LAND COVER FRACTIONS MAPPING USING MODIS IMAGERY OVER NANGGROE ACEH DARUSSALAM (NAD) PROVINCE, INDONESIA

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ABSTRACT

Land cover analysis plays an important role in many environmental applications nowadays. The objective of this study is to assess the capability of Moderate Resolution Imaging Spectroradiometer (MODIS) scene for land cover mapping over Nanggroe Aceh Darussalam (NAD) province, Indonesia. Standard supervised classification techniques were used in this study namely maximum likelihood, minimum distance-to-mean, parallelepiped and parallelepiped (with Maximum Likelihood Tie Resolution) by using PCI Geomatica 9.1 image processing software. The accuracy of each classification map was assessed using the reference data set consisted of a large number of samples collected per category. The results from this multispectral classification analysis of this study area indicated that urban features could be clearly identified and classified relative to the surrounding terrain and its associated desert features. In this study, Kappa statistic and overall accuracy were calculated and compared for the three supervised classification techniques. Geometric correction was performed to the digital image using the nearest neighborhood method with second order polynomial. This preliminary study has produced a promising result with a geocoded image. This indicates that land features can be carried out using remote sensing classification method of the MODIS imagery.

ABSTRAK

Analisa tutupan lahan memiliki peranan yang sangat penting pada banyak aplikasi bidang lingkungan. Penelitian ini bertujuan untuk menilai kemampuan citra *Moderate Resolution Imaging Spectroradiometer* (MODIS) dalam aplikasi pemetaan tutupan lahan untuk provinsi Nanggroe Aceh Darussalam (NAD), Indonesia. Teknik klasifikasi tersedia standar yang digunakan dalam penelitian ini dinamai *maximum likelihood, minimum distance-to-mean, parallelepiped and parallelepiped* (*with Maximum Likelihood Tie Resolution*) menggunakan perangkat lunak pengolahan citra PCI Geomatica 9.1. Hasil yang diperoleh dari analisa klasifikasi multispektral tersebut mengindikasikan bahwa fitur *urban* dapat teridentifikasi dengan jelas dan terklasifikasi relatif terhadap keadaan sekelilingnya dan asosiasinya terhadap fitur *desert*. Dalam studi ini, statistika Kappa dan ketelitian secara keseluruhan dikalkulasi dan dibandingkan untuk ketiga teknik pengklasifikasian tersebut. Koreksi geometris dilakukan terhadap citra digital tersebut menggunakan metode *the nearest neighbourhood* dengan polinomial orde kedua. Penelitian awal ini telah menghasilkan suatu citra *geocoded*. Ini mengindikasikan bahwa fitur lahan dari citra MODIS tersebut dapat diklasifikasi menggunakan metode klasifikasi penginderaan jauh.

Kata kunci: *Land cover fractions, MODIS imagery, Supervised classification, Kappa statistic, geocoded image*

1 INTRODUCTION

There has been a growing interest in the use of remote-sensing systems for a regular monitoring of the earth's surface. Remote sensing is an attractive source of the thematic maps such as

those depicting land cover as it provides a map-like representation of the Earth's surface that is spatially continuous and highly consisted, as well as available at a range of spatial and temporal scales. Thematic mapping from remotely sensed data is typically based on an image classification (Foody, 2002). In the past few years, there has been a growing interest in the used of remote-sensing systems for a regular monitoring of the earth's surface (Bruzzone and Prieto, 2002). Many researchers used remotely sensed images in their land cover and land use studies [Tapiador and Casanova, (2003), Shrestha and Zinck, (2001) and Friedl, et al., (2001)].

The study area was Nanggroe Aceh Darussalam (NAD) province, Indonesia which is the place nearest with epicentre of the earthquake that occurred on 26th December 2004. The earthquake as an underwater earthquake, later measured at 9.0 on the moment magnitude scale, occurred off the coast of NAD on the Island of Sumatera, in the Indonesian Archipelago.

In this study, we are using MODIS imagery for land cover classification. The objective of this study was to estimate the land cover coverage area of NAD after the tsunamis by using MODIS imageries. Supervised classification methods were applied to the digital images. The monitoring task can be accomplished by supervised classification techniques, which have proven to be effective categorization tools (Bruzzone, et al., 2002). Post-classification of accuracy assessment also has been done in this study.

2 STUDY AREA AND DATA

The MODIS imageries used in this study was acquired on 29th December 2004. The selected study area was Nanggroe Aceh Darussalam (NAD) province, Indonesia. Figure 2-1 shows the study area. The study area is in the Sumatera Peninsula, located between latitudes 2°N and 6°N and longitudes 95°E and 99°E. The MODIS data was free download from MODIS Rapid Response Project appropriately: "Image courtesy of MODIS Rapid Response Project at NASA/GSFC" captured on 29th December 2004. MODIS data with the sensor on board the Terra satellite are one of the most used for environmental studies. MODIS (or Moderate Resolution Imaging Spectroradiometer) is a key instrument aboard the Terra (EOS AM) and Aqua (EOS PM) satellites. Terra's orbit around the Earth is timed so that it passes from north to south across the equator in the morning, while Aqua passes south to north over the equator in the afternoon. Terra MODIS and Aqua MODIS are viewing the entire Earth's surface every 1 to 2 days, acquiring data in 36 spectral bands, or groups of wavelengths. These data will improve our understanding of global dynamics and processes occurring on the land, in the oceans, and in the lower atmosphere.

Figure 2-1:The study area of NAD province, Indonesia

3 METHODOLOGY

MODIS is playing a vital role in the development of validated, global, interactive Earth system models to predict global change. It is enough to assist policy makers in making sound decisions concerning the protection of our environment (National Aeronautics and Space Administration). In this study, three visible bands (1, 4 and 3) of MODIS onboard Terra satellite were used in the multispectral classification analysis using the classifiers mentioned earlier. Figure 3-1 shows the raw satellite image of the NAD province, Indonesia.

Table 3-1: SPECTRAL RANGE OF BANDS AND SPATIAL RESOLUTION FOR THE MODIS DATA USED IN THIS STUDY

Band	Spectral Range (nm)	Spatial Resolution (m)
Band 1	620 – 670	250
Band 3	459 – 479	250
Band 4	545 – 565	250

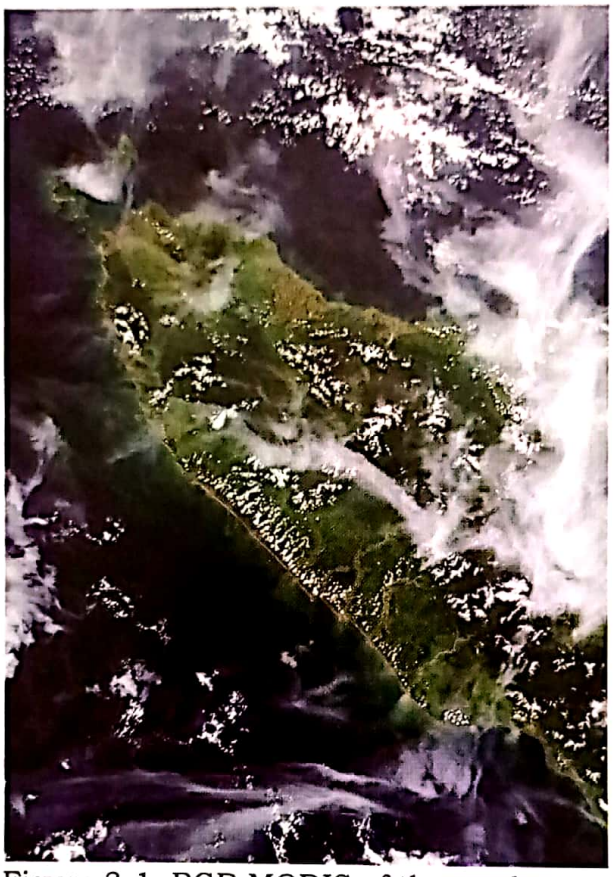

Figure 3-1: RGB MODIS of the study area

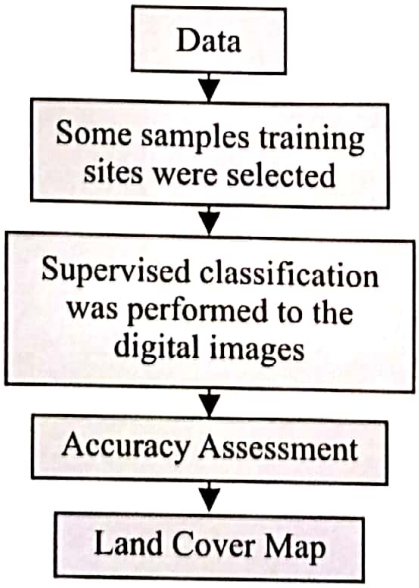

Figure 3-2: Flow chart for data processing of the images

Figure 3-1 is shown the raw MODIS images. A total of 52 training sample areas were selected in this analysis. The aim of the classification analysis is to categorize all of the pixels into same classes. Basically, the process can be divided into three steps, the pre-processing, data classification and output.

For the first step of pre-processing, two satellite images were chosen for land cover classification. For the second step of data classification, the satellite images were processed using PCI Geomatica 9.1 software package. Supervised classifications operate in three basic steps: training, classification and accuracy assessment (Figure 3-2). The training sites were needed for supervised classification. Training data sets have been chosen within the areas of exactly know identity of agricultural vegetation. The areas were established using polygons. They are delineated by spectrally homogeneous sub areas, which have, class name given. Once the training sites and classes were assigned, the images were then classified using the three supervised classification methods [Maximum Likelihood, Minimum Distance-to-Mean, Parallelepiped and Parallelepiped (with Maximum Likelihood Tie Resolution)].

4 DATA ANALYSIS AND RESULTS

Accuracy assessment was carried out to compute the probability of error for the classified map. A total of 200 samples were chosen randomly for the accuracy assessment. Many methods of accuracy assessment have been discussed in remote sensing literatures. Two measures of accuracy were tested in this study, namely overall accuracy and Kappa coefficient. In thematic mapping from remotely sensed data, the term accuracy is used typically to express the degree of 'correctness' of a map or classification (Foody, 2002). The results in this study are shown in Table 4-1 and Table 4-2.

Finally, the land cover map was generated using Figure 4-1. The MODIS satellite image was rectified using the second order polynomial coordinates transformation to relate ground control points in the map to their equivalent row and column positions in the MODIS scences. A nearest neighbour geometric correction method was applied to the acquired satellite image.

Table 4-1: THE KAPPA COEFFICIENT FOR THE IMAGE

Classification method	Kappa coefficient
Maximum Likelihood	0.8102
Minimum Distance-to-Mean	0.6028
Parallelepiped	0.2952
Parallelepiped (with Maximum Likelihood Tie Resolution)	0.8623

Table 4-2: THE OVERALL CLASSIFICATION ACCURACY FOR THE IMAGE

Classification method	Overall classification accuracy (%)
Maximum Likelihood	82.2613
Minimum Distance-to-Mean	62.3219
Parallelepiped	25.0350
Parallelepiped (with Maximum Likelihood Tie Resolution)	85.2316

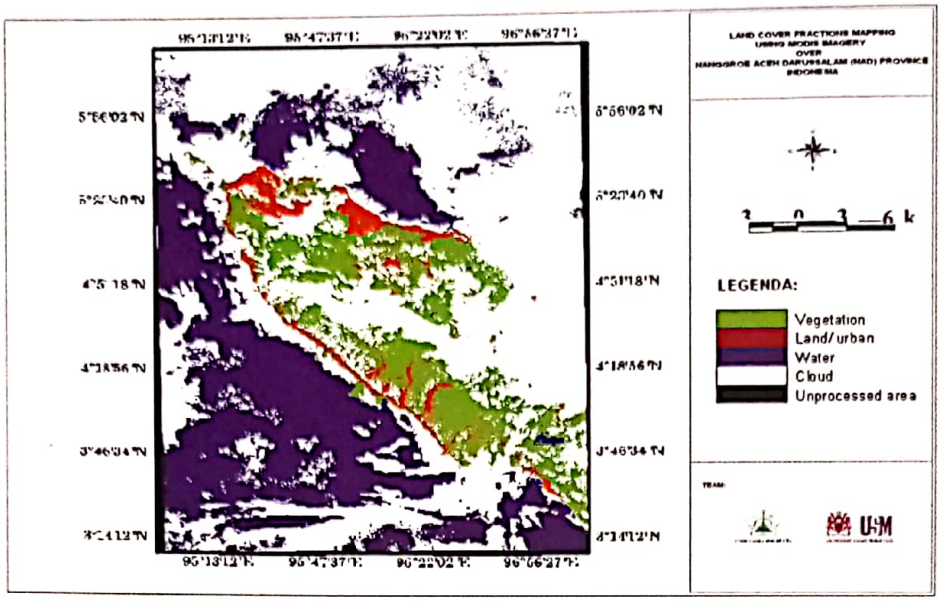

Figure 4-1: The land cover map using MODIS image

5 CONCLUSION

It is possible to produce an accurate classification map by using the MODIS imagery. A broader study area can be obtained by this satellite image. The results presented in this study, show the efficiency and high accuracy of Parallelepiped (with Maximum Likelihood Tie Resolution) classifier. Parallelepiped (with Maximum Likelihood Tie Resolution) was the best classifier in this study because it produced the highest degree of the accuracy. The result indicates that the use of MODIS imagery for land cover mapping is feasible.

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