DEVELOPMENT OF THE NEW ALGORITHM FOR MANGROVE CLASSIFICATION

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Abstract

The objective of the study is to develop the algorithm for mangrove classification and density. Regression and correlation analysis was used to perform the equation. CE1 = (0.663*Band 3) + (0.l55*Band 4) - (l.4*Band 5) + 0.995 And CE2 = 36 * Band 4 + 6*Band 5 + Band 3 were two formula that have been used to classify the mangrove. The object will be classified as mangrove when the value of CE1 is between -31.439 and 0.888, and value of CE2 is greater than or equal to 2000. On the other hand, density of the mangrove was expressed as DE = (2 * Band 4)/(Band 1+Band 3). Mangrove classification result in this study was similar to those of the existing methods. Statistical approach in this study generally gives the higher result tendency than other methods.

Key words: Mangrove, Landsat ETM+, Empirical Model, Image Classification

I. Introduction

Mangroves have important functions in coastal ecosystem such as protection of area from erosion, production of organic matter, and protection of area for young fauna (Notohadipoero and Siradz, 1978). Mangrove ecosystem, both structurally and functionally dependent heavily on various important environments factors such as climates, tides, waves and currents, salinity, dissolved oxygen, soil and nutrients (Aksornkoae, 1995). Mangrove forest in Indonesia used to be approximated 3.8 million hectares, distributed for conservation (31%), for production forest (36%) and for other needs (33%). In Bali, total of mangrove forest is around 3,000 hectares (Anwar and Subiandono, 1997). Some of the mangrove ecosystem have been degraded (Budhiman and Dewanty, 2002; Wouthuyzen *et* a., 2002).

To know total of mangrove area and its distribution using remote sensing data, the mangrove need to classify. There were several algorithms to classify the object using remote sensing data such as minimum distance, box classifier, and maximum likelihood. All of the existing supervised classification algorithm use training area (Lillesand and Kiefer, 1993). Accuracy of the classification result is essentially decided by precision of training area. It depends on experience of the user/classifier. Local knowledge is very important to decide the appropriate training area. It is usually difficult to perform for the unknown area.

In order to speed up the classification process of the mangrove using remote sensing data, development of the algorithm is required. In this case, the equation is performed instead of using of training area.

The aim of the study is to develop the algorithm for mangrove classification and density using the empirical model, and compare the classification result with the existing method.

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II. Methodology

The study was conducted at Benoa Bay, Badung Regency, Province of Bali, centered at 8°44'35" S and 115°12'04" E (Figure 1). Remote sensing data used in this study were Landsat TM acquired on April, 24th 1994 and Landsat ETM+ recorded on March, 21st 2003. Algorithm for mangrove classification and density was developed using the regression and correlation method (Figure 2).

Classification result of this study was compared with the existing classification methods, which are Minimum Distance, Box Classifier, and Maximum Likelihood.

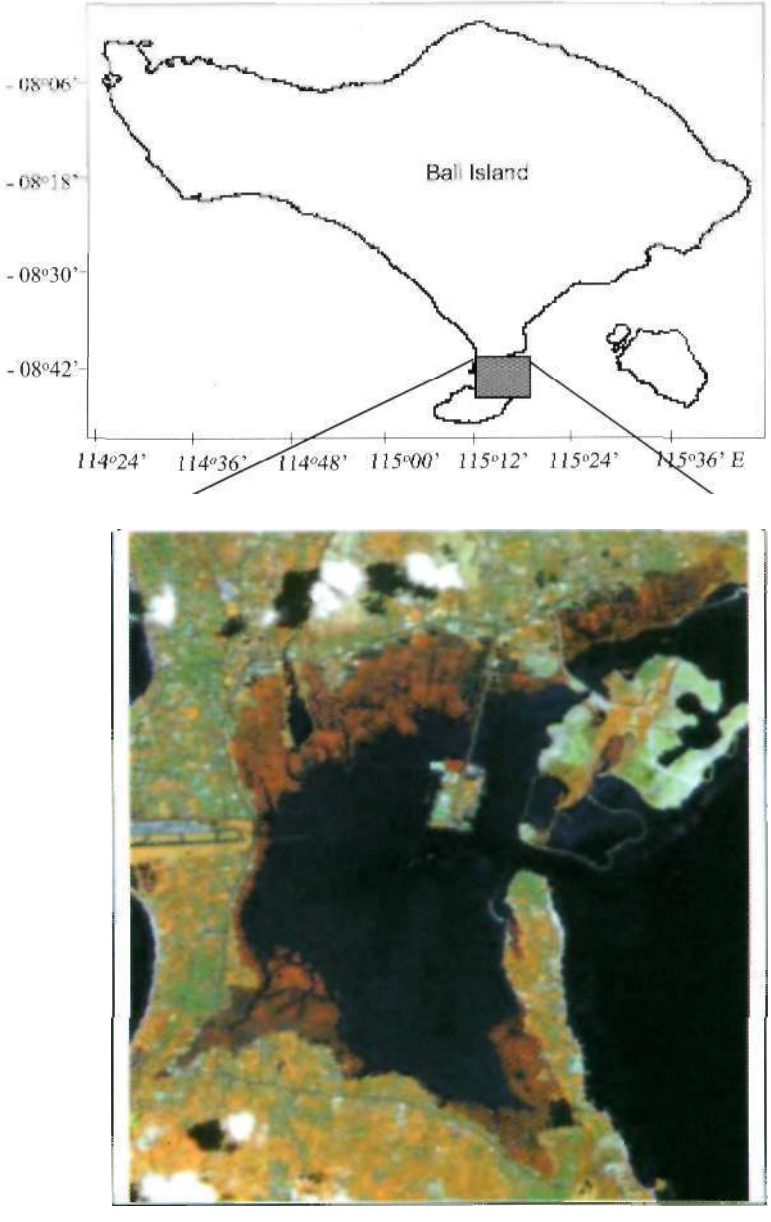

Figure 1. Map of the study sites

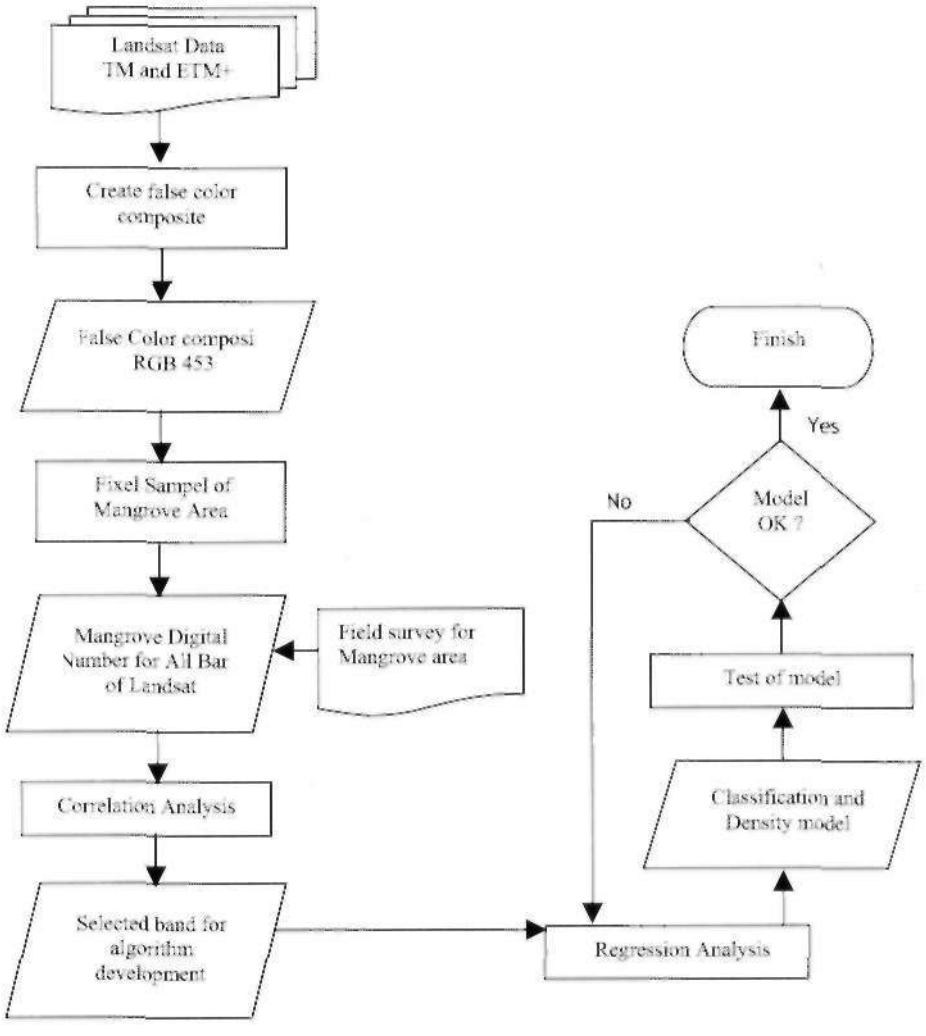

Fig. 2. Flowchart of study

III. Result and Discussion

3.1 Classification and density algorithm

Digital number in each band of Landsat ETM+ for the mangrove object statistically are shown in Table 1, and spectral characteristic of mangrove and several objects in study area and their surrounding are shown in Fig. 3.

Based on the correlation analysis, Band 3, Band 4 and Band 5 of Landsat ETM+ are selected to perform the algorithm, since these bands have a significant correlation to mangrove representation. Regression analysis result showed 2 equations for mangrove classification, those were:

CE1 = (0.663*Band 3) + (0.155*Band4) - (1.4*Band5) + 0.995

CE2 = 36 * Band 4 + 6*Band 5 + Band 3

where Band 3, Band 4, and Band 5 are Band 3, Band 4, and Band 5 of Landsat TM, respectively.

The object will be classified and recognized as mangrove, when the value of CE1 is between -31.439 and 0.888, and value of CE2 is at least 2000. On the other

hand, development of mangrove density algorithm were used for Band 1, Band 3, and Band 4. The equation mangrove density algorithm qualitatively given by the following equation: $DE = \frac{2 * B4}{B1 + B3}$

Application of the classification and density algorithm in the study area and in the north east of Lombok Island is shown in the Figure 4 and Figure 5.

Table 1. Statistic value of Landsat ETM+ Digital Number.

Statistic Parameter	Band					
	1	2	3	4	5	7
n	100	100	100	100	100	100
Average	70.81	52.9	38.3	74.44	37.83	18.43
Min	65	49	32	50	25	14
Max	75	59	47	99	51	28
Dev. Std.	1.895	1.7	2.64	12.02	3.704	2.315

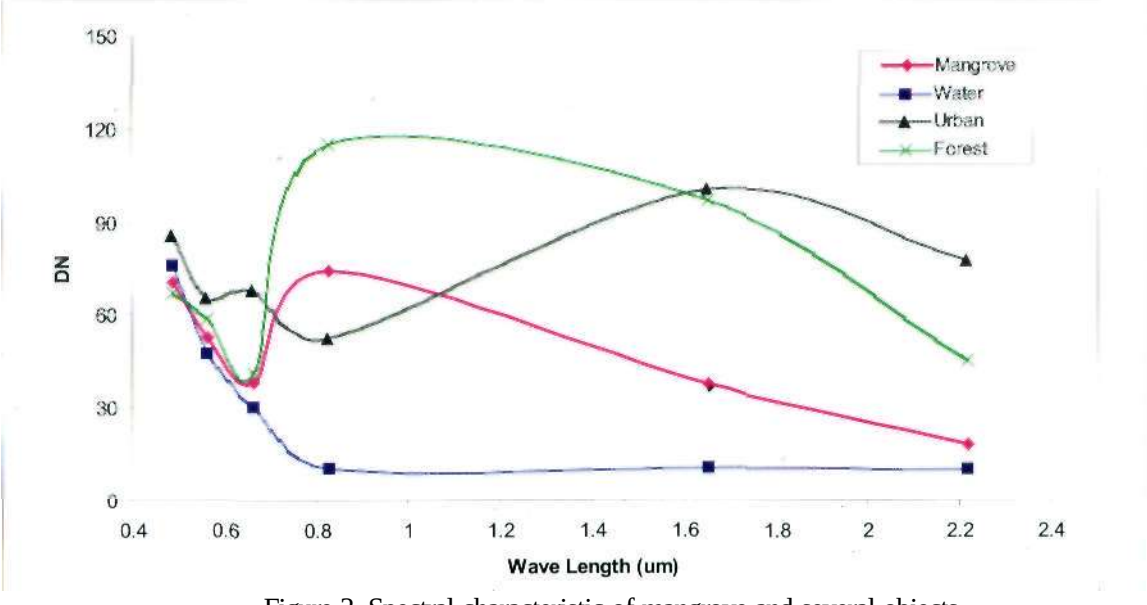

Figure 3. Spectral characteristic of mangrove and several objects in study area and their surrounding

3.2 The comparison between classification algorithm and the existing method

Comparing the classification result using the algorithm (statistical approach) and the existing method (Minimum Distance, Box Classifier, and Maximum Likelihood) was performed in two dates of Landsat acquisitions, i.e. 1994 and 2003 (Figures 6 and 7). Based on the comparison of the total area of the mangrove classification, result was given that all of the existing method and algorithm method, developed in this study yielded the similar area with the tendency of the algorithm method, provided by the more much result of a total area (Table 2).

Table 2. The comparison of area of classification result

Classification Method	LandsatTM 1994		Landsat ETM+ 2003	
	Nr. Pixel	Area (Ha)	Nr. Pixel	Area (Ha)
Minimum Distance	6,369	573.21	8,450	760.50
Box Classifier	5,807	522.63	8,504	765.36
Maximum Likelihood	5,604	504.36	8,227	740.43
Statistical Approach	5,409	486.81	9,484	853.56

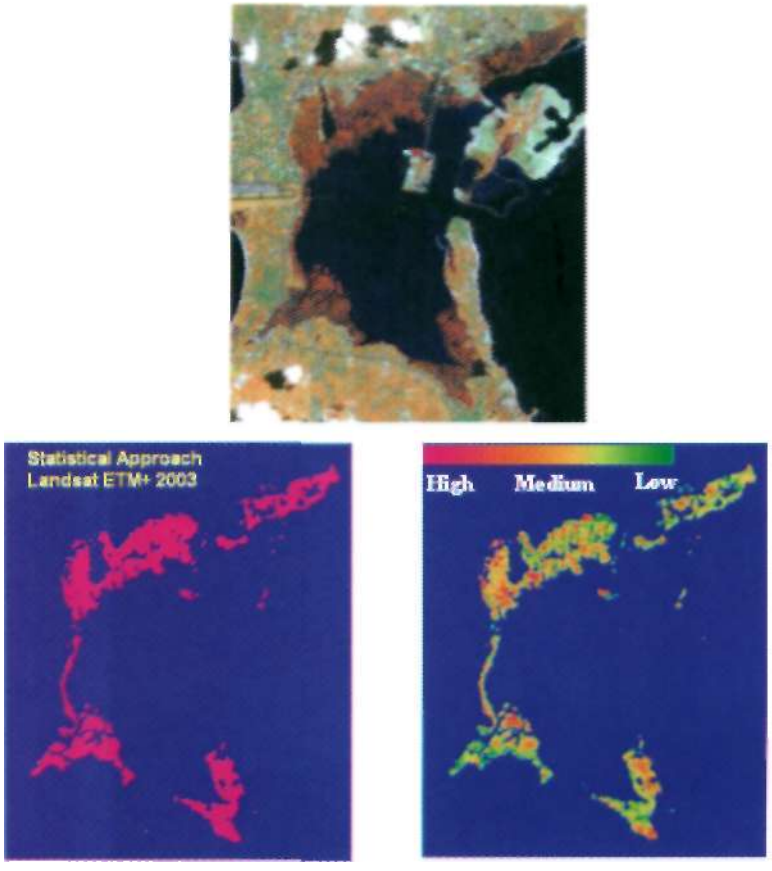

Fig. 4. Classification and density algorithm applied in Southern of Bali Island.

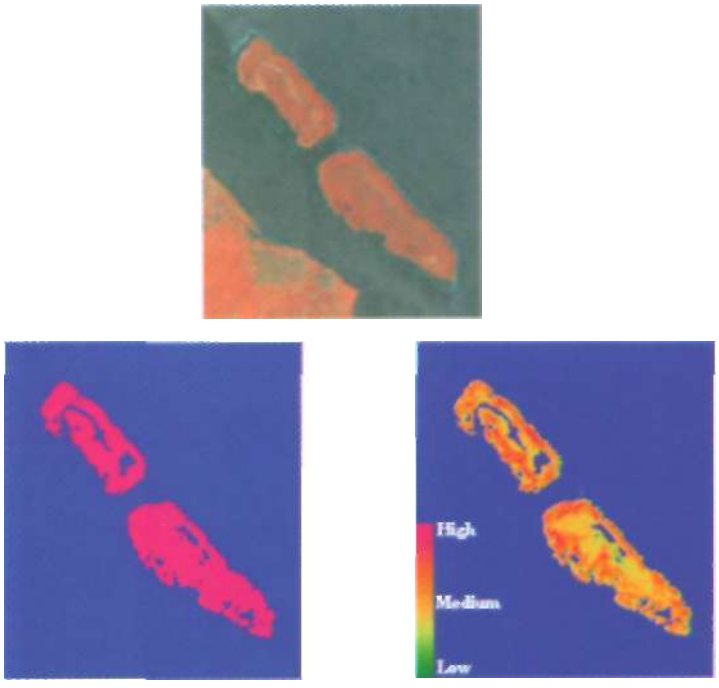

Figure 5. Classification and density algorithm applied in North East of Lombok Island

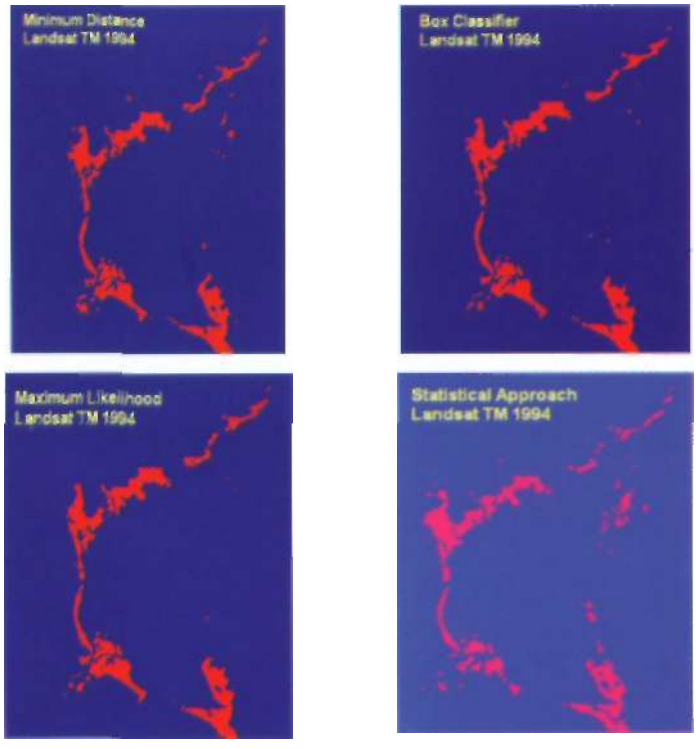

Figure 6. The comparison between classification result of Landsat TM 1994 used empirical model (statistical approach) and existing method.

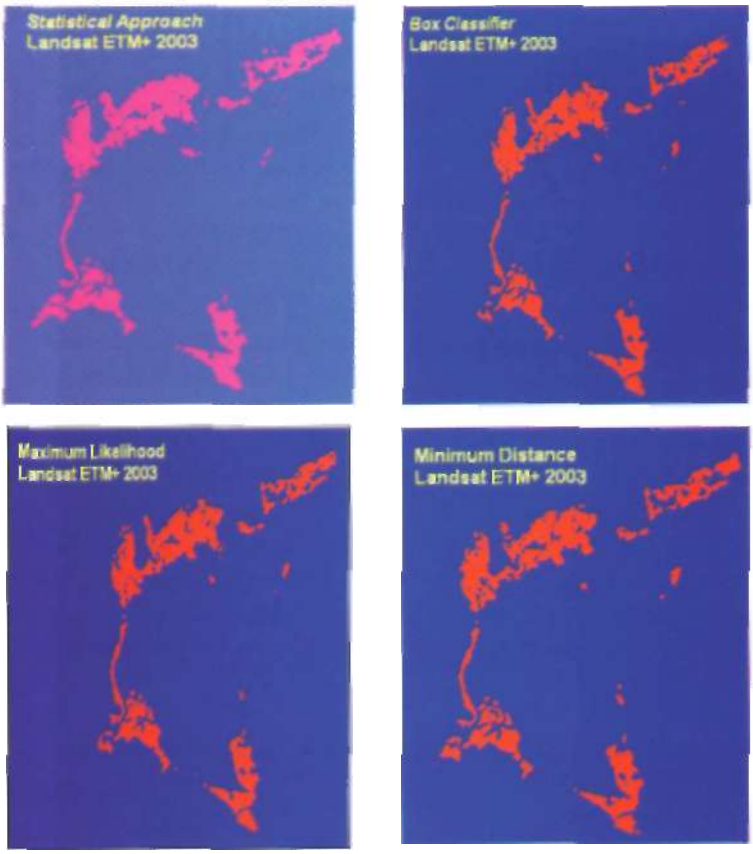

Figure 7. The comparison between classification result of Landsat TM 2003 used empirical model (statistical approach) and existing method.

V. Conclusion

By mean of statistical analysis, model for mangrove classification and density can be performed. Two equations CE1 = (0.663*Band 3) + (O.I55*Band'4) - (1.4*Band 5) + 0.995 and CE2 - 36 * Band 4 + 6*Band 5 + Band 3, have been used to classify the mangrove. The object will be classified as mangrove when the value of CE1 is between -31.439 and 0.888, and value of CE2 is greater than or equal to 2000. On the other hand, density of the mangrove was expressed as DE == (2 * Band 4)/(Band 1+Band 3). Mangrove classification result in this study provided the similar result compared with the existing method. Statistical approach in this study generally gives the higher result tendency than existing methods.

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