34th Asian Conference on Remote Sensing 2013 (ACRS 2013)

Bali, Indonesia
20-24 October 2013

Volume 1 of 5

Editors:
Gatot H. Pramono
Dadan Ramdani
Baba Barus
Reiza M. Ariansyah

ISBN: 978-1-62993-910-0

UPDATE OF MONGOLIAN DISASTER MANAGEMENT DATABASE BY RS DATA

V.Batsaikhan[1]* and D.Amarsaikhan[2]
[1]Disaster Research Institute, National Emergency Management Agency of Mongolia
Partizany gudamj-6, Ulaanbaatar, Mongolia
[2]Institute of Informatics, Mongolian Academy of Sciences
av.Enkhtaivan-54B, Ulaanbaatar-51, Mongolia

*Corresponding author: batsaikhan.v@gmail.com

ABSTRACT

Disaster management database refers to the digital database used to freely exchange all kinds of spatial and attribute information about the disaster and about the objects and locations. One of the important issues is that once the database is developed, it needs to be regularly updated. As database contains a variety of data sets, different types of information will require different approaches for the update. Surely, for the spatial database update, remote sensing (RS) images with different spectral and spatial resolutions could be used. In the present study, for the update of a land cover layer, supervised classification has been performed using Landsat TM image. For the accuracy assessment, overall performance was applied and it indicated an accuracy of 85.78%.

Keywords: Disaster management database, RS image, Update, Classification

INTRODUCTION

As it is known that a joint project of the National Emergency Management Agency, Mongolian Academy of Sciences and National University of Mongolia entitled "Web-based disaster geoinformation database of the National Emergency Agency" started its activities in 2012 (Bulgan *et al.* 2011). The main aim of the project was to develop disaster management system that refers to the ability of digital systems to freely exchange all kinds of spatial information about the disaster and about the objects and locations, and also cooperatively, over networks, run software capable of manipulating such information (Batsaikhan *et al.* 2012).

Within the framework of the project, conceptual model which describes a conceptual framework for the abstraction, simplification and classification of the phenomena and their relationships as viewed by the user community of the database, has already been made (Batsaikhan *et al.* 2012). Also, some activities for entering spatial and attribute data sets have been carried out. For the representation of spatial data sets a layer based approach was mainly used as it can easily separate different themes and store them as logically and physically independent data sets. In addition, it should be noted that spatial entities were represented as points, lines and polygons. The attribute data were mainly represented in tabular forms using MS Access, Excel and other database related programs.

One of the important issues is that once the database is developed, it needs to be regularly updated. In general, for the spatial database update, satellite images with different spectral and spatial resolutions could be used. The aim of this study is to describe how a supervised classification can be used for generation of a land cover layer within the disaster management database. For this purpose, multichannel Landsat ETM+ data of northern Mongolia with a spatial resolution of 28m data was classified using a Mahalanobis distance classifier.

THE STUDY AREA AND DATA SOURCES

As a test site, a forest-dominated area in northern Mongolia has been selected. The area represents a forest ecosystem and is characterized by such main classes as coniferous forest, deciduous forest, grassland, light soil, dark soil and water. The annual precipitation in the region is about 350-400 mm and it makes the area as the most humid region in the country. As data sources, multispectral Landsat ETM+ data of August 2007 with a spatial resolution of 28m, a topographic map of 1986, scale 1:100,000 and a forest taxonomy map of 1984, scale 1: 500,000 have been used. The selected test site in a Landsat ETM+ image frame is shown in figure 1.

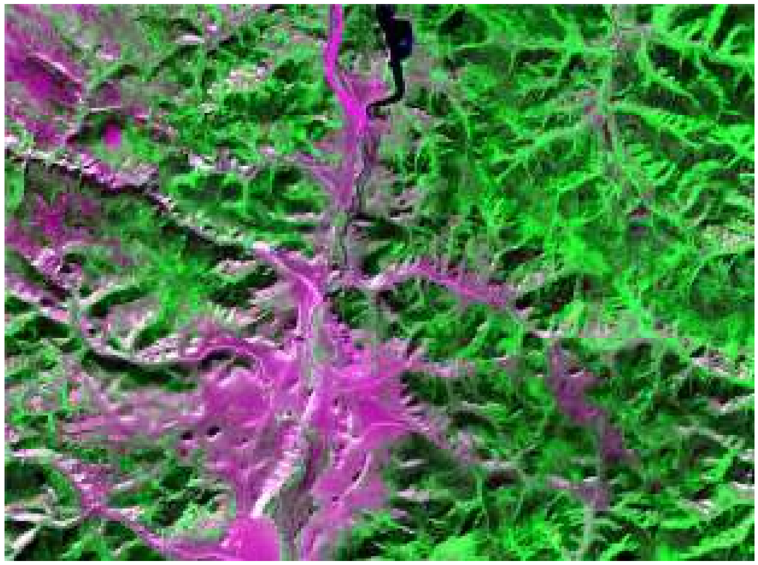

Figure 1. Landsat ETM+ image of the test area

DERIVATION OF FEATURES

At the beginning, the multispectral Landsat ETM+ image was geometrically corrected to a UTM map projection using a topographic map of the study area, scale 1:100,000. The ground control points have been selected on clearly delineated crossings of linear features and other clear sites. In total 16 points were selected. For the transformation, a second order transformation and nearest neighbor resampling approach have been applied and the related root mean square error was 0.94 pixel.

Generally, it is desirable to add some orthogonal features to any classification process to increase its decision-making. In the present study, for this aim, texture features have been used. To derive the texture features from the combined Landsat image, contrast and dissimilarity measures (using an 11x11 window size) have been applied and the results were compared. The bases for these measures are the co-occurrence measures that use a grey-tone spatial dependence matrix to calculate texture values, and the matrix shows the number of occurrences of the relationship between a pixel and its specified neighbor (ENVI 1999).

The contrast measure indicates how most elements do not lie on the main diagonal, whereas, the dissimilarity measure indicates how different the elements of the co-occurrence matrix are from each other (Lee *et al.* 2004). By applying these measures, initially 9 features have been derived, but after thorough checking of each individual feature only 2 features, including the result of the contrast measure applied to the green band and the result of the dissimilarity measure applied to the near infrared band of Landsat, were selected.

CLASSIFICATION AND GENERATION OF A LAND COVER LAYER

To define the sites for the training signature selection from the images, several areas of interest representing the selected classes (i.e., coniferous forest, deciduous forest, grassland, light soil, dark soil and water) have been selected. The separability of the training signatures was firstly checked in feature space and then evaluated using transformed divergence (Mather and Koch 2010). After the investigation, the samples that demonstrated the greatest separability were chosen to form the final signatures. The final signatures included about 548-956 pixels. For the classification, the following feature combinations were used:

1. The original spectral bands of the Landsat data.
2. Red, green and near infrared bands of the Landsat data.
3. Multiple bands including the Landsat red, green and near infrared images as well as two other derivative bands obtained from texture measures.

For the actual classification, a Mahalanobis distance classifier has been used. The Mahalanobis distance classifier is a parametric method, in which the criterion to determine the class membership of a pixel is the minimum Mahalanobis distance between the pixel and the class centre. The Mahalanobis distance (MD_k) is expressed as follows:

$$MD_k=(x_i- m_k)^t V_k^{-1}(x_i- m_k) \quad (1)$$

where x_i is the vector representing the pixel, m_k is the sample mean vector for class k, and V_k is the sample variance-covariance matrix of the given class.

The sample mean vectors and variance-covariance matrices for each class are estimated from the selected training signatures. Then, every pixel in the dataset is evaluated using the minimum Mahalanobis distance and the class label of the closest centroid is assigned to the pixel (Richards and Jia 1999).

To increase the reliability of the classification, to the initially classified images, a fuzzy convolution with a 5x5 size window was applied. The fuzzy convolution creates a thematic layer by calculating the total weighted inverse distance of all the classes in a determined window of pixels and assigning the centre pixel the class with the largest total inverse distance summed over the entire set of fuzzy classification layers, i.e. classes with a very small distance value will remain unchanged while the classes with higher distance values might change to a neighboring value if there are a sufficient number of neighboring pixels with class values and small corresponding distance values (ERDAS 1999).

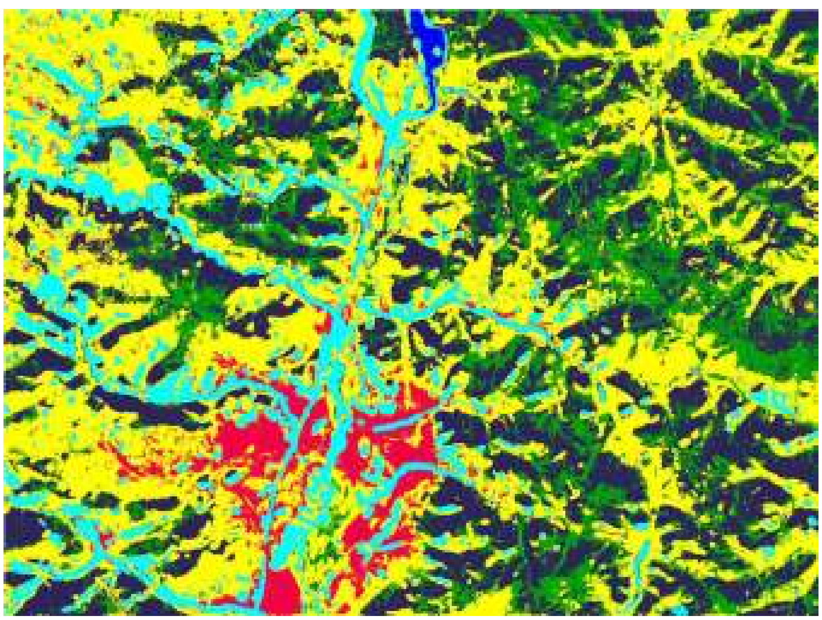

Figure 2. Classified image using Landsat and two other derivative bands

The visual inspection of the fuzzy convolved images indicated that there are some improvements on the borders of the neighboring classes that significantly influence the separation of the decision boundaries in multidimensional feature space. When the results were compared, the classification result of the Landsat image gave the worst result, because there are high overlaps among grassland and forest classes. However, these overlaps decrease on other images, specifically on the image for the classification of which derivative features have been used.

For the accuracy assessment of the classification results, the overall performance has been used. This approach creates a confusion matrix in which reference pixels are compared with the classified pixels and as a result an accuracy report is generated indicating the percentages of the overall accuracy (ENVI 1999). As ground truth information, different regions containing 5,737 purest pixels have been selected. The regions were selected on a principle that more pixels to be selected for the evaluation of the larger classes such as grassland and coniferous forest than the smaller classes such as deciduous forest and dark soil. The overall classification accuracies for the selected classes were 74.76%, 79.97% and 85.78% for the original Landsat bands, the three features and multiple bands, respectively.

CONCLUSIONS

The aim of this research was to generate a land cover layer used for update of disaster management database of Mongolia using a supervised classification method. For this purpose, multispectral Landsat image, a topographic map, and a forest taxonomy map were used. To produce a reliable land cover map from the Landsat image, a Mahalanobis distance classification method was applied. To increase the reliability of the classification, a fuzzy convolution with a 5x5 size window was used. As could be seen from the analysis, the multispectral image could produce a land cover map with a reasonable accuracy when applied a supervised classification.

REFERENCES

[1] Amarsaikhan, D., Battsengel, V., Amarjargal, Sh., Egshiglen, E., Ganzorig, M. and Enkhjargal, D., 2011. Applications of optical and microwave RS for forest mapping in Mongolia. In: CD-ROM Proceedings of the ACRS, Taipei, Taiwan, October 2011.

[2] Amarsaikhan, D., Saandar, M., Ganzorig, M., Blotevogel, H.H. and Enkhjargal, D., 2012. Comparison of multisource image fusion methods and land cover classification. International Journal of Remote Sensing, 33(8), pp. 2532-2550.

[3] Batsaikhan, V., Bulgan, G., Amarsaikhan, D. and Bayarbaatar, D., 2012, Development of disaster management database of Mongolia, Full paper published in CD-ROM Proceedings of the ACRS, Pattaya, Thailand.

[4] Bulgan, G., Amarsaikhan, D., and Tsogzol, G., 2011. Structure of the integrated disaster information database, Scientific reports of the Institute of Informatics, Mongolian Academy of Sciences.

[5] ENVI, 1999, User's Guide, Research Systems.

[6] ERDAS, 1999. Field guide. 5th Ed. ERDAS, Inc. Atlanta, Georgia, USA.

[7] Lee, K., Jeon, S.H. and Kwon, B.D., 2004. Urban feature characterization using high-resolution satellite imagery: texture analysis approach, MAPASIA 2004.

[8] Mather, P.M. and Koch, M., 2010. Computer Processing of Remotely-Sensed Images: An Introduction, Fourth Edition, (Wiley, John & Sons).

[9] Richards, J.A., and Jia, X., 1999. Remote Sensing Digital Image Analysis-An Introduction, Third Edition, (Berlin: Springer-Verlag).