High Spatial Resolution Land Cover Mapping Using ALOS Data Over Kedah, Malaysia

H. S. Lim, M. Z. MatJafri, K. Abdullah and N. Mohd. Saleh

School of Physics, Universiti Sains Malaysia, 11800 Penang, Malaysia.
Tel: +604-6533888, Fax: +604-6579150
E-mail: hslim@usm.my, mjafri@usm.my, khirudd@usm.my, nasirun@usm.my

Abstract
Land cover analysis plays an important role in many environmental applications nowadays. Satellite images can provide a high spatial resolution land cover map. This study investigated the potential of using digital camera for land cover mapping over Kedah, Malaysia using ALOS AVNIR data. The standard supervised classification techniques, such as the maximum likelihood, minimum distance-to-mean, parallelepiped and neural network, were applied to the multispectral satellite images. The land cover information was extracted from the digital spectral bands using PCI Geomatica 9.1.8 software package. The neural network classifier was performed to the satellite images and the results were compared with four standard supervised classification techniques, such as the maximum likelihood, minimum distance-to-mean and parallelepiped. Training sites were selected within each scene and land cover classes were assigned to each classifier. High overall accuracy (>90%) and Kappa coefficient (>0.90) was achieved by the neural network classifier in this study. The best supervised classifier was chosen based on the highest overall accuracy and Kappa statistic. The results produced by this study indicated that the neural network classifier could be used to classify the land features into a land cover map. This study suggested that the land cover types of Kedah, Malaysia can be accurately mapped using ALOS data.

Keywords: ALOS AVNIR, Land Cover, Neural network classifier.

1. INTRODUCTION

Remote sensing can be used for several purposes. In the past few years, there has been a growing interest in the use of remote-sensing systems for regular monitoring of the earth's surface [1]. 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 [2]. Our objective has been to evaluate high-resolution digital camera imagery in a variety of applications involving land use and land cover mapping. Supervised classification techniques have become effective categorization tools, which require the availability of a suitable training set. Land cover classification is an important topic in a lot of remote sensing applications [3]. The objective of this study was to map the land cover features over Kedah, Malaysia using ALOS AVNIR data. Supervised classification methods were applied to the digital satellite images. The monitoring task can be accomplished by supervised classification techniques, which have proven to be effective categorization tools [2]. Post-classification of accuracy assessment also has been done in this study.

Many researchers used remotely sensed images in their land cover and land use studies [4, 5, 6, 7]. Supervised classification of multispectral remote sensing imagery is commonly used for land cover determination [8]. The neural network classifier was performed to the satellite images and the results were compared with four standard supervised classification techniques, such as the maximum likelihood, minimum distance-to-mean and parallelepiped. The neural network classifier was found to produce the highest accuracy in this study.

2. STUDY AREA

The selected study area was Yan, Kedah. Yan, Kedah, Malaysia, which is 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.

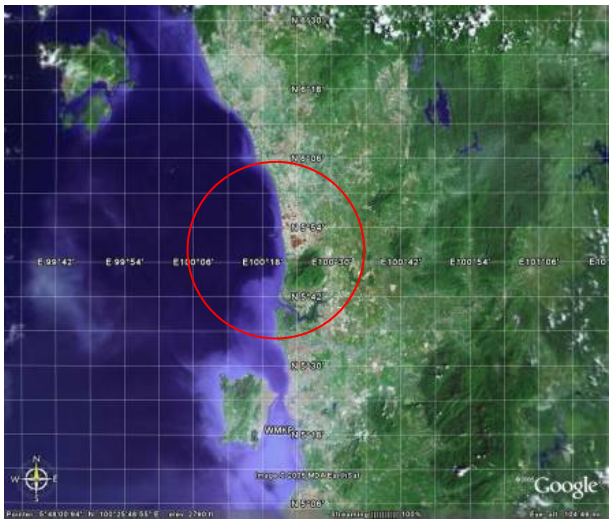

Figure 1. Study area

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.

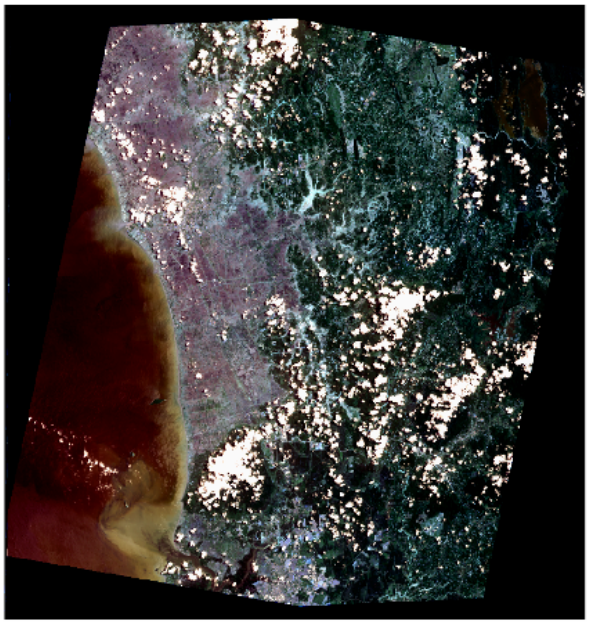

Figure 2. Raw satellite image used in this study

The aim of the classification analysis is to categorize all the pixels in the digital camera imagery into land cover classes. The satellite image was classified using three supervised classification methods with a set of the training data set. The mosaic digital image was classified into 4 classes using three visible bands (Vegetation, Urban, Water and cloud). The available ground truth data were used in the accuracy assessment analysis for the classified map. The accuracy of the classified map was analysed using confusion matrix and Kappa coefficient.

The areas were established using polygons. They are delineated by spectrally homogeneous sub areas, which have, class name given. A total of 35 sample-training areas were studied in this analysis. 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 Neural Network). Accuracy assessment was carried out to compute the probability of error for each classified map. The overall accuracy is expressed as a percentage of the test-pixels successfully assigned to the correct classes.

The classified map produced by each classifier was checked with the confusion or error matrix and Kappa statistic. The results obtained are presented in Table 1.

The neural network classifier produced Kappa

coefficient of 0.9159. The high Kappa coefficient suggests a good relationship between the classified image and the reference data. 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 neural network classifier for categorizing land cover for Kedah, Malaysia was 91.25%. The classified land cover maps using Neural Network are shown in Figure 4.

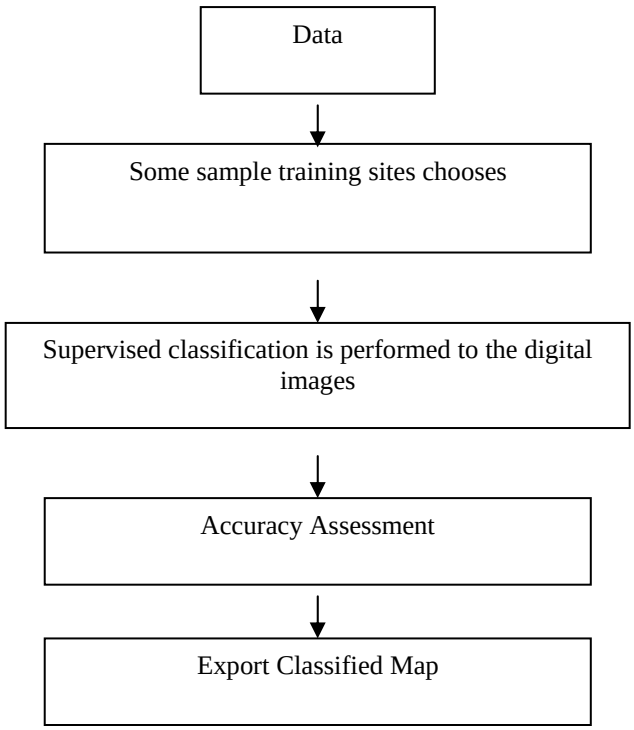

Figure 3. Flow chart for data processing of the images

Table 1. The overall classification accuracy and Kappa coefficient

Classification method	**Kappa coefficient**	**Overall classification accuracy (%)**
Maximum Likelihood	0.8535	86.36
Minimum Distance-to-Mean	0.6221	60.15
Parallelepiped	0.6212	69.85
Parallelepiped (with Maximum Likelihood Tie Resolution)	0.8723	88.36
Neural network	0.9159	91.25

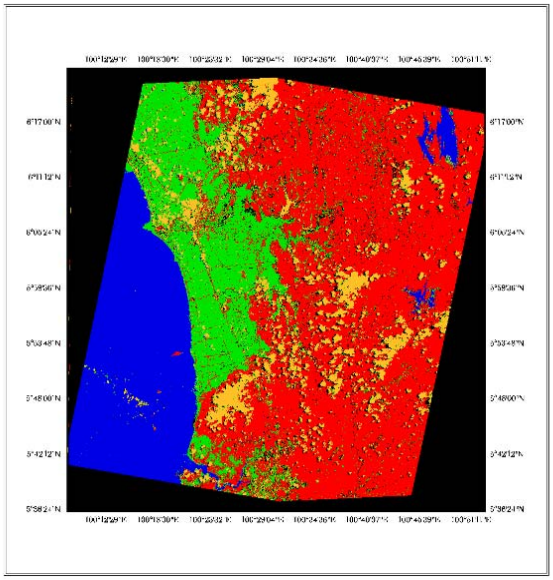

Figure 4. The land cover map using ALOS AVNIR image [Colour Code: Orange = Cloud, Green = wet land, Blue = Water, Red = Vegetation and Black = Area outside the image]

4. CONCLUSION

The land cover map produced by this study with higher accuracy indicated that the satellite ALOS imagery could provide useful information for remotely sensed data. As a result of this study, the neural network classifier produced highest degree of accuracy.

Acknowledgements

This research is conducted under the agreement of JAXA Research Announcement titled '2nd ALOS Research Announcement for the Advanced Land Observation Satellite between the Japan Aerospace Exploration Agency and the Research - The use of ALOS data in studying environmental changes in Malaysia' (JAXA – 404)

References

[1] Bruzzone, L. and Prieto, D. F., 2002, A partially unsupervised cascade classifier for the analysis of multitemporal remote-sensing images. Pattern Recognition Letters, 23, 1063–1071.

[2] 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.

[3] 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.

[4] Tapaidor, F. J. and Casanova, J. L., 2003, Land use mapping methodology using remote sensing for the regional planning directives in Segovia, Spain. Landscape and Urban Planning, 62, 103-115.

[5] Langley, S. K., Cheshire, H. M. and Humes, K. S., 2001, A comparison of single date and multitemporal satellite image classifications in a semi-arid grassland. Journal of Arid Environments, 49, 401–411.

[6] Shrestha, D. P. and Zinck, J. A., 2001, Land use classification in mountainous areas: integration of image processing, digital elevation data and field knowledge (application to Nepal). JAG, 3(1), 78-85.

[7] Friedl, M. A., Mclver, D. K., Hodges, J. C. F., Zhang, X. Y., Muchoney, D., Strahler, A. H., Woodcock, C. E., Gopal, S., Schneider, A., Cooper, A., Baccini, A., Gao, F. and Schaaf, C., 2002, Global land cover mapping from MODIS: algorithms and early results. Remote Sensing of Environment, 83, 287–302.

[8] Duda, T. and Canty, M., 2002, Unsupervised classification of satellite imagery: choosing a good algorithm. International Journal of Remote Sensing, 23(11), 2193–2212.