Pixel-Based and Object-Based of Land Cover Classification and Change Analysis in the Mandalay City Using High Resolution Remote Sensing Data

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ABSTRACT: Landcover types of Mandalay city area were analyzed on the basis of the classification results using the pixel-based and object-based classification through image analysis approaches. A high-resolution satellite image (2002 & 2014) was used to carry out the image classification. This research is aimed to compare the result of land cover classification and its change detection between pixel-based and object-based classification. The pixel-based classification was carried out by Maximum Likelihood algorithm and Minimum Distance to Mean algorithm in this research. On the other hand, object-based classification was performed through eCognition Developer software. The classification change detection technique has been used to analyze the Land cover change during 2002 and 2014. Water, Vegetation Buildup, and Bare land were classified as land cover classes. The accuracy of the classified maps was analyzed by estimating the Kappa value and overall accuracy. Based on accuracy assessment land cover classification through pixel-based classification using Maximum Likelihood method, it shows that total accuracy and Kapp value are 83.33% and 83.89% in 2002 and 86.66% and 81.50% in 2014. In the case of object-oriented land cover classification, it shows that total accuracy is 80.38% in 2002, and 87.50% in 2014 respectively Change Detection between both the images for all land cover classes was computed.

KEYWORDS: land cover, pixel-based classification, object-based classification

1. INTRODUCTION

Land cover change studied has become an essential part of current plans for dealing with environmental and natural resource management across the globe both by natural resource management across the globe both by national and local organizations. Land cover identification in this study using remote sensing data such as satellite images of 2002 (Quick Bird) and 2014 (Worldview)was done for 12years from 2002 until 2014. Change detection is an important process in monitoring and managing natural resources and urban development because it provides a quantitative analysis of the spatial distribution of the population of interest. Change Detection is useful in such diverse applications as land cover change analysis, monitoring shifting cultivation, the observed changes varied from one land cover category to another with some maintaining a constant change (increase or decrease) over the two analysis periods (2002 and 2014). Land cover change detection (LCCD) is a significant tool that can be used to increase resiliency to natural disasters. This region is famous for urban areas which continuously change due to its rapid development so that time-series the result of this land cover change identification can be used for urban planning and problem-solving about environmental and etc. In this study, land cover change detection of Mandalay City using Remote Sensing and GIS techniques are presented.

2. METHODOLOGY

2.1 STUDY AREA

The study area, Mandalay is located in the central dry zone of Myanmar by the Irrawaddy river at 21.98° North, 96.08° East, 80 meters (260 feet) above sea level. Its standard time zone is UTC/GMT +6:30 hours. Mandalay city is located at the center of Myanmar and is the second-largest city hosting the biggest industrial and commercial center in the Central Region of Myanmar. The built-up areas in Mandalay city can be classified into two regions: Mandalay is bounded by the Ayeyarwady River in the west, Shan Mountainous area in the east, and the Myint Nge River in the south (Figure 1). The city population has increased from about 500,000 in 1998 to over a million in 2002 and to 1.4 million in 2014. Mandalay City is composed of five townships known as Aung Myay Thazan, Chan Aye Thazan, Maha Aung Myay, Chan Mya Thazi, and Pyi Gyi Ta Khun Townships where people now live around one million.

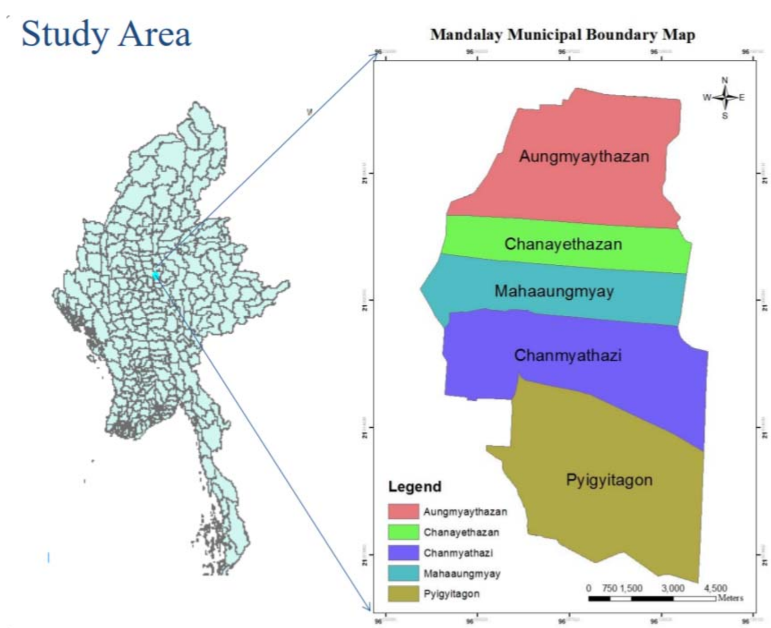


Figure 1, Study Area

2.2 Data Description

These images with QuickBird 60cm Global High-Resolution Satellite Imagery &WorldView-2 (50cm) Global High-Resolution Satellite Imagery. The basic data used in this study are digital satellite images comprising of scenes for the years of 2002 and 2014. The UTM projection and world geographic system (WGS) 1984 datum are taken for geo-referencing. The aim of this research is to detect land cover changes in Mandalay City during the study period. High resolution image data processing is done using software ArcGIS 10.7.1, QGIS 3.4.0, and eCognition Developer have been used to analyze image processing and classification. The overall research methodology is shown in Figure 2.

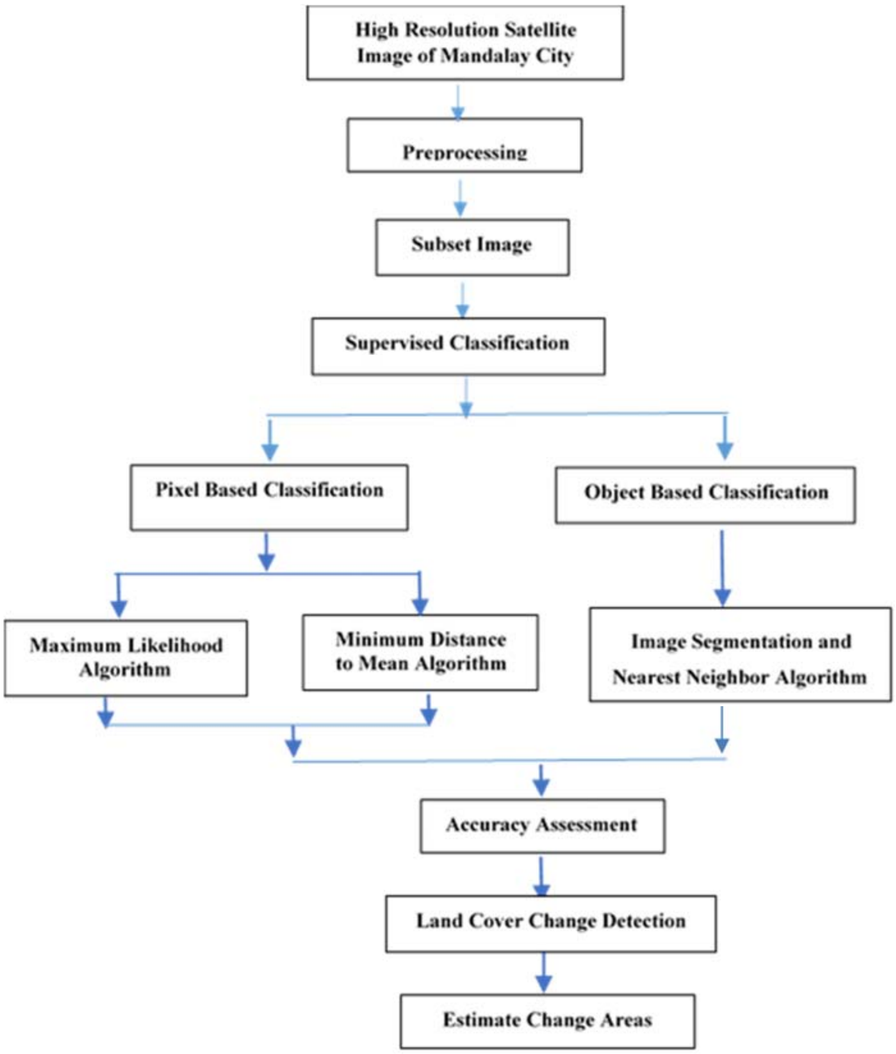


Figure 2, Research Workflow

2.3 (a)Pixel-Based Classification

In this research, pixel-based classification used supervised image classification using the Maximum likelihood method & Minimum Distance to Mean algorithm to determine the land cover analysis through software ArcGIS 10.7.1 & QGIS 3.4.0. The numbers of reference points or training points collected from Mandalay City by mean of UTM Map (1:50,000 scale) topo-sheets This classification method is the most widely used and easiest method to apply pixels to the land cover analysis. The class division of land cover analysis is based on four classes that are Water, Vegetation, Buildup, and Bare land.

(b) Supervised image classification using minimum distance to mean algorithm

The semi-automatic supervised classification of remote sensing images, providing tools to expedite the creation of ROIs (training areas) through region growing or multiple ROI creation. The spectral signatures of training areas can be automatically calculated and displayed in a spectral signature plot. It is possible to import spectral signatures from external sources.

(c) Object-Based Classification

Object-based classification in this study was used to classify land cover with eCognition software. The object-based classification approach is carried out through two steps; segmentation and classification. The process of segmentation is the most important step in object-based classification because in this process the image data will be interpreted into the land cover analysis based on a combination of color (spectral values) and shape properties. The class division of land cover is based on four classes that are Water, Vegetation Buildup, and Bare land.

3. RESULT & CONCLUSIONS

Pixel-based and objects-based classification approaches have been performed by classifying the remote sensing image QuickBird 60cm Global High-Resolution Satellite Imagery &WorldView-2 (50cm) Global High-Resolution Satellite Imagery. Based on remote sensing and GIS techniques, the images are classified as Water, Vegetation Buildup, and Bare land cover maps of (2002 and 2014) are shown in Figures 3, 4, and 5.

3.1. Pixel Based Image Classification 2002 and 2014

In pixel-based classification the following steps involved in the supervised classification method: classification stage and accuracy assessment, change detection, and change matrix stage. These stages are applied in the classification process of High-Resolution Satellite Imagery images. The selected algorithm for performing the supervised classification is Maximum Likelihood classification. and Minimum Distance to Mean algorithm classified image shows the distribution of land covers types according to this algorithm. The observed changes varied from one land cover category to another a constant change (increase or decrease) over the two analysis periods (2002-2014). As a result, Maximum Likelihood classification it can be seen that water bodies were decreased. Vegetation in the surrounding area indicates that the vegetation area gradually was 20 % decreased during twelve years. In addition, buildup had significantly changed 41% of land cover was increased between 2002 and 2014 as shown in Figure 3 and 4.

Table 1. Land Cover Classification Scheme

No	Categories	Description
1.	Water	Areas had surface water including ponds, lakes, stream, reservoirs and rivers
2.	Vegetation	Areas used for crops cultivation such as rice & bean
3.	Buildup	Areas associated with rural and urban settlement
4.	Bare land	Area covered with little or no vegetation on ground surface

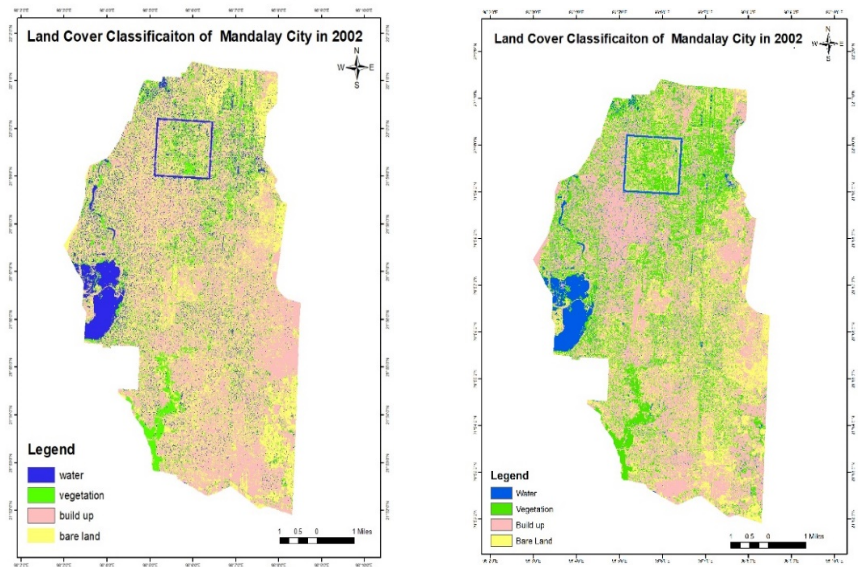


Figure 3. Land Cover Classification of Mandalay City in 2002

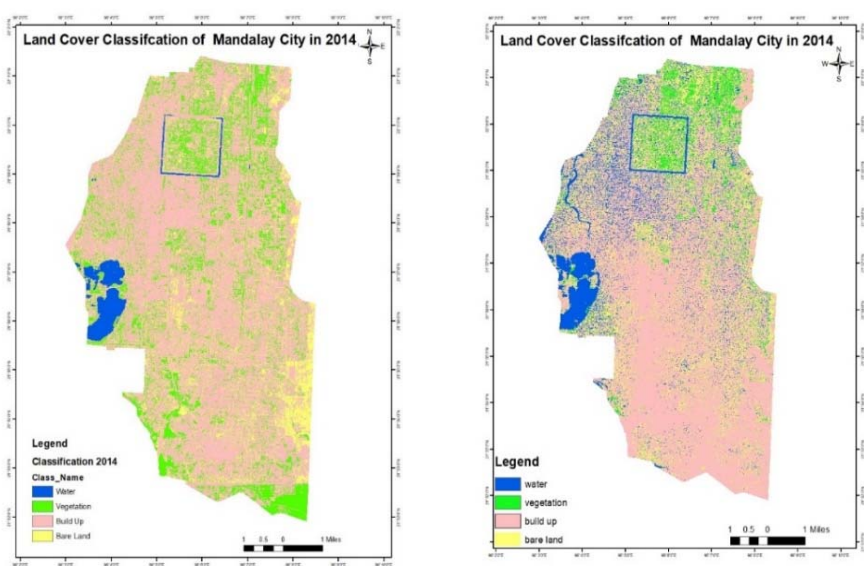


Figure 4. Land Cover Classification of Mandalay City in 2014

3.2 Object-based classification:

Segmentation is the main process in the eCognition software and its aim is to create meaningful objects. This shape combined with further derivative color and texture properties can be used to initially classify the image by classifying generated image objects. Based on these parameters, segmentation process is performed. Classification using the nearest neighbor, as the classifier which is similar to supervised classification, and therefore training areas have been selected. In eCognition software, the training areas are training objects; one sample object covers many typical pixel samples and their variation. In classification starting with a few samples and adding only necessary samples in subsequent steps is a very efficient way to come up with a successful classification. Figure 5 shows classified map of landcover in Mandalay city in 2002 and 2014.

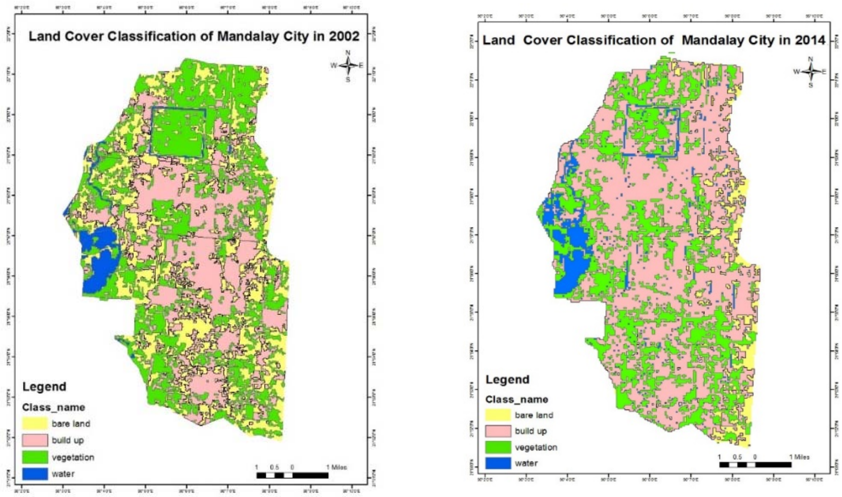
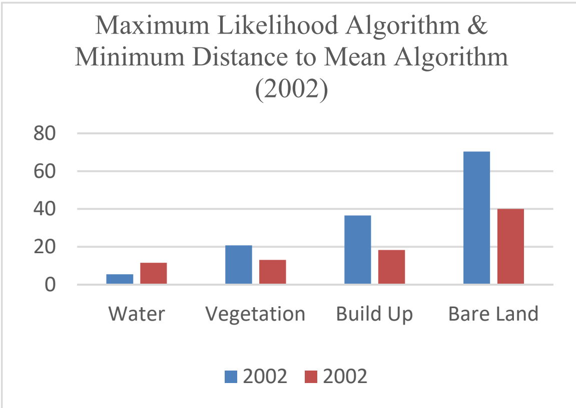


Figure 5. Land Cover Classification Mandalay City in 2002 & 2014

3.3 Comparison of Classification Methods

Table 2. Comparison of Classification Method

Algorithm	**Maximum Likelihood Algorithm (sq-km)**		**Minimum Distance to Mean Algorithm (sq-km)**	
Land Cover Classes	**2002**	**2014**	**2002**	**2014**
Water	5.51	4.61	11.56	17.40
Vegetation	20.71	16.37	12.11	13.82
Build Up	36.51	51.54	48.37	51.61
Bare Land	70.31	40.59	40.07	30.27



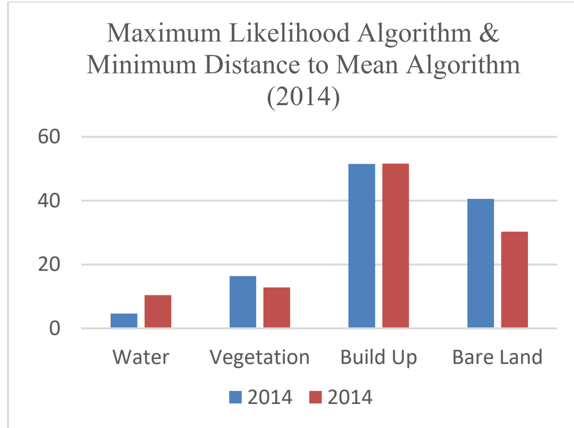


Figure 6. Comparison of Classification Method for Land cover Map in 2002 & 2014

In the pixel-based classification using algorithm according to classification results, only built up area is increased from 36.51 sq-km to 51.54 sq-km. Waterbody, vegetation and bare land area have been reduced respectively. In this study, the proportion of water bodies was dropping dramatically about change in 19%, change in vegetation 20%, change in bare land 42%, and build-up area is scientifically increase is build up 41% during the period of (2002-2014) are shown in Table.4 & Figure.6.

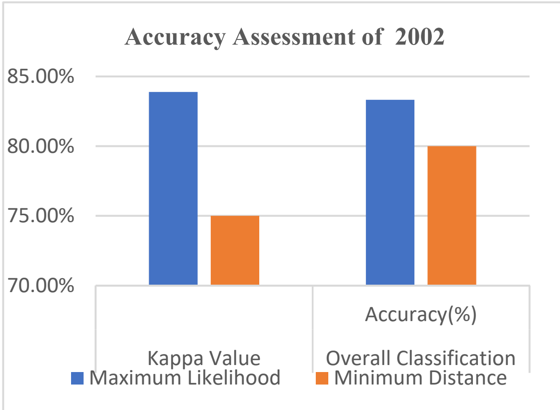
3.4 Overall Accuracy Assessment

The comparison between landcover classification based on supervised pixel-based classification using Maximum likelihood classification and Minimum Distance to Mean classification of overall accuracy value for each other 83.33%and 80.00% in 2002 and 86.66%and 83.00% in 2014/. In Pixel Based classification based on the results of accuracy assessment, the Land Cover analysis obtained using Maximum Likelihood Classifier, which gave better accuracy with 84 % and 82% Kappa values for 2002 and 2014, has been utilized for studying the change. Object-based is shown with the percentage of accuracy value for each other 80.39% and 87.15%. An accuracy assessment was done to evaluate the performance of classification methods. The object-based classification was the highest value of accuracy using segmentation methods is shown in Tables 3, 4, and Figures 7 and 8.

Table 3. Overall Accuracy Assessment for Pixel based classification

2002 Land Cover Map		
Methods	Kappa Value	Overall Classification Accuracy (%)
Maximum Likelihood	83.89%	83.33%
Minimum Distance	75.00%	80.00%

2014 Land Cover Map		
Methods	Kappa Value	Overall Classification Accuracy (%)
Maximum Likelihood	81.50%	86.66%
Minimum Distance	75.00%	83.00%



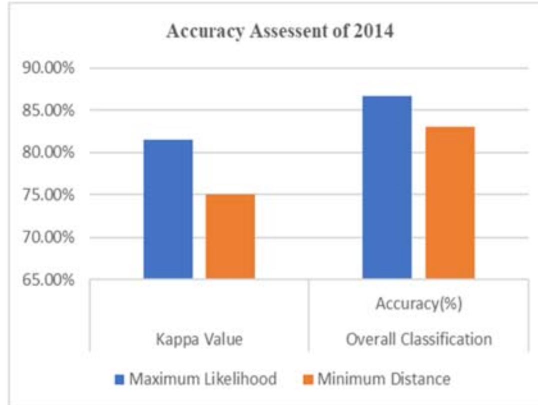


Figure 7. Overall Accuracy Assessment for Pixel- based classification in 2002 & 2014

Table 4. Overall Accuracy of Object Based Classification

Accuracy of Object Based Classification (%)	Land Cover 2002	Land Cover 2014
Overall Accuracy	80.38%	87.50%

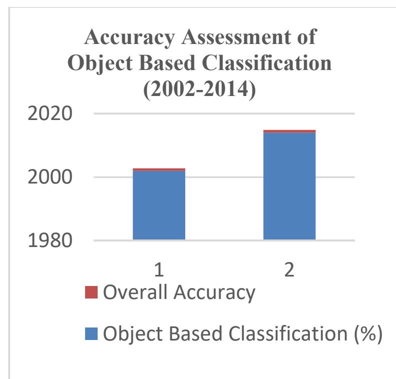


Figure 8. Overall Accuracy of OBC

3.5 Land Cover Change Map (2002-2014)

. Table 5. Change Detection Matrix (2002-2014)

Land Cover Classes	**2014**			
2002	**Water**	**Vegetation**	**Build Up**	**Bare Land**
Water	2.88	0.25	5.78	0.60
Vegetation	0.30	5.61	7.71	0.72
Build Up	0.50	0.85	16.01	0.42
Bare Land	0.93	2.91	5.17	0.86

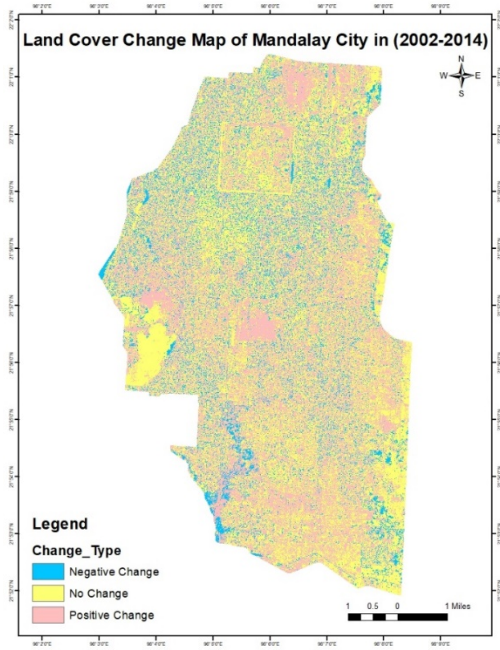


Figure 9. Land Cover Change Map of Mandalay City (2002-2014

4. CONCLUSION

In this research supervised classification of pixel-based and object-based of land cover classification and change analysis in the Mandalay City using High-Resolution Remote Sensing Data was carried out and observed Land cover change was analyzed (increase or decrease) over the two periods (2002-2014). This study was carried out to detect changes of land cover classification, respectively. Accuracy assessment was done to evaluate the performance of classification methods. Results indicated that Maximum likelihood algorithm produced acceptable Land Cover classification with kappa coefficient 81.50% for 2014 and 83.89% for 2002. Changes are mainly in built up areas which was significantly increased in 2014, the Buildup area had significantly changed during (2002-2014). As a result, it can be seen that water bodies, vegetation and bare land were decreased during 2002-2014. The vegetation is changed to urban built-up area during 2002-2014 period. The dominant directions of urban expansion were South East and South in 2002- 2014. Mandalay District, with a population of 1.7 million, occupies 28% of Mandalay Region in terms of population size. About 76.4% of the district population are urban residents. Currently, Mandalay is the second-most populous city in Myanmar with 1,225,133 people living within its borders. The population is expected to grow by 50% over the next 10 years. This study demonstrates the ability of Remote Sensing and GIS in capturing high-resolution data changes in land cover analysis.

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