Land Cover Classification and Change Analysis of the City Area and its Vicinity

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Abstract

Land cover/use change detection is an important component for better understanding the interactions of the human activities with the environment and necessary to simulate environmental changes. This study investigates land cover changes in the surrounding Magway city by using Remote Sensing and Geographic Information System, during the years 2000-2015. Six reflective bands of two Landsat images are carried out by using Maximum Likelihood Algorithm with the aid of ground truth data. The images of the study area are categorized into three major classes: agricultural land, built-up and others. Change detection analysis performed to compare the quantities of land cover class conversions between time intervals. The result of this study indicates that during the 15 years, built-up has increased by 7%, agriculture and others have decreased by 4.6 and 2.5% respectively. As a result, suggestions for the appropriate land use in the Magway city and surrounding will made for the future.

Keywords: *Land cover changes, Classification, RS and GIS*

1. Introduction

Land cover and land use change has become a central component in current strategies for managing natural resources and monitoring environment changes. Land cover/use change models are used by researchers and professionals to explore the dynamics and drivers of land cover/use change and to inform policies affecting such change.

Land cover changes can be related to natural process (e.g, flooding, and wildfire) and anthropogenic activities (e.g, urbanization, agriculture). The rate of change and the nature of land cover transitions can also differ in time and space. Some regions are relatively stable (e.g, permanent forest); whereas, other areas are subject to rapid and persistent transformation (e.g, urban expansion of previously vegetated areas). Increased human population and technological development has been found to accelerate land cover change [3, 6, and 11]. Annual land cover information is valuable to aid in formulation of socio-economic policies and data provision for environmental applications.

Land cover change directly affects the environment because of loss of green are and agricultural land, the water body also becomes down. The reason behind the change in land cover is also the increase in the population of the city and because of this the city is spreading everywhere in the haphazard way. Therefore, the analytical results of LULC change can help policy makers and land planners to take better decisions.

Magway is an agricultural region and its economy largely depends on agriculture. It provides livelihood to about 67% of the population. The city has been selected as a case study because has experienced significant land cover/use changes since its growth and developmental activities such as building, road and anthropogenic activities since 1990. It is necessary to monitor land use and land cover change information to investigate how much impacts on the agricultural lands, natural vegetation cover and environment.

Up-to-date, adequate and reliable land cover/use information from the past to present is vital to understand and evaluate several social, economic and environmental consequences of these changes [3, 5, 13 and 14]. With the advent and development of the integrated geospatial techniques that integrate the use of Remote Sensing (RS), Geographic Information Systems (GIS) and Global Positioning System, the enumeration of spatio-temporal LULC dynamics has become easy, quick, cost-effective and accurate [9].

The aim of this study is to produce maps of land cover of Magway on year 2000 and 2015 and to analyze the nature and extent of land cover/use changes of the study area in the past 15 years (2000-2015).

2. Study area

Geographically the study area is located in between 20° 09’ 15” N and 94° 56’ 43” E and Magway city situated in arid region, the central of Myanmar (Figure1). The study area cover a surface area of 8150km^2 (or 3120 mi^2). The Ayarwaddy River is the west of this region. The average temperature in this region is 36°C. Magway has experienced land cover changes where the industrial, government Universities and settlement increasing are concentrated since 1999. So, it has significant land cover/use changes.

3. Materials and Methods

3.1. Data

Landsat8 OLI (path 133, row 46) were used in this study. The images are acquired in summer season and in good quality, with no effective clouds. A Landsat8 OLI image was downloaded from http://landsat.usgs.gov.

ArcGIS 10.1 software was used for all image preparation, spatial analysis and mapping. Topographic maps served as the base maps and were rectified (UTM WGS84). Elevation and slope maps are generated from Digital Elevation Model.

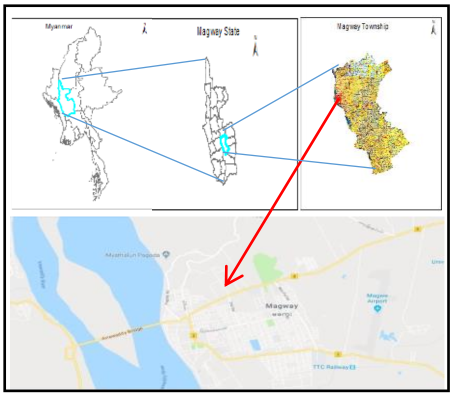

Figure 1. Location map of the study area

3.2. Image Preprocessing

The preprocessing step includes atmospheric correction, bands combination, and Extract study area and image registration.

The atmospheric correction is a necessary step to accurately extract quantitative information from the Landsat [7]. The images are atmospherically corrected using Dark Object Subtraction (DOS) method in the QGIS 2.12.2.

By combining all the bands, a composite raster is obtained using ArcGIS. Different color composites are used to improve visualization of different objects on the imagery. Infrared color composite NIR, SWIR and Red are applied in the identification of varied levels of vegetation growth and in separating different shades of vegetation. Other color composites such as Short Wave Infra-red (SWIR), Near Infra-red (NIR) and Red combination which are sensitive to variations in moisture content are applied in identifying the built-up areas and bare soils [4]. These color composites are selected to assist the selection of the training sites of each class and analysis purposes.

With the help of ArcGIS 10.1 are geo-referenced using datum WGS, 1984 and Universal Transverse Mercator (UTM) Zone 46), few ground control points and rectified the satellite images.

The satellite image contains very large area, but the study area is small. So, the image of the study area was clipped by overlaying geo-referenced out line boundary of Magway block map as AOI (Area of Interest) using the “Extract by Mask” function in the “Spatial Analyst Tools” module of ArcGIS software.

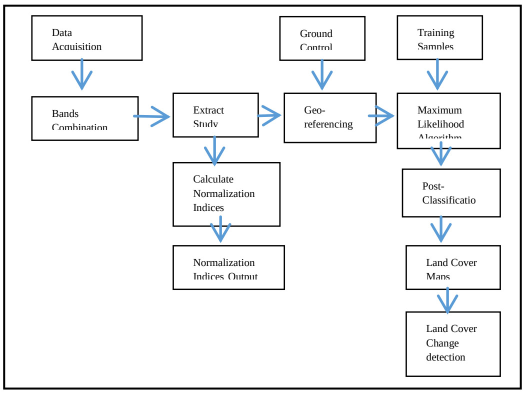

Figure 2. An Overview of Methodology

3.3. Image Classification

In this research, first are used Normalized Indies and then Supervised classification method was employed for monitoring and mapping land cover changes of this area in the ArcGIS 10.1.

3.3.1. Calculation of the Normalized Difference Indices

For better classification results some indices such as normalized difference vegetation index (NDVI), normalized difference built-up index (NDBI) and normalized difference water index (NDWI) are used in this study. The value of indices has ranges from -1 to +1. The vegetation, built-up area and water body are extracted by the following equations:

$$NDVI = (NIR - R)/ (NIR + R) \quad (1)$$

$$NDBI = (NIR - SWIR)/ (NIR + SWIR) \quad (2)$$

$$NDWI = (G - NIR)/ (G + NIR) \quad (3)$$

where R, G, NIR and SWIR are the red, green, near-infrared and shortwave-infrared bands [15].

3.3.2. Maximum Likelihood Classifier

MLC is performed according to the following steps [12].

(1). Display the three-band overlay composite image. The visible channel, near infrared channel and the 10.3-11.3 um channel are associated with red, green and blue, respectively so that the clouds look white, vegetation looks green, water looks dark and lands without vegetation looks different shades of brown. Take a careful look at the available features and determine the set of classes into which the image is to be segmented.

(2). Using 'box-cursor' to choose representative training samples for each of the desired classes from the color composite image. These pixels are said to form training data.

(3). Use the training samples to estimate the mean vectors and covariance matrixes for MLC classifier. These two parameters determine the properties of the multivariate normal models.

(4). Using the trained classifier to classify every pixel in the image into one of the desired classes. Since we have no useful information about the priori probability for each class, in which case a situation of equal prior probabilities is assumed. The final discriminant function $g(x)$ is taken as:

$$g(x) = -\ln(|\textstyle\sum_i|) - (x - m_i)^t \textstyle\sum_i^{-1}(x - m_i) \quad (4)$$

Where m_i and $\sum_i$ are the mean vector and covariance matrix of the data in class ω_i. N is the number of bands. In order to reduce poor classification due to small probabilities, threshold values T_i are determined for each class based on that 95% of the pixels would be classified. According to χ^2 tables, the threshold values T_i can be obtained by:

$$Ti = -12.6 - \ln(|\textstyle\sum_i|) \quad (5)$$

Finally, we can get the decision rule for maximum likelihood supervised algorithm:

$$x \in \omega_i, \text{ if } g_i(x)>g_j(x) \text{ and } g_i(x)>T_i, \text{ for all } j \neq i \quad (6)$$

Classes don't meet the above decision rule will be classified as unknown class.

(5). Color-encode and show the classified image. Estimate the number of pixels and area for each class and show the statistics for each class.

3.4. Post Classification

Post-classification refinement is done to improve classification accuracy and reduction of misclassification [6]. After classification, ground verification was done in order to check the precision of the classified land cover/use map. Based on the ground verification necessary correction and adjustments were made. The map from t1 (e.g., 2000) was compared with the map produced at time t2 (2015) and a complete matrix of categorical change obtained.

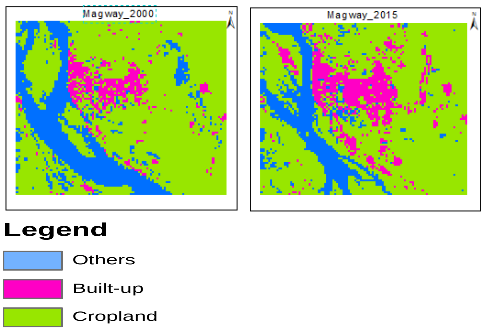

Figure 3. Land cover simulate map 2000 and 2015

Table 1. Description of land cover/use classes used for analysis of changes between 2000 and 2015

	Land Cover	Description
1	Others	This class of land cover describes the area cover with water, tree, bare –soil and paddy.
2	Built-up area	This class describes the land cover with buildings in the rural and urban. It includes commercial, residential, industrial and transportation infrastructures (railways and roads).
3	Cropland	The land which mainly used for growing food crops such as beans, peanut, etc . Crops in this land are either grown by irrigation or rain-fed.

3.5. Change Detection Analysis

Change detection analysis describes and quantifies difference among imagery of the same scene at different epoch. The process of change detection depends on the phenomenon or scene at different times. The change detection process adopted for this study is the post feature under investigation. This is because the method is simple to implement and it provide through “from to” statistics suitable for decision making. The method was executed by using the two land cover maps generated for 2000 and 2015. The outcome was a land cover change map from 2000 and 2015. Table 2 shows the statistical analysis of change detection of both the imagery [10].

Table 2. Land Cover Statistics using Maximum Likelihood Classifier

Class Name	**2000 Area In%**	**2015 Area In %**	**Change Area In %**
Others	16.027557	11.477235	-4.550322
Built-up	7.647949	14.657693	7.009744
Cropland	76.324494	73.865072	-2.459422

4. Results

During 2000-2015, it was observed that majority of the changes occurred from agriculture and built-up. The agricultural land is the largest land use of the city. Built-up areas are changed from 7.65% in 2000 to 14.66% in 2015. Agricultural area decreased 2.5% during 2000-2015. Most of the agricultural areas, vacant land are changed as built-up areas during 2000-2015. Because of the increasing population and human activities are increasing the demand on the land. The land cover map results from the integration of remote sensed data with thematic features from land cover models. It shows three classes of land cover: built-up, cropland and others.

5. Conclusions

The aim of the study is to investigate land cover/use changes in Magway city and its surrounding area between 2000 and 2015. This research provides the evidence of land cover change due to the increasing of built-up area in Magway area. Agricultural area decreases closer to the city and surrounding the city. Evaluation of land cover/use changes using remote sensing and geographic information system technologies over the time period in the study area verified that agricultural is transformed into built-up. Thus, land cover/use classification and change analysis is made possible by these technologies in less time, at low cost and with better accuracy.

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