An Analysis on the Spatial Distribution of Land Use and Land Cover in Mandalay City by Using Different Classification Techniques

Aung Nandar Htun*, Hla Myitzu, Hla Kyi***, Aung Myint******

Abstract

Knowledge of land use and land cover is important for many planning and management activities concerned with the surface of the earth. The term land cover relates to the type of feature presented on the surface of the earth and the term land use relates to the human activities associated with a specific piece of land. The study of the land use patterns and the monitoring of changes are very important for economic planning and country development. LULC features of the study area have been identified by using image classification techniques. Firstly, unsupervised classification was applied to image pixels to automatically identify distinct spectral classes in the image data. Secondly, Maximum Likelihood Classification was done using field data and informal questions which were asked during trip. Finally, NDVI was obtained from Landsat 7 ETM+ data and this method can successfully estimate the spatial distribution of land use and land cover, especially vegetative cover. By using the Image Classification Methods one can understand more about land use and land cover. The advantages of these methods are time and cost saving particularly for the images of large area.

Keywords: Spatial Distribution, Classification, Vegetative Cover

Introduction

Land cover information is vital for supporting decisions concerning the management of the environment and for understanding causes and trends of human and natural processes on the Earth’s surface. Therefore, land cover maps are required for several organizations such as governmental agencies and research institutions and for a number of applications.

Aim and objectives

The primary goal of the project is to understand the dynamics of LU LC in the Mandalay city. The main objectives are as follow:

- To produce land use / land cover classification map using image classification techniques,
- To study detailed land cover types classification and
- To find out vegetative cover.

---

* Lecturer, Department of Geography, Yadanabon University.

** Lecturer, Department of Geography, Yadanabon University.

*** Professor, Dr, Department of Geography, Mandalar University.

**** Lecturer, Department of Geography, Yadanabon University.

Study Area

Mandalay City is located between North latitude 21° 52' and 22° 0' and East longitudes 96°03' and 96° 09'. Mandalay is situated on Mandalay – Kyaukse plain which is between the Ayeyarwady River in the west, bordered on the north and east by Patheingyi Township. The altitude of Mandalay Plain varies from 210 to 250 feet above sea-level. Topographically, Mandalay area has an elevation of 250 feet and above on the eastern portion and the surrounding area of Mandalay Hill, and becomes lower toward the Thingazar Chaung on the west and the Taungthaman Lake on the southwest with about 210 feet above sea level.

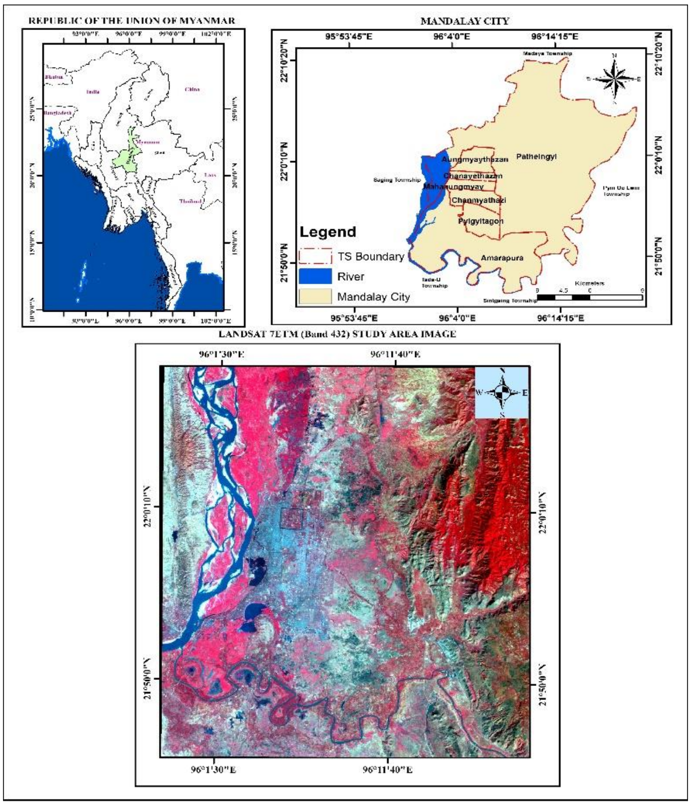


Figure (1). Location Map of Mandalay City

Source: Landsat 7ETM & Topo maps

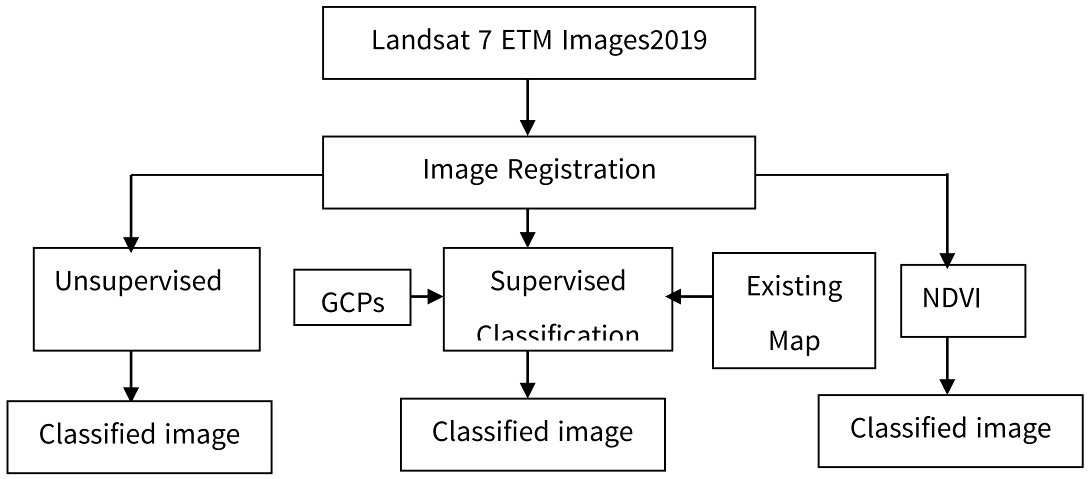
Data collection and Methodology

At first, the study was primarily defined to use GIS-based spatial data, later onto fulfill a good study including satellite data, field survey data and to extract land use and land cover information.

This study is conducted to identify land use and land cover information by using image classified techniques. Image Classification Techniques are as follow;

- Unsupervised Classification Method
- Supervised Classification Method (Maximum Likelihood Classification Method)
- Vegetation Index Method

Methodology



Data and Source

Table (1).Data Use in this Study

Data	Source	Additional information
Landsat 7ETM+	Download from http://www.earth explorer.usgs.gov	133-45 (path-row) acquired FEB 08, 2019
Topo maps (1:500,000)	Mandalay City Development Committee	84 N/16,93B/4, 93B/8, 93C/1

Equipment and Software

GPS (Global Positioning System) and digital camera are very useful for data collection and it helps to record all filed snapshot view of the study area.

The image preprocessing and classification processing were done by commercial software such as ENVI 4.7 software and ERDAS IMAGINE 2014. Data analysis was performed using ArcGIS 10.4.1.

Classification Process

Land use classes are assigned based on existing topo map.

Table (2). Land Use Land Cover Classes

No.	Land cover name	Description
1.	Water body	River, Stream and Lake
2.	Agricultural Land	Paddy field, crop field, orchard, garden crop
3.	Forest Land	deciduous forest, dry deciduous (open) forest
4.	Built-up area(Urban Area)	Settlement, infrastructure
5.	Sandbank	Dune

Classified Techniques

Unsupervised Classification

Unsupervised classification was done by algorithm ISODATA without any training area. This classification produced 30 classes through the satellite data and then reclassified them to five classes according to Table (2). Even classified data are regrouping; it still could not distinguish between urban, sandbank and agriculture land. Finally, we conducted ground truth verification by field data.

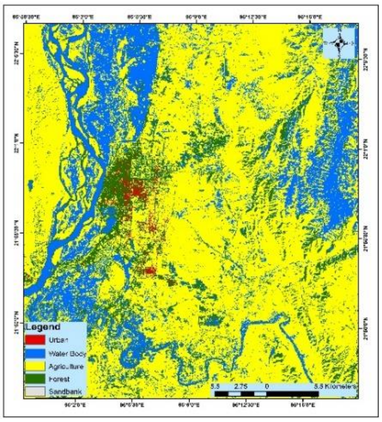


Figure (2). Unsupervised classification

Source: Unsupervised classification by the Researcher

Ground Data Collection

Ground data collection was performed on the field trip. GPS coordinates and pictures were taken along the way. Ground truth represents true land cover. Ground truth can be used as training data for various classification. This ground truth collection was done to obtain accurate location point data for each land use and land cover class included in the classification scheme according to existing topo map.

Asking some informal questionnaires was also performed to confirm the previous land use during the field trip. Half of ground truth were used as training data to classify the images.

Selection of Region of Interest (ROI)

Both the field experience and visual interpretation were applied to select the region of interest for different classes. Relatively larger number of pixels were included in each ROI in order to get a better statistical interpretation of each class.

The ROI were established for each class to get the classified images using half of ground truth data. Several points for each class were selected as ROI because reflectance value was changed according to different patterns in each class.

Supervised Classification

Supervised Classification procedures are the essential tools used for the extraction of quantitative information from remotely sensed image data. Maximum Likelihood classifier is one of the most popular methods of classification in remote sensing. The maximum likelihood classifier quantitatively evaluates both the variance and covariance of the category spectral response patterns when classifying an unknown pixel. Supervised classification was performed using ROI explained above.

Vegetation Index Method

The Normalized Difference Vegetation Index (NDVI) is a simple numerical indicator that can be used to analyze remote sensing measurements, typically but not necessarily from a space platform, and assess whether the target being observed contains live green vegetation or not. Thus, NDVI was one of the most successful of many attempts to simply and quickly identify vegetated areas and their "condition," and it remains the most well-known and used index to detect live green plant canopies in multispectral remote sensing data**.**

The NDVI is calculated from these individual measurements as follows:

$$NDVI = \frac{(\text{near infrared band} - \text{red band})}{(\text{near infrared band} + \text{red band})}$$

These spectral reflectances are themselves ratios of the reflected over the incoming radiation in each spectral band individually, hence they take on values between 0.0 and 1.0. By design, the NDVI itself thus varies between -1.0 and +1.0. NDVI is sometimes simply called NVI (normalized vegetation index).

Accuracy Assessment

Accuracy is determined empirically, by selecting a sample of pixels from the thematic map and checking their labels against classes determined from reference data (ground truth).

Preparation of Land Use Map

There was confusion in some classes after classification. The main source of confusion in the map is the agriculture class because it is diverse and includes a variety of different agriculture types. Most of the harvested paddy fields are homogenous with bare land and some built up area during defining ROI. Some parts of built-up area are not continuous. Deciduous forest is also confused with grass land because of falling leave at that time. Some parts of rivers and streams are also discontinuous because of influencing the reflectance of surrounding area. Misclassification occurs between those classes.

All classes of classified images were segmented to separate layers and exported as a polygon-vector format then converted into shape files in ArcGIS software for additional GIS analysis. Each polygon maintained the pre-assigned land use code corresponding to each land category.

Results and Discussion

The results of the study come from analyzing together with remote sensed data and geo-spatial data. The main contents are geo-spatial database with their description, tables and maps.

Land Use and Land Cover Classification

The classified images are shown as outputs of classification step in Figure (3). Total 124 ground control points were collected during field survey. Half of them is used for each image classification Methods. The rests are used in verification step. There was some confusion in satellite images during setting region of interest (ROI). The classified images accuracies were more than an acceptable accuracy of 80%.

Segmenting the images into separate layers of each class was generated in ArcGIS. Manual digitizing and map generalization such as simplification and aggregation were also done in order to get the accurate land use map. The statistical data of each classified techniques were calculated using query language in ArcGIS 10.4.1 .

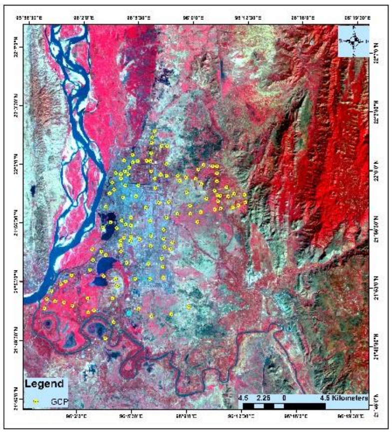


Figure (3).Ground Control Points Collected During field Trip

Source: GPS Mark of Field Survey

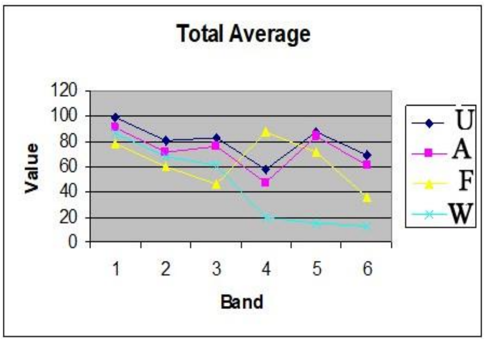


Figure (3.1).Reflectance Values in

Image Classification Based on Maximum Likelihood Method

ETM class 1 represents Urban areas (24%) within the reference domain. Some ETM class 2 appears in the riparian zones within the high gradient subclass due to the presence of water and/or moist soil conditions. The water body (4%) is defined as class 2 in this classified image. ETM class 3 and class 4 indicate agriculture and forest cover, just 71%. Sandbank included in this land use class, although it represents a very small proportion (<1%) of the Class 5 land use within reference domain.

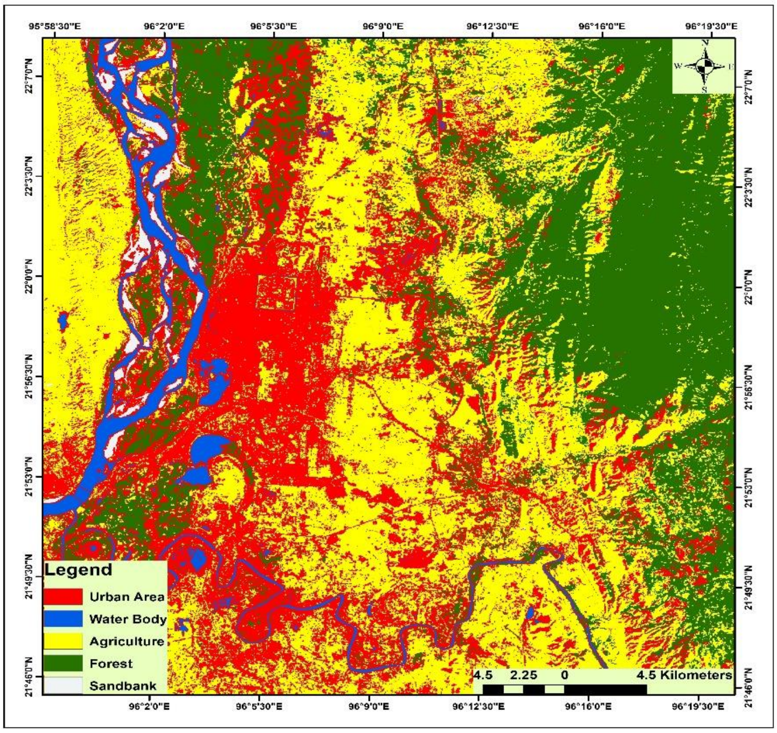


Figure (4). Land Use Land Cover Map Based on Maximum Likelihood Method

Source: supervised classification by the Researcher

Image Classification Based on NDVI Classification Method

Among the classification methods, classification based on NDVI can give very good result if we try to extract vegetative cover information from image. It could not separate urban area, sandbank and agriculture land clearly.

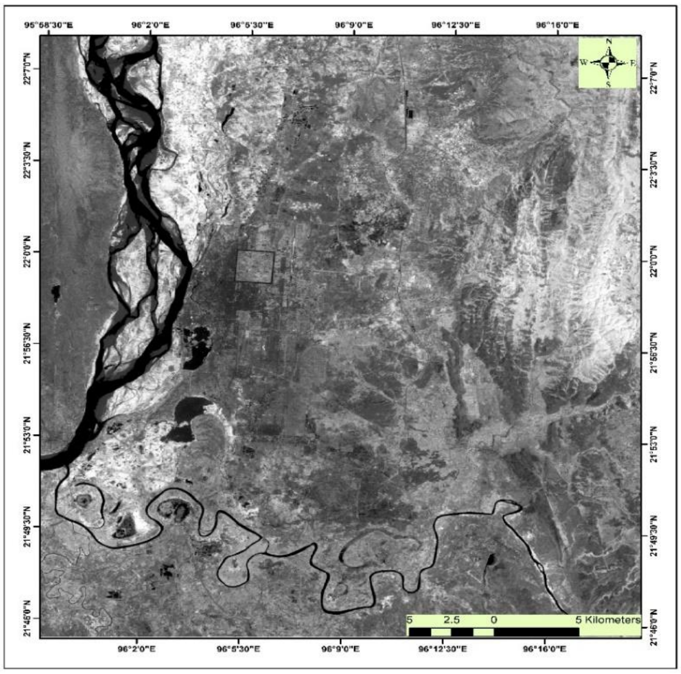


Figure (5). Normalized Difference Vegetation Index Image

Source: Computed by the Researcher

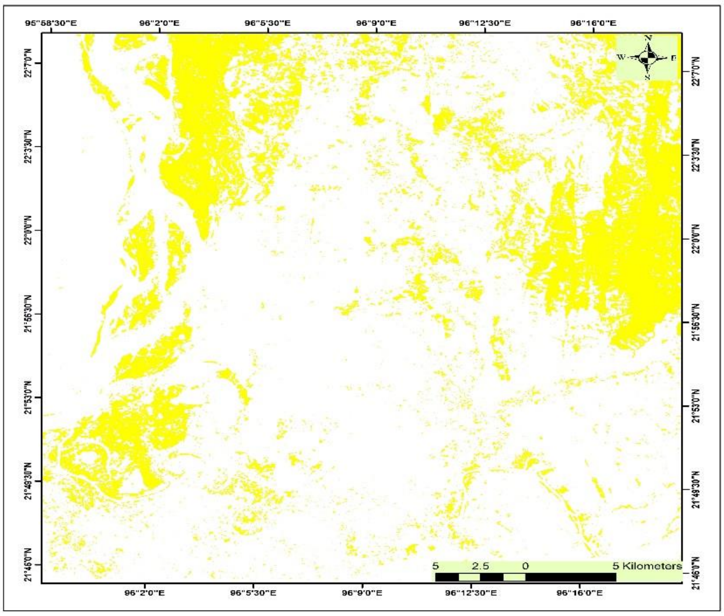


Figure (6). Land Use Land Cover Vegetation Map Based on NDVI Classification Method

Source: Computed by the Researcher

Finding and Result

Many shifting land use patterns driven by a variety of social causes, result in land cover changes that affects biodiversity, water and radiation budgets, trace gas emissions and other processes that come together to affect climate and biosphere. The effect of land use and land cover changes on the hydrological processes is mainly represented by the changes in vegetation interception, soil evaporation, plant transpiration, infiltration and soil water content.

Land use in tropical regions such as Mandalay region in Myanmar is influenced not only by proximate (direct) actors such as farmers or loggers, but also by many others, such as government agencies.

Conclusion

The state of ecosystems, biological communities and species are continuously changing as a result of both natural processes and the activities of humans. In order to detect and understand these changes, effective ecological monitoring programs are required. The technical approach of remote sensing and GIS and the intensive field survey facilitate a comprehensive qualitative and quantitative analysis of vegetation patterns, general land use pattern.

Normalized Difference Vegetation Index (NDVI) data is another possible way to produce land use and land cover dataset over wide area. It can estimate area of each land use more accurate than the pixel based classification by original remote sensing data. Examination for the case of study area showed prosperous results in discrimination of vegetation. Although a lot of improvement of method is required, this method is expected to contribute to compilation of land use dataset in regional scale.

Acknowledgements

First of all, we would like to express our heartfelt gratitude to Dr. Tint Moe Thuzar, Rector, and Pro-rectors, Yadanabon University for their permission to carry out the research and their encouragement. We wish to express my gratitude to Dr. Khin Win (Professor and Head of Geography Department, Yadanabon University) for assigning to us to conduct research work entitle "An Analysis on Spatial Distribution of Land Use and Land Cover Information in Mandalay City by Using Different Classification Techniques". We are also gratitude to Dr. Yu Yu Swe (Professor Department of Geography, Yadanabon University) editing the manuscript of this paper.

References

Ajayi, T. R, 1995. Moving average and trend surface analysis of regional geochemical data: Ife-Ilesa gold field, Southwestern Nigeria.J. Mining and Geology, 31, pp.21_38.

Anderson, et al. 1976. A Land Use and Land Cover Classification System for Usewith Remote Sensor Data. Geological Survey Professional Paper No. 964, U.S. Government Printing Office, Washington, D.C. p. 28.

Elbers, C, Lanjouw J, Lanjouw, P, 2002. Micro-Level Estimation of Welfare. Policy Reseach Working Paper 2911, World Bank, Washington, DOC.

Gierman, D.M., 1981. Land Use Classification for Land Use Monitoring. Land Directorate Environment Canada Working Paper No. 17, pp. 1-40.

Lemmens, M., 2002. The survey triangle. Pinpoint. GIM International, vol. 16, no. 5, pp. 11.

Uchida, S,1998, Extraction of soil characteristics and monitoring of agricultural land use in the semi-arid tropics of India using remote sensing. JIRCAS J., 6, pp.39-52.