Land Use and Land Cover Change Detection Using Remote Sensing and GIS Techniques: A Case Study of Belin Township in Thatone District

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Abstract*– Nowadays, land use and land cover (LULC) changes due to both human beings and natural environment. Consequently, LULC changes impact on water resources such as forestry, water bodies, agriculture land, wetland, urbanization, industrialization and so on. The aim of this research is to detect LULC changes in Belin Township. ERDAS IMAGINE 2015 and ArcGIS 10.4.1 have been used to analyze the images processing and classification. LULC conditions of this area for the time periods 1999, 2009 and 2018 have been considered and downloaded from Landsat ETM+ satellites images. Maximum likelihood method has been conducted in supervised image classification technique. The ground truth data or reference points are used to classify the image classification applying Google Earth Pro. Moreover, forest, settlement, water bodies, agriculture and bare land of five LULC classes are identified in this study. Bare land and Settlement are significantly unchanged during two decades. Further, forest area was increased approximately 22.36% between 1999 and 2018. However, the water bodies of this study area were decreased slightly. LULC by agriculture land was decreased between 1999 and 2018. The finding results of this research paper can contribute effectively about LULC change detection and help decision makers to develop plan in this study area.

***Keywords:* LULC, Remote Sensing, GIS, Change Detection, Image Classification**

I. Introduction

Land Use/Land Cover (LCLU) change studies have become an essential part of current plans for dealing with environmental and natural resource management across the globe, both by national and local organizations. Change Detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times (Singh, 1989). As a result of population growth, agricultural and urban expansion, and a reduction in forest cover and rangelands, different types of LCLU change are taking place at an intensive level in developing countries. Change detection is an important process in monitoring and managing natural resources and urban development because it provides quantitative analysis of the spatial distribution of the population of interest. Change Detection is useful in such diverse applications as land use change analysis, monitoring shifting cultivation, assessment of deforestation, the study of changes in vegetation phonology, seasonal changes in pasture production, damage assessment, crop stress detection, disaster monitoring, day/night analysis of thermal characteristics as well as other environmental changes (Singh, 1989).

Geographic Information Systems (GIS) and Remote Sensing (RS) techniques provide effective tools for analyzing the land use dynamics of the region as well as for monitoring, mapping and management of natural resources. Some recent studies have shown the use of RS and GIS in land use Change Detection. Micro-watershed study helps in identifying the areas causing problems and ultimately becomes a step towards planning to mitigate the problems. The present study aims at mapping of Land Use / Land Cover for the years (1995, 2003 and 2012) and quantifying the changes in Land Use. Another recent development in the use of satellite data is to take advantage of increasing amounts of geographical data available in conjunction with geographic information systems to assist in interpretation. Geographical data describe objects from the real world in terms of (a) their position with respect to a known coordinate system, (b) their attributes that are unrelated to the position and (c) their spatial interrelations with each other ,which describe how they are linked together or how one can travel between them (Burrough, 1986).

In this study, land use and land cover change detection of Belin Township using Remote Sensing and GIS techniques are presented.

II. Study Area

Belin Township is a town in the Mon State of south-east Myanmar. The Belin River flows into the Gulf of Martaban. The area of Belin Township is about 19945 km^2. It situated between is East Longitude of 96° 53.687’ and 97° 30.148’, North Latitude 16° 56.953’ and 17° 42.734’ .The average annual temperature in it is 27° C and wind speed and relative humidity are about 4 mph (6km/hr) and 86%. The total population of Belin Township is

181075 according to 2014 census data. Location of Belin Township is shown in Fig 1.

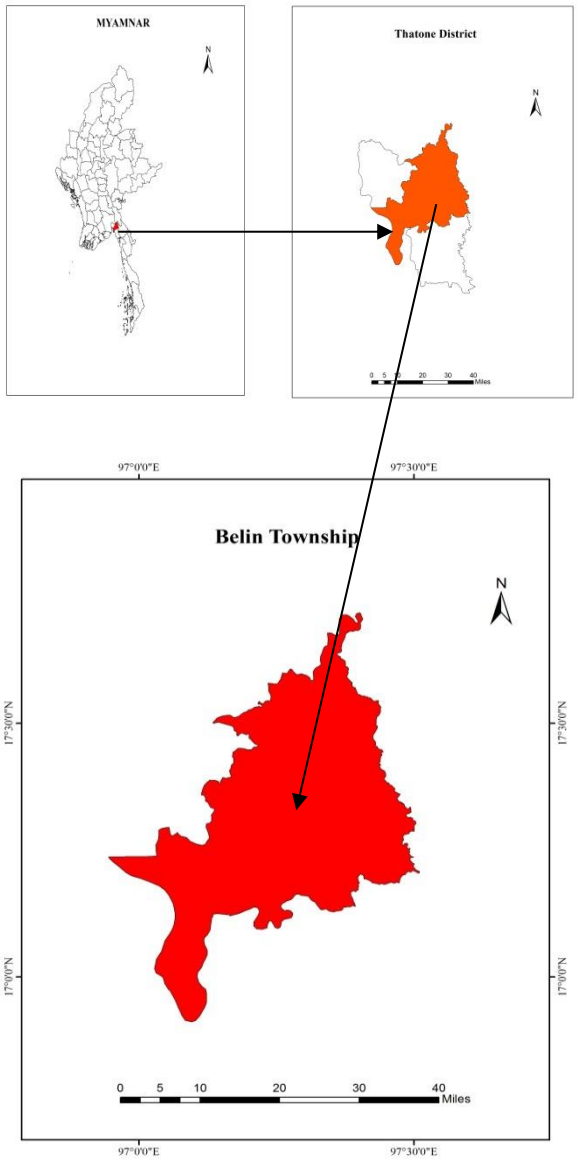

Fig 1. Location of Study Area

III. Data Sets And Methodology

A. Data Sets

Satellite Images and topographic maps were collected from different sources. These images with 30 m spatial resolution were downloaded from USGS Earth Explorer. Topographic maps such as country and district borderlines were purchased from MIMU (Myanmar Information Management Unit) data sets. Table 1 shows details of Landsat Data from USGS Earth Explorer.

Table 1 Details of Landsat Data from USGS Earth Explorer

No	Acquisition Date	Sensor	Path	Row	Resolution (m)
1	1999/04/03	Landsat 5/TM	132	48	30
2	2009/04/06	Landsat 7 /ETM+	132	48	30
3	2018/02/26	Landsat 7 /ETM+	132	48	30

B. Methodology

The yearly downloaded Landsat images were pre-processed radiometric corrections, haze, and removal of scan-lines error in Landsat 7. Layer stacking, images composition activities had done by using ERDAS IMAGINE 2015. Results of Images were also converted into Universal Transfer Mercator (UTM Zone 46 N) projection. Extraction of Sub Basin Map was made vector shape file in ARCGIS 10.4.1.

In this study, twenty years land use land cover data sets were created for the years 1999, 2009, and 2018. Five classification of land use and land cover such as water bodies, forest, settlements, agriculture land and bare land for this area were considered. The land use and land cover changes are also determined. The following classification scheme was used to check the change detection in this study. Table 2 shows land use and land cover classification scheme.

Table 2 Land Use and Land Cover Classification Scheme

No	Categories	Description
1	Water bodies	Areas had surface water including ponds, lakes, stream, reservoirs and rivers
2	Forest	Areas covered with dense natural forest
3	Settlement	Areas associated with rural and urban settlement
4	Agriculture land	Areas used for crops cultivation such as peanut, sesame, pulses and cotton and tobacco
5	Bare land	Area covered with little or no vegetation on ground surface

The numbers of reference points or training points collected from Belin Township by mean of Google Earth Pro. Signatures of polygonal training data were drawn and created in ERDAS IMAGINE 2015 software. Image classification LULC was studied using pixel-based supervised classification of the imagery with

maximum likelihood method. This method is based on ground reference points and each pixel in the image is compared with each signature and classified accordingly. Each pixel in the image data set is categorized into land cover class it most closely resembles. If the pixel is insufficiently similar to any training data set, it is usually labeled unknown. The category label assigned to each pixel in this process is then recorded in the corresponding cell of an interpreted data set.

Change detection method was used to identify, describe and quantify differences between images of the same area but different periods while percentage changes was calculated by dividing it with the total area and multiplying by hundred. It is also pixel based comparison and detects the changes more effectively. Results of two or more different images were compared in order to determine the changes for the periods between 1999 and 2018.

IV. RESULTS AND DISCUSSION

In this study, Landsat 5 and 7 satellite images of 1999, 2009 and 2018 were used for GIS and RS image analysis. Based on remote sensing and GIS techniques, the images are classified as water bodies, forest, settlement, agriculture land and bare land. Temporal land use maps of (1999, 2009, and 2018) are shown in figures 2 to 4.

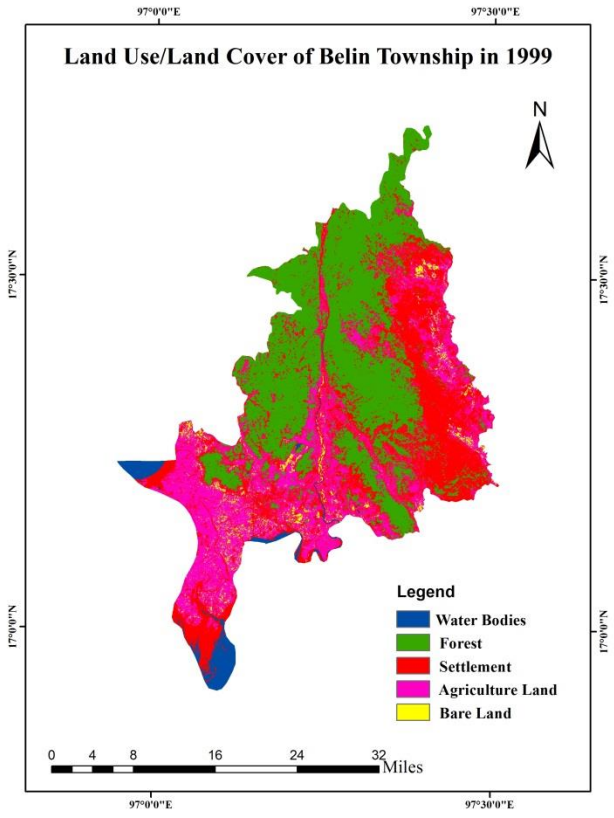

Fig 2. LULC of Belin Township in 1999

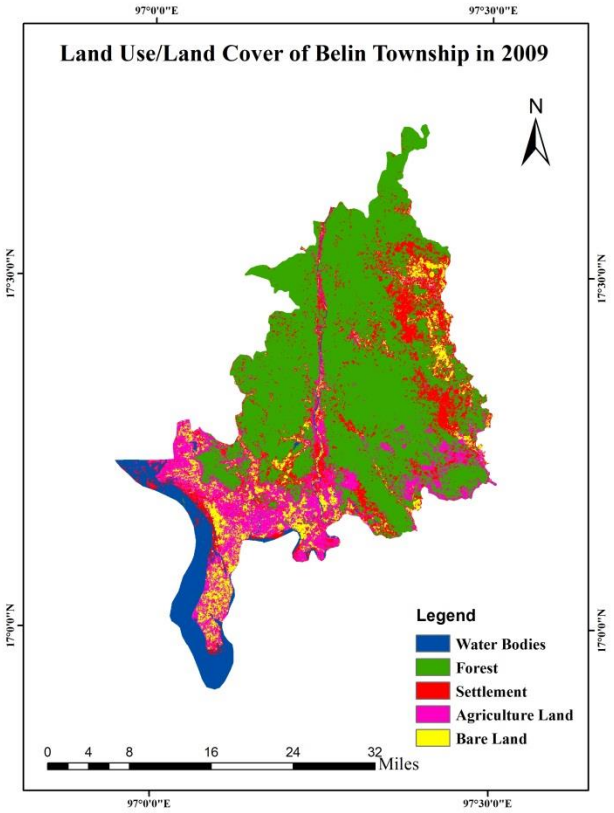

Fig 3. LULC of Belin Township in 2009

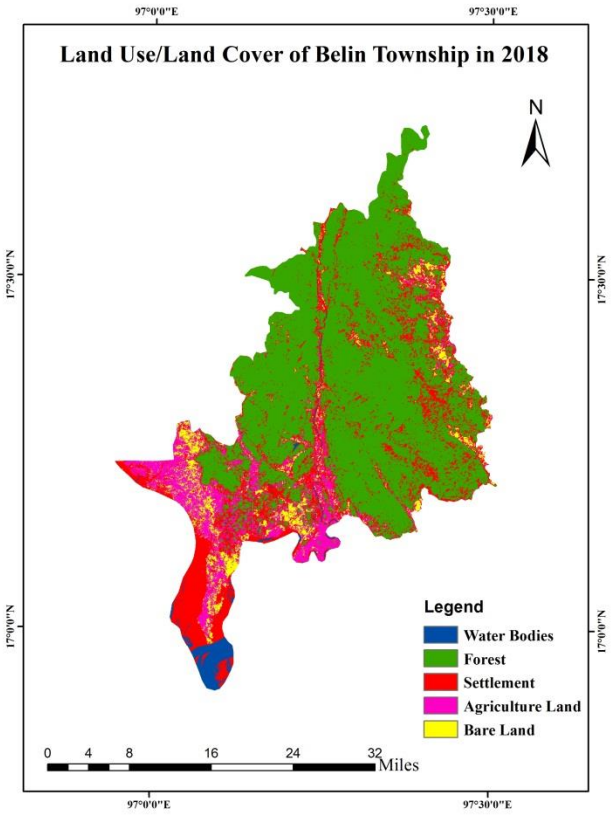

Fig 4. LULC of Belin Township in 2018

Table 3 to 5 show area, area (%) and change in area (%) of land use and land cover classification scheme.

Table 3 Area of Land Use and Land Cover for Belin Township

No	LULC categories	Area (sq.km)		
		1999	2009	2018
1	Water Bodies	591.885	1515.006	267.558
2	Forest	7752.303	11218.95	12215.93
3	Settlement	6308.406	2836.827	4663.962
4	Agriculture Land	4770.954	2931.048	1906.686
5	Bare Land	522.216	1443.933	891.603
	Total	19945.764	19945.764	19945.739

Table 4 Area (%) of Land Use and Land Cover for Belin Township

No	LULC categories	Area (%)		
		1999	2009	2018
1	Water Bodies	2.97	7.60	1.34
2	Forest	38.87	56.25	61.25
3	Settlement	31.63	14.22	23.38
4	Agriculture Land	23.92	14.70	9.56
5	Bare Land	2.62	7.24	4.47
	Total	100	100	100

Table 5 Change in Area (%) of Land Use and Land Cover for Belin Township

No	LULC categories	Change in Area (%)	
		1999-2009	2009-2018
1	Water Bodies	+4.63	-6.25
2	Forest	+17.38	+5.00
3	Settlement	-17.41	+9.16
4	Agriculture Land	-9.22	-5.14
5	Bare Land	+4.62	-2.77

Figure 5, 6 and 7 show area percentage of LULC of Belin Township in 1999, 2009 and 2019.

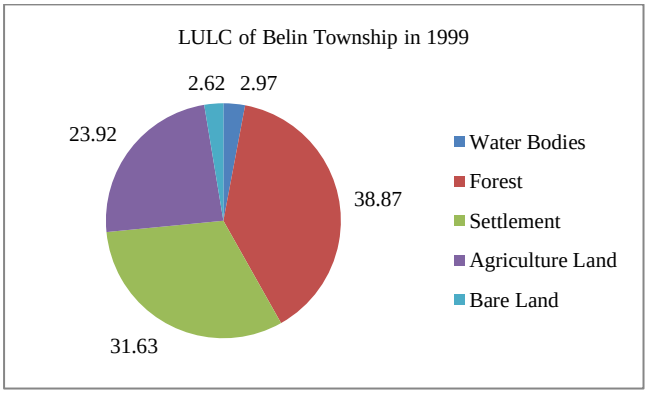

Fig 5 Land use classification in 1999

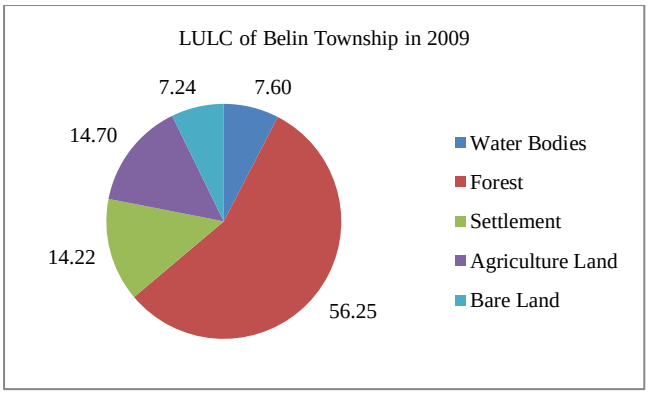

Fig 6 Land use classification in 2009

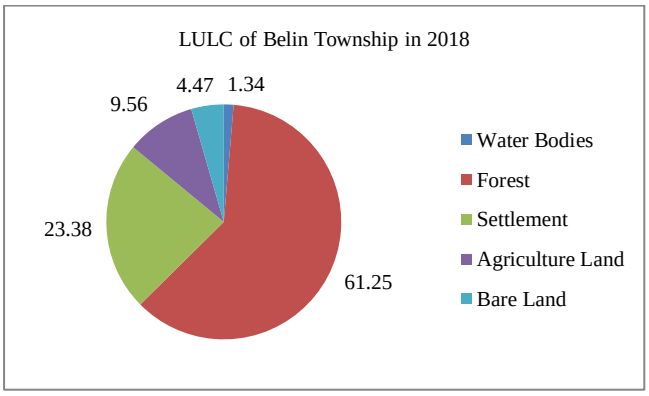

Fig 7 Land use classification in 2018

Change in water bodies: LULC by water bodies in this study was 591.885 km^2, accounting for 2.97% of the total area in 1999. The water bodies cover expansion and its fraction share for the years 2009 was 7.6%.Nevetherless, the proportion of water bodies was dropping dramatically about 1.34% in 2018 respectively. The water bodies area had increased during the study time of 1999 to 2009, but it had decreased during the period of 2009 to 2018.

Change in forest: The forest cover extent and total area for the years 1999, 2009 and 2018 in Belin Township were 7752.303 km^2, 11218.95 km^2 and 12215.93 km^2 accounting for 38.87%, 56.25% and 61.25% respectively. The forest cover had shown dramatic increase in 2009. This was related to the increased plantation and conservation of wood.

Change in settlement: LULC by urban and rural area in this area was 6308.406 km^2, accounting for 31.63% of the total area in 1999. The settlement cover reduces and its proportional share for the years 2008, 2013 and 2018 were 31.63%, 14.22% and 23.38%, respectively as shown in Table 4. The settlement land had decreased during the period of 1999 to 2009, but it had slightly increased during the study time of 2009 to 2018.

Change in agriculture land: LULC by agriculture land in this area was 4770.954 km^2, accounting for 23.92 % of the total area in 1999. The settlements area of proportional rate share for the years 2009 and 2018 were 14.70% and 9.56% respectively. The settlements during the study period between 1999 and 2009 had shown decrease. During the period of 2009 to 2018, the settlements had shown continuously decline.

Change in bare land: LULC by bare land area was 522.216 km^2, accounting for 2.62% of the total area in 1999. The bare land cover extent and its proportional share for the years 2009 and 2018 were 7.24% and 4.47 %, respectively. The settlements during the study period between 1999 and 2018 had shown fluctuate.

IV. CONCLUSION

`In this research, supervised classification of multi-temporal satellite images is an effective tool to quantify current land use as well as to detect changes in a changing environment. The observed changes varied from one LULC category to another with some maintaining a constant change (increase or decrease) over the two analysis periods (1999-2009 and 2009-2018). As a result, it can be seen that water bodies were decreased in the last two decade. The conservation of forest land in the surrounding area indicates that the forest area gradually was increased of 22.38% during twenty years. In addition that, the settlement land had not significantly changed. LULC by agriculture land was decreased between 1999 and 2018. It may be concluded that the land use/land cover of bare land was not significantly increased or decreased.

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