

THEOS Potential Study of Shallow Coral Reefs Mapping at Surin Islands National Park, Pan-nga Province, THAILAND

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Abstract: Coral reefs classification consumed a lot of time and money, recently growth of remote sensing technology can overcome some of these difficulties. In this study, the author compares the two satellites data sets from THEOS and Landsat TM 5 TM, in order to categorize the shallow coral reefs around Surin Islands National Park, Pang-nga Province, Thailand, to enable the mapping and coral reefs classification by satellite images. The object based classification method is employed to compare the images from THEOS and Landsat TM 5 TM for coral reefs mapping. The outcome from mapping classification compared with survey data accuracy checking of the method. The author found that image from THEOS has higher efficiency and accuracy than Landsat TM 5 TM, with significance.

1. INTRODUCTION

Nowadays, remote sensing technology becomes more effective tool to utilize satellite data in various applications for more than two decades. In order to realize the importance of earth observation system, Thailand has decided to develop its own satellite through the cooperation agreement between Royal Thai Government and the France Republic, then the first earth observation satellite “Thailand Earth Observer System: THEOS” has been commenced and its successful launched on October 1st, 2008 to explore natural resources. As THEOS is in full operation, there are many people studying of the THEOS imagery potential to apply in various application fields. With 0.45 - 0.52 micrometers blue band of THOES multispectral sensor, the classification of shallow coral reefs is selected for this research. Reefs are built up from coral skeletons and held together by layers of calcium carbonate produced by coralline algae. Reefs are extremely diverse marine ecosystems being host to over 4,000 species of fish, massive numbers of cnidarians, mollusks, crustaceans, and many other animals. The depth of shallow water coral reefs is around 10 - 30 ft. Normally, the coral reefs study in Thailand must focus on biological information and it is difficult to the detection changing of coral reefs area, due to the limitation of expert, technique, budget and time. So, the coral reefs mapping by remote sensing technique is one interesting field for study THEOS potential to classify and mapping shallow coral reefs at Surin Islands, Thailand. Finally, applying remote sensing technique to classify and mapping shallow coral water propose to find boundary, classification data and change detection of overall shallow coral.

2. STUDY SITE, FIELD METHODS AND DATA

2.1 Study site.

Surin Islands National Park is the one popular place to snorkeling in Thailand. It locate in Andaman Sea (375300E, 1042700N approx.) with area of 33750 acres, the reefs are highly developed due to a lot of “Blue Hole” was found (Thorn et al, 1991).

THEOS and Landsat TM 5 images of the study site have been selected (figure 1). The first one, THEOS image (acquisition in February 8, 2009 with satellite incidence angle 48.28°), the second one is Landsat TM 5 image (acquisition in January 26, 2009). The tide level of both dates is almost similar with approximate cloud cover of 12.5% and 15% respectively.

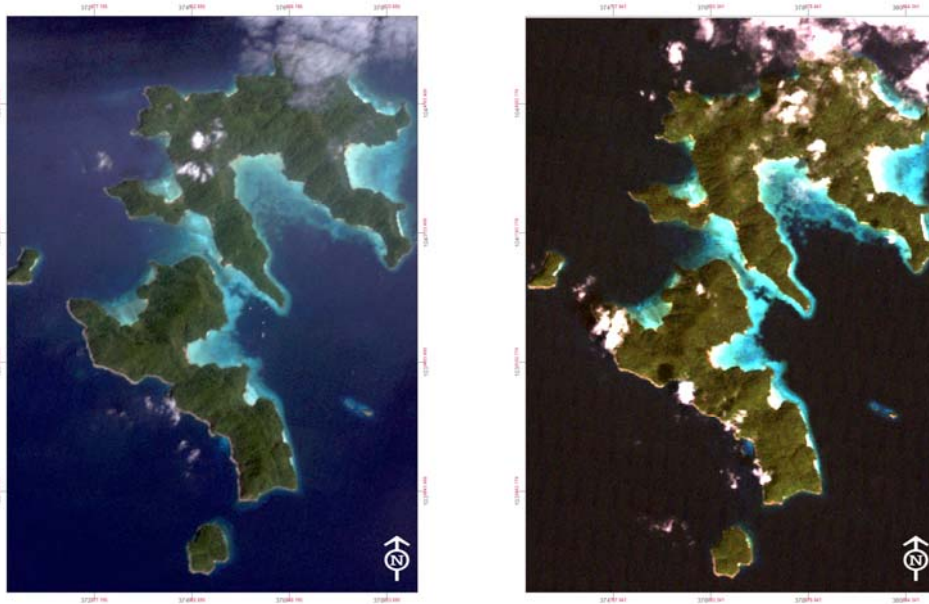


Figure 1 Shows the true color composite of THEOS (left) and Landsat TM 5 (right) multispectral images.

2.2 Image pre-processing.

The satellite images used in the study are product level 2A. These images are radiometrically corrected and geocoded, i.e. resampled on a cartographic grid. Level 2A imagery products are suitable for users requiring moderate accuracy and/or large area coverage.

However, compensation for the influence of water depth on bottom reflectance should be carried out (Green et al.,2000). The accuracy significant improvement increased when water column effect was consider (Mumby et al., 1998). The depth - invariant index algorithm proposed by Lyzenga (1998) is as follow:

$$\text{depth - invariant index}_{ij} = \ln(L_i) - \left[\left(\frac{k_i}{k_j} \right) * \ln(L_j) \right]$$

where $\frac{k_i}{k_j} = a + \sqrt{(a^2 + 1)}$,

$$a = \frac{\sigma_{ii} - \sigma_{jj}}{2\sigma_{ij}}$$

and

$$\sigma = \overline{X_i X_j} - (\overline{X_i} * \overline{X_j})$$

($X_i = \ln(L_i)$, where L_i is the pixel radiance in band i . σ_{ij} is the variance of band i , σ_{jj} is the covariance between band i and j . $\frac{k_i}{k_j}$ is the ratio of attenuation coefficients.)

Generally in the classification shallow coral reef, the water column effect should be omitted. Anyway, in this study, it used to improve the classification algorithms.

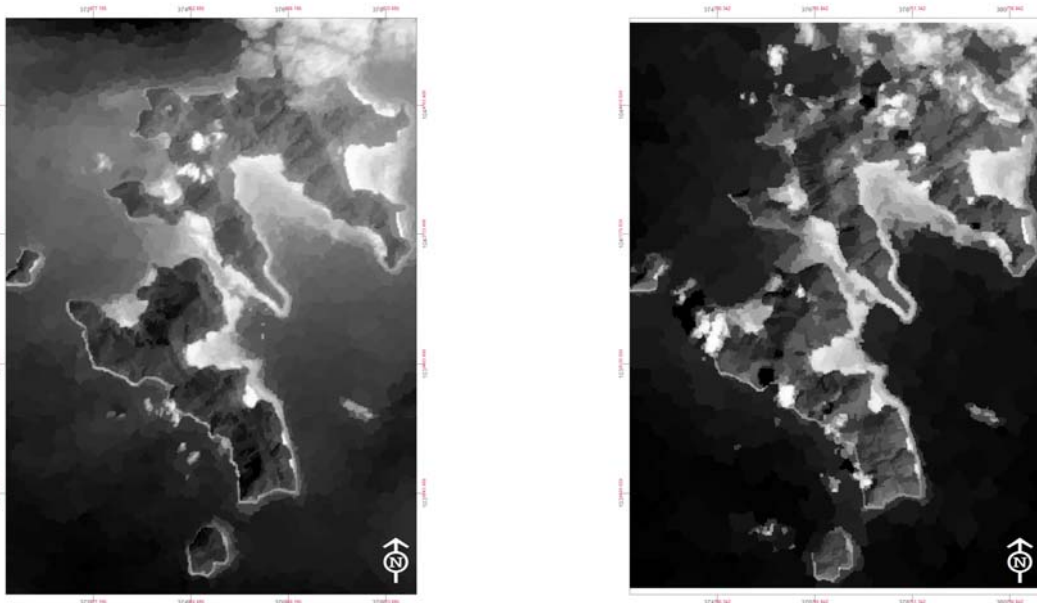


Figure 4 Shows the depth-invariance index of THEOS (left) and Landsat TM 5 (right).

2.3 Image Classification processing.

The concept (of image segmentation and object classification) was presented by Kettig and Landgrebe 1976, it approach the satellite image classification of recent years. Afterwards, the objected - based classification is a new technology of digital image classification. Such algorithm requires one or more image segmentations, which should be supported by the additional information to make the segments more appropriate on classification improvement.

An object - based classification based the image object which grouping pixels value by using statistic and characteristic of neighbor pixel together. The linear stretch is selected to enhance the images. Then, the classification algorithm has been created to classify shallow coral reef; the first algorithm is used to categorize water from other object, such as terrestrial and clouds. The suggest of band composite for **R G B** which clearly visual in shallow coral reef, is ($\frac{blue}{NIR}$, $blue$, $\frac{red}{NIR}$) (Sariwut, 2002), See figure 3.

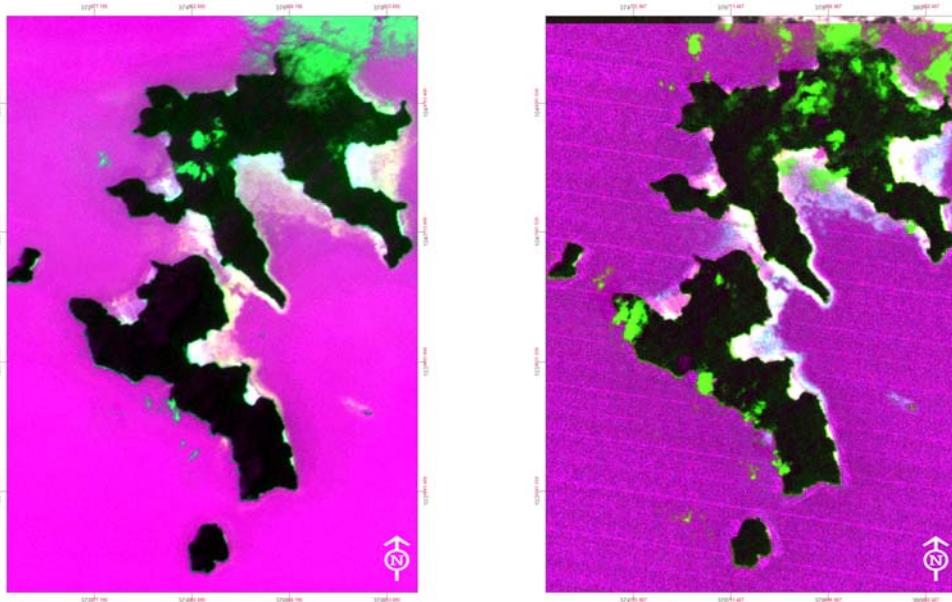


Figure 3 Shows Band composite of $\frac{blue}{NIR}$, $blue$, $\frac{red}{NIR}$ (RGB) of THEOS (left) and Landsat TM 5 (right) Images.

To classify the differences into water object, the second algorithm is used to categorize in-depth. There are four classes; sea, algae & sea grass, shallow coral reefs, and others (see figure 4).

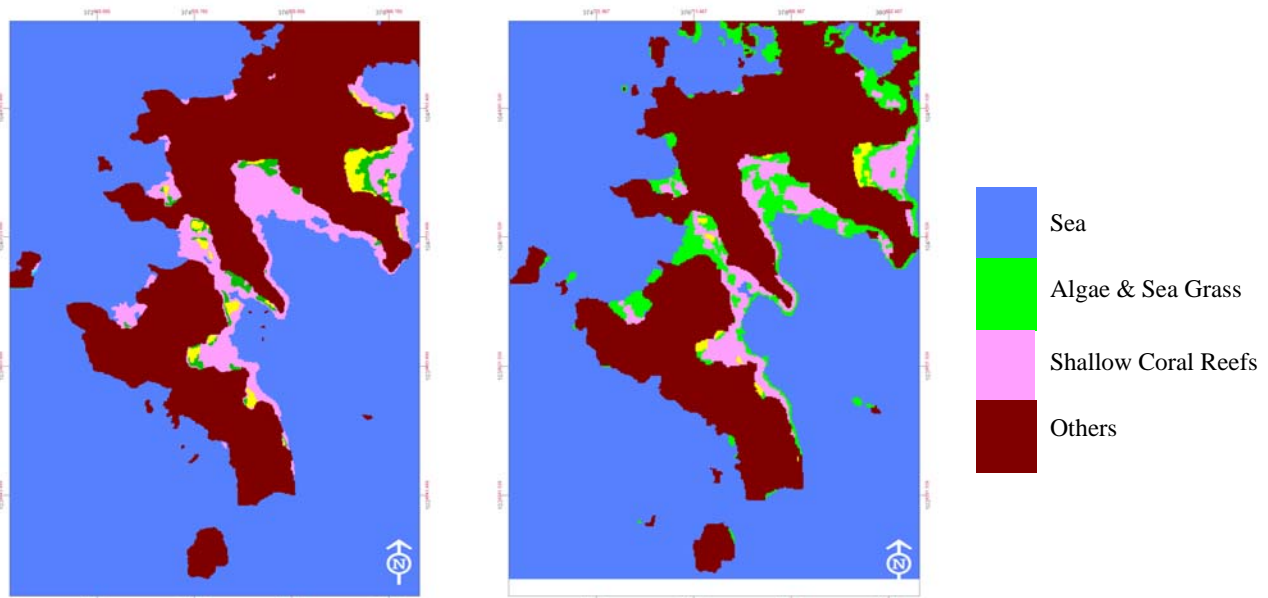


Figure 4 Shows the object - based classification of THEOS (left) and Landsat TM 5 (right).

2.4 Field methodology and accuracy assessment.

Theoretically, survey of the study areas along with the acquisition of the images is an ideal. However, in practical, the time gap between ground survey and image acquisition is around 3 months. The field survey has been used for the accuracy assessment by randomizing more than 20 points around the study site (see figure 5), coordinate collection of each sample points by using the GPS receivers, and recording characteristic under water.

The error matrix based on Training and test area mask (TTA Mask) is used to define test areas for an accuracy assessment of the classification results by comparing the classification result with ground truth information (TTA).

In this study, the shallow coral reef classification accuracy of 87.90% was achieved in Surin Island (THEOS), while the 77.63% accuracy was obtained by Landsat TM 5 (see table 1 and 2).



Figure 5 Shows sample observation points around study site.

Table 1 Shows the error matrix based on TTA mask of THEOS image's shallow coral reefs classification

Reference Data							
Class	Others	Coral	Sea	Sand	Algae/ Seagrass	Total	Error of Commission
Others	352	0	0	0	0	352	1.0000
Coral	0	308	49	36	44	437	0.7048
Sea	0	12	1713	0	2	1727	0.9919
Sand	23	6	0	169	0	198	0.8535
Algae/Seagrass	0	26	7	0	133	166	0.8012
Total	375	352	1769	205	179	2880	
Error of Omission	0.9387	0.8750	0.9683	0.8244	0.7430		0.9288

**Kappa is 0.879

Table 2 Shows the error matrix based on TTA mask of Landsat TM 5 image's shallow coral reefs classification

Reference Data

Class	Others	Coral	Sea	Sand	Algae/ Seagrass	Total	Error of Commission
Others	650	0	0	38	0	688	0.9448
Coral	0	116	92	8	19	235	0.4936
Sea	47	21	900	0	17	985	0.9137
Sand	12	2	0	73	0	87	0.8391
Algae/Seagrass	0	28	16	0	41	85	0.4824
Total	709	167	1008	119	77	2080	
Error of Omission	0.9168	0.6946	0.8929	0.6134	0.5325		0.8558

**Kappa is 0.776

3. DISCUSSION AND CONCLUSIONS

This research compares the capability of THEOS for mapping shallow coral reefs with Landsat TM 5. Due to the different of spatial resolution (15m and 30m, respectively), the result of classification shallow coral reef from THEOS image is better than Landsat TM 5 with significant of 90% confidence. On the other hand, Landsat TM 5 has spectral band more than THEOS (7 bands and 3 bands) is not considered. THEOS image has capability of classifying and mapping shallow reefs with higher degree than Landsat TM 5 . Anyway, multispectral THEOS image (15m.) showed the roughly classification result.

The Future work is needed to improve algorithm on in-depth categorization of shallow coral reef, such as dead coral, live coral, type of coral and others by fusing multispectral data with panchromatic data (pan-sharpening). The good spatial resolution may give the better result of shallow coral reef and need further study.

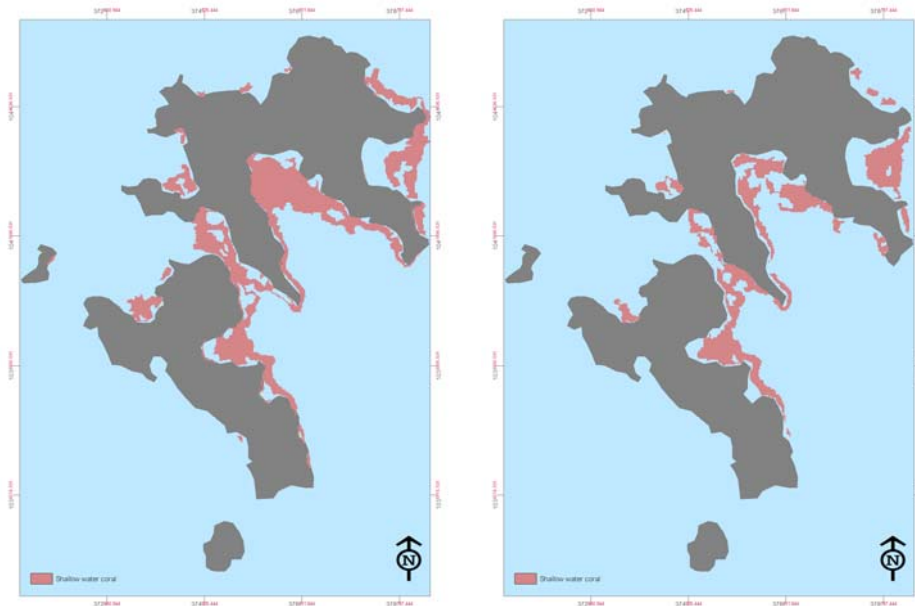


Figure 5 Show the shallow coral reefs mapping from THEOS (left) and Landsat TM 5 (right).

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