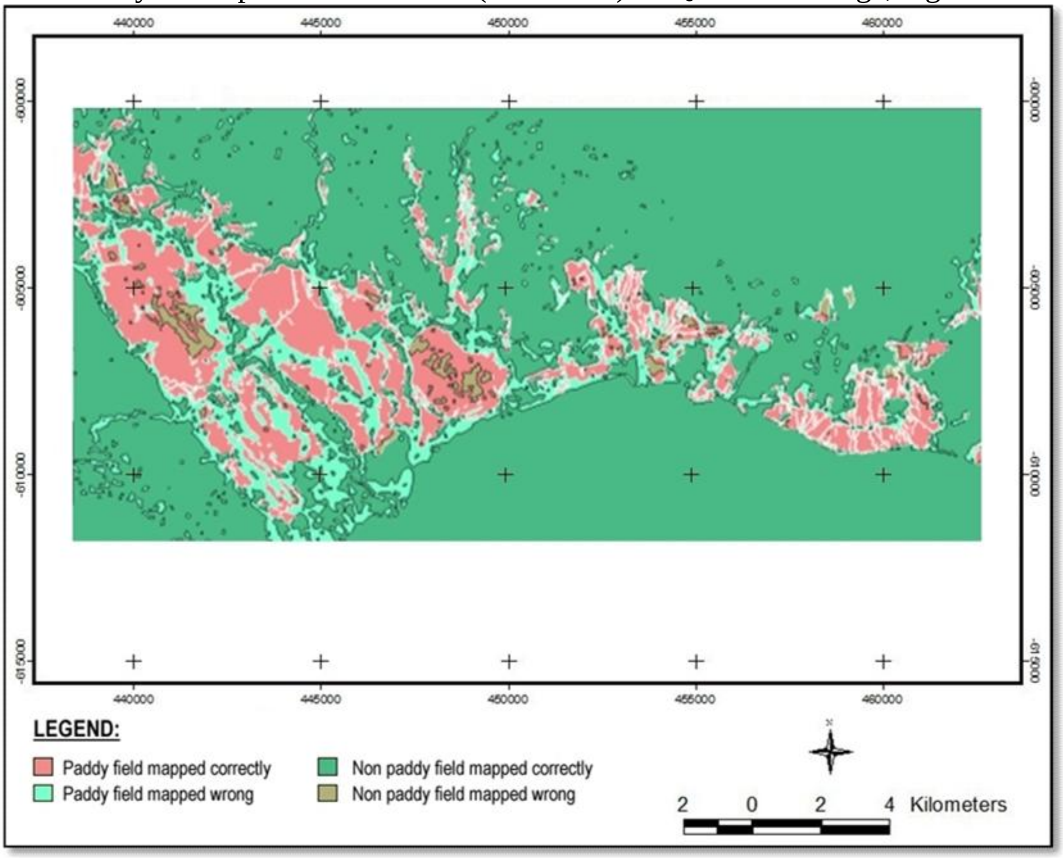

Figure 5. Overley paddy field classification with reference

4 CONCLUSION

Rapid paddy field mapping can be done with the analyses of multitemporal Landsat vegetation index with the accuracy of 87.4%. However, a validation on several areas with different characteristics of the field is still needed.

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REFERENCES

Affan, M.J., 2002, Forest fire danger level assessment based on vegetation index and KBDI (in Indonesian), Thesis, Department of Geophysics and Meteorology, Faculty of Mathematics and Natural Sciences, IPB, Bogor.

Dirgahayu, D., 1999, Applications prediction model for forecasting general rice harvested rice in Java period from January to April 1998 (in Indonesian), *LAPAN Magazine*, 1(2).

Frederik M.C.G., R.A. Ambarini, F. Meliani, and Y.F.A. Oktofan, 2011, Rice growth vegetation monitoring using SPOT (in Indonesian). *Proceedings of Annual meeting of Indonesian remote sensing society.*

Geospatial Information Agency, 2012, Topographic Map (in Indonesian), www.bakosurtanal.go.id [accessed on 5 February 2012].

Nugroho, D.A., B.M. Sukojo, and Y. Wahyudi, 2008, identification of rice with radian to convert data in image ASTER reflectance: case study Subang (in Indonesian), *Proceeding of annual meeting of indonesian remote sensing society*.

Panuju, H. Febria, H.T. Bambang, T. Boedi, A. Kasno, Aufa, and H.A. Syafril, 2009, Variations on MODIS vegetation index value growth cycle of rice (in Indonesian), *Scientific journals Geomatics*,15(2).

Yang, C.M. and M.R. Su., 1998, Correlation of spectral reflectance to growth in rice vegetation. *Proceedings of the 19th Asian conference on Remote Sensing*, Manila, Philippines, 1-3pp.