Land Cover Mapping Over Penang Island, Malaysia Based On Frequency-Based Contextual Classification

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Abstract
Land cover classification is one of the primary objectives in the analysis of remotely sensed data. The objective of this study is to assess the capability of ALOS scene for land cover mapping. The ALOS scene covers Penang Island, Malaysia. A frequency based contextual classifier was used in this study by using PCI Geomatica 9.1 image processing software. Contextual classification is employed when neighbouring pixels are taken into account. 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 the study area indicated that urban features could be clearly identified and classified relative to the surrounding terrain and its associated desert features. High overall accuracy (>90%) and Kappa coefficient (>0.90) was achieved by the contextual classifier in this study. Finally, a land cover map was generated using the frequency based contextual classifier over Penang Island, Malaysia.

Keywords: ALOS AVNIR, Land Cover, Frequency based contextual classifier.

1. INTRODUCTION

Landscape pattern represents a key variable in management and understanding of the environment, as well as driving many environmental models. Remote sensing can be used to provide information on the spatial pattern of land cover features, but analysis and classification of such imagery suffers from the problem of class mixing within pixels [1]. Land cover mapping at coarse spatial resolution provides key environmental information needed for scientific analyses, resource management and policy development at regional, continental and global levels [2]. The increasing availability of remote-sensing images, acquired periodically by satellite sensors on the same geographical area, makes it extremely interesting to develop the monitoring systems capable of automatically producing and regularly updating land-cover maps of the considered site [3]. The objective of this study is to investigate the potentiality of using digital imagery for land cover mapping. A frequency based contextual classifier was applied to the digital images.

High-resolution imagery in the form of aerial photography has been available for many years. Our objective has been to evaluate high-resolution digital ALOS AVNIR imagery in a variety of applications involving land use and land cover mapping. Land cover classification is an important topic in a lot of remote sensing applications [4]. Supervised classification of a frequency based contextual classifier method was applied to the digital image. The monitoring task can be accomplished by supervised classification techniques, which have proven to be effective categorization tools [3]. Post-classification of accuracy assessment also has been done in this study.

2. STUDY AREA

The study area is the Penang Island, Malaysia, located within latitudes 5^o 12’ N to 5^o 30’ N and longitudes 100^o 09’ E to 100^o 26’ E. The map of the region is shown in

Figure 1. The satellite image was acquired on 24 April 2007.

Figure 1. Study area

3. DATA ANALYSIS AND RESULTS

All image-processing tasks were carried out using PCI Geomatica version 9.1.8 digital image processing software at the School of Physics, Universiti Sains Malaysia (USM). The satellite image was then geometrically corrected by second order polynomial equation using the nearest neighbor method. Figure 2 shows the raw satellite image.

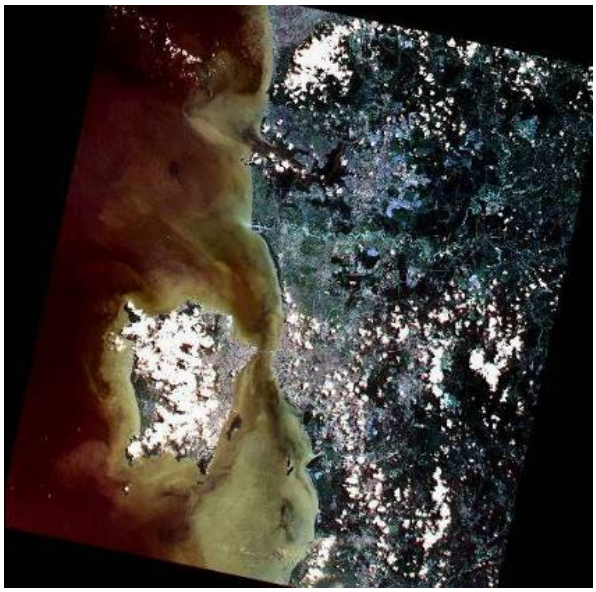

Figure 2. Raw satellite image used in this study

The frequency based contextual classifier performs classification of multispectral imagery using a grey level reduced image and a set of training site bitmaps. The frequency based contextual classifier performs the second of two steps in frequency-based contextual classification of multispectral imagery. It inputs a grey level vector reduction image (must be 8-bit layer) and a set of training site bitmap layers, and creates a classification image under the specified output window. Each input bitmap can be assigned a unique output class value for the classification image. The contextual classifier uses a pixel window of specified size around each pixel.

The aim of the classification analysis is to categorize all the pixels in the digital imagery into land cover classes using a frequency based contextual classifier. For the first step of pre-processing, one digital image of ALOS AVNIR data was chosen for land cover mapping (Figure 2). For the second step of data classification, the digital image was processed using PCI Geomatica 9.1 software package. The frequency based contextual classifications operate in three basic steps: training, classification and accuracy assessment. Training sites were needed for frequency based contextual classification. Selection of training areas in this study was based on the colour image. The areas were established using polygons. They are delineated by spectrally homogeneous sub areas, which have, class name given. They are four classes in this study. Once the training sites and classes were assigned, the images were then classified using the frequency based contextual classifications classification methods.

Accuracy assessment was carried out to compute the probability of error for the classified map. A total of 300 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 [5].

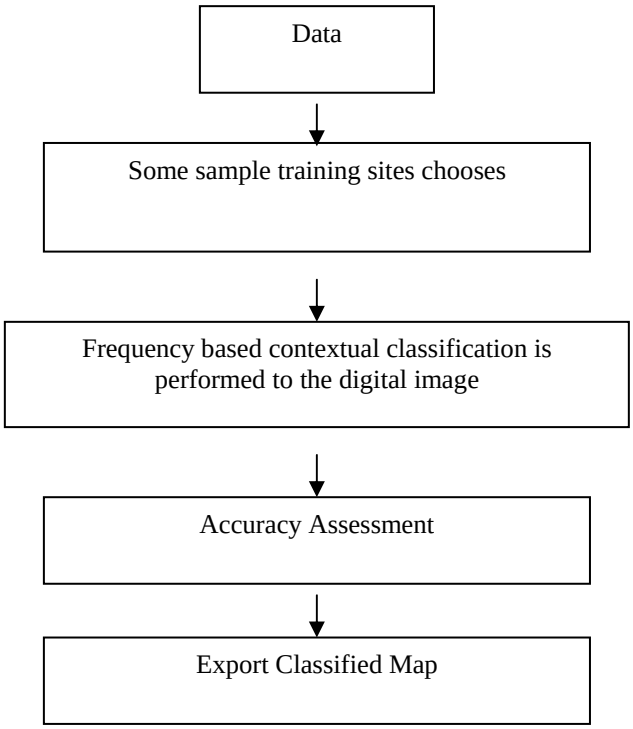

Figure 2. Flow chart for data processing of the image

The assessment results showed a reasonably good agreement between the land cover data set and the reference data. The overall classification accuracy achieved by the frequency based contextual classifier for categorizing land cover over Penang Island, Malaysia was 93.5%.

Table 1. The overall classification accuracy and Kappa coefficient

Classification method	**Contextual classifier**
Kappa coefficient	0.9219
Overall classification accuracy (%)	93.5

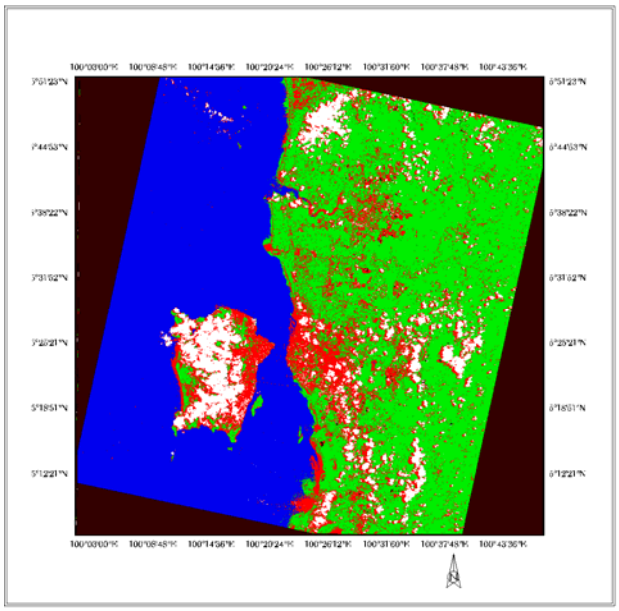

Figure 3. The land cover map using ALOS image [Colour Code: Red = urban, Green = Vegetation, Blue = Water, White = Cloud and Black = Area outside the image]

4. CONCLUSION

In this study, the proposed classification technique of a frequency based contextual classifier in order to classify land cover from remotely sensed data has been successfully presented. This study indicates the feasibility of using ALOS data for land cover mapping over Penang Island, Malaysia.

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References

[1] Tatem, A., Lewis, H., Atkinson, P. and Nixon, M. S., 2002, Super-Resolution Land Cover Pattern Prediction Using a Hopfield Neural Network. Remote Sensing of the Environment, 79.

[2] Latifovic, R., Zhu, Z. L., Cihlar, J., Giri, C. and Olthof, I., 2004, Land cover mapping of North and Central American-Global Land Cover 2000, Remote sensing of environment, 89, 116 – 127.

[3] Bruzzone, L., Cossu, R. and Vernazza, G. (2002). Combining parametric and non-parametric algorithms for a partially unsupervised classification of multitemporal remote-sensing images. Information Fusion 3, 289 –297.

[4] Keuchel, Naumann, S., Heiler, M. and Siegmund, A., 2003, Automatic land cover analysis for Tenerife by supervised classification using remotely sensed data. Remote Sensing of Environment, 86, 530–541.

[5] Foody, G. M., 2002, Status of land cover classification accuracy assessment. *Remote Sensing and Environment*, 80, 185–201.