EXTENDED ABSTRACT

ANALYSIS OF LAND USE/LAND COVER CHANGES IN HAMBANTOTA DIVISIONAL SECRETARIAT DIVISION FROM 2008 TO 2019 USING REMOTE SENSING AND GIS TECHNIQUES

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Abstract

The classification of land use / land cover (LU/LC) for certain area plays a major role in planning, management, and monitoring programs as well as it helps to study the changes which are happening in the environment and ecosystem. This study aims to evaluate LU/LC changes in Hambantota Divisional Secretariat Division from 2008 to 2019. Hence LU/LC cover changes spatially with time; this study is conducted by using supervised classification, particularly maximum likelihood classification and accuracy assessment using Remote Sensing and GIS techniques. The results revealed that the increment of water bodies (2.39%), agriculture (0.44%) and built-up areas (27.66%), and decrement of barren lands (11.61%) and forest cover (18.88%) with the time due to the vast development over the years. The overall accuracy for both 2008 and 2019 ranged from 86.7 percent to 83.3 percent and the Kappa coefficient ranged from 0.888 to 0.912.

Keywords: Remote sensing, supervised classification, land use/ land cover

1. Introduction

Identifying and analyzing Land use / Land cover (LU/LC) for a given area of interest is considered as important for policy making, designing urban, agricultural, and industrial areas, monitoring environmental changes and natural resource management, administrative and business purposes. In fact, land use and land cover are changed with time and space with the changes of the physical and social characteristics of the community (Tilhun A & Teferie B, 2015). Land cover is the physical characteristics of the earth's surface such as vegetation, soil, water, and other physical features of the land and the things created by humans such as settlements. Land use change is the conversion of a piece of land use by humans, from one purpose to another. Developments are caused to change LU/LC in a given area. Sometimes LU/LC change brings many detrimental effects to the both city dwellers and its environment (Uduporuwa J.M, 2020).

LU/LC change in a particular area can be analyzed and identified using remote sensing and GIS techniques. These techniques facilitate to study the detailed and accurate land use classification and LU/LC changes. GIS and remote sensing applications lead to do different kinds of geospatial analyses at a low cost with higher accuracy. There are different methods of assessing the capability and ability of pixel-based image classification algorithms (supervised and unsupervised) (Adejoke A.O & Badaru Y.U, 2014) are the common methods used in remote sensing and GIS techniques for understanding LU/LC classification. In Supervised classification, the user develops the spectral signatures of known categories, such as urban and forest, and then the software assigns each pixel in the image to the cover type to which its signature is most comparable (Rwanga S. S & Ndambuki J.M, 2017). An unsupervised classification is a form of pixel-based classification and, an algorithm is chosen that will take a remotely sensed data set and find a pre-specified number of statistical clusters in multispectral or hyperspectral space (Mohd H.I et al., 2009).

One of the most important final steps in the classification process is accuracy assessment. The aim of accuracy assessment is to examine the agreement between classes at specific locations on the classified image and in the reference data (Enderle D.I.M & Weih Jr R.C, 2005) and its build up the user confidence and the classification quality. However, supervised and unsupervised technique relatively shows different levels of accuracy after accuracy assessment was performed (Mohd H.I, et al., 2009).Therefore the generation of the LU/LC classification map is essential to clarify and understand the behavior of the ecosystem of any region at given a time. The accuracy of the LU/LC classification provides accurate and confidential information for resource managers, planners, and decision makers. Hambantota district, has undergone large-scale developments under government plans to transform in to Sri Lanka's second- largest urban hub. These developments mainly affect to natural environment. Proper development plan should better manage the natural environment and get closer to a sustainable condition. Therefore, there is a problem regarding the sustainability of those developments. The objectives of the study are,

1. Identify major land use categories in Hambantota divisional secretariat division.
2. Evaluate the LU/LC classification of Hambantota divisional secretariat division from 2008 to 2019 using supervised classification in remote sensing and GIS techniques.
3. By conducting the accuracy assessment method from the supervised classification technique evaluate the accuracy of the LU/LC classification.
4. Make guidance for future urban planning in the area by observing the existing deforestation and land degradation.

2. Methodology

As primary data, LANDSAT 7Enhanced Thematic Mapper Plus (ETM+) satellite images have been taken for January 11th 2008 and LANDSAT 8 Operational Land Manger/ Thermal Infrared Sensor (OLI/TIRS) satellite images have been taken for January 11th 2019 from United States Geological (USGS) Earth Explorer and as supporting data Google Images for the particular area were obtained from Google Earth Pro for 2008 and 2019. Secondary data has been collected through published and unpublished data on the land use changes related to a particular area.

Step 1

The quality of those Landsat satellite images was influenced by cloud cover and radiometric errors. The image was then processed in ERDAS IMAGINE 2014 software.

Step 2

After applying the corrections, Bands 3, 2, and 1 are used to combine to make true-color composite images for LU/LC analysis. Then, the study area was extracted by clipping from the prepossessed satellite using ArcGIS 10.5 software.

2.1 Classification

Supervised classification has been used to evaluate LU/LC for the Hambantota divisional secretariat area as it is a more suitable method for LU/LC classification because resultant informational classes are tied to specific areas of known identity and serious classification errors can be easily detected. Supervised classification using Maximum Likelihood Classification is the preferred method of image classification, because of the probability of classification is calculated for each class rather than calculation is based on distance. This method comprises the training stage, classification stage, and accuracy assessment method. According to the land use pattern for Hambantota divisional secretariat area five training samples such as water body, reservoir, forest area, agriculture area, barren lands, and built-up areas were generated. Generally, the training samples are taken into a vector layer that digitized over the raster scene. By identifying patterns, the computer system is instructed to identify pixels with similar characteristics. Finally, area changes for each land used changes were found.

2.2 Accuracy Assessment

After classification, Google Earth images for a particular area for 2008 and 2019 were used for accuracy assessment. The accuracy assessment shows how effectively pixels were sampled into the correct land cover classes. The accuracy assessments were made through a confusion or error matrix. A confusion matrix contains information about actual and predicted classifications done by a classification system (Ayyanna et al., 2018).

$$Overall\ Accuracy = \frac{Total\ number\ of\ correct\ samples}{Total\ number\ of\ samples} \times 100\% \quad (1)$$

Producer accuracy is given by equation 2. User accuracy is given by equation 3.

$$Producer's\ Accuracy = \frac{Number\ of\ correclty\ classified\ pixels\ in\ each\ category}{\underset{(The\ coloum\ total)}{Total\ number\ referece\ pixels\ in\ that\ category}} \times 100\% \quad (2)$$

$$User's\ Accuracy = \frac{Number\ of\ correclty\ classified\ pixels\ in\ each\ category}{\underset{(The\ Raw\ total)}{Total\ number\ referece\ pixels\ in\ that\ category}} \times 100\% \quad (3)$$

Kappa can be used as a measure of agreement between model predictions and reality (Tilhun A Teferie B, 2015) which is given by equation 4.

$$K = \frac{N\sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r}(x_{i+} \times x_{+i})}{N^2 - \sum_{i=1}^{r}(x_{ii} \times x_{+i})} \quad (4)$$

3. Results and Discussions

3.1 Land Use and Land Cover (LU/LC) Classification Based on Supervised Classification

According to the LU/LC classification for the current study area, five major land uses and land cover types were identified (see Figure 1). Changes in land use classes for the corresponding areas for 2008 and 2019 are presented in Table 1.

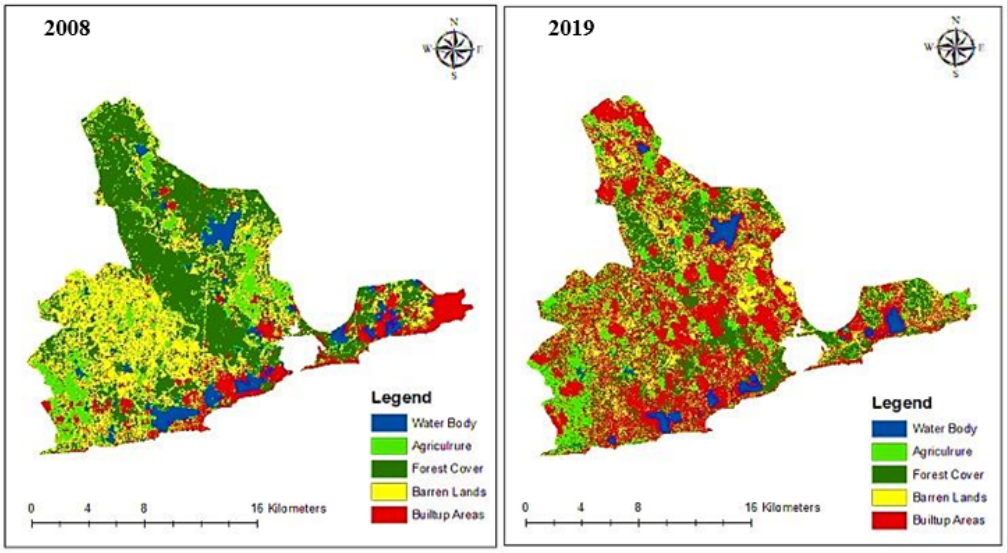

Figure 1. LU/LC classification of Hambantota Divisional Secretariat division from 2008 to 2019

Table 1. LU/LC Classification and their corresponding areas for 2008 and 2019

Category	2008		2019		Conversion Rate (+/-)
	Area(m^2)	Area (100%)	Area(m^2)	Area (100%)	
Water Body	26,398,112	8.57	33,765,786	10.96	+7,367,674
Agriculture	34,086,890	11.06	35,449,544	11.50	+1,362,654
Forest Cover	129,283,032	41.95	71,089,945	23.07	-58,193,087
Barren Lands	79,492,776	25.80	43,737,864	14.19	-35,754,912
Buildup Aras	38,895,099	12.62	124,112,763	40.28	+85,717,664

According to the values given by the classification in 2008 forest cover obtained huge area rather than other land use classification. Forest area covered by 41.95%, and barren land covered by 25.08%. Water body, agriculture and build-up areas gain 8.57%, 11.06%, and 12.62%, respectively which are shown the least amount of land use categories.

Land use in 2019 shows that forest cover occupied 23.07% and built up areas occupied 40.28% which means, there is a huge increment of built-up areas by27.66% and decrement of forest areas by 18.88%. However, area belongs to water body gain 10.9%, agriculture 11.50% which shows slight increment compared with 2008 by 2.39%, 0.44%, and barren lands gain 14.19% which is decreased by 11.61%. According to table 1, water body, agriculture, and build-up areas were increased by 736.8 hectares, 136.2 hectares and 8571.8 hectares respectively. Forest and Barren lands were decreased 5819.3 hectares, and 3475.4 hectares respectively.

According to the data given by classification, the LU/LC change shows significant variation from 2008 to 2019. This happened with the rapid development in the Hambantota divisional secretariat area after 2009. In order to develop Hambantota area, the construction of highways, conference halls, administrative areas, new seaport, and international airport were carried out after 2009 under the major development projects which were started by the local and foreign governments.

3.2 Accuracy Assessment

When considering the accuracy assessment of the LU/LC classification from supervised classification in 2008 the overall accuracy is 86.7%. The user accuracy for water body, agriculture, and forest cover is 100% and for barren lands and built-up areas are 83.3% and 50% respectively. Producer accuracy for water body and barren land obtains 100%, as well as agriculture, forest cover, and barren lands,

obtained 85.7%, 75%, 83.3% respectively. The Kappa Index Accuracy is obtained as 0.888 which shows a complete agreement between classified maps and the reference data.

In 2019, the overall accuracy is 83.3%. The user accuracy of land use obtained 100% for water body and agriculture, 83.3% for forest cover and built-up areas and 50% for barren lands. When considering producer accuracy, 100% of barren lands, 85.7% of water body, 75% in agriculture, and barren lands and 83.3% of forest cover. The Kappa Index Accuracy is obtained 0.912. When analyzing overall accuracy data for land use classification from 2008 to 2019, it shows a very good agreement in land use.

4. Conclusion

The LU/LC change in Hambantota Divisional Secretariat Division shows significant variation after 2009 due to the rural development programs which were carried out by the local governments. This study is carried out to evaluate and study spatial changes of land use patterns in Hambantota divisional secretariat division between 2008 to 2019.

This study revealed that there is a significant change of the LU/LC change during the past 11 years, which is shown by the LU/LC classification maps with two time periods. This study observed that built-up areas increased significantly and forest cover and barren lands have been lost significantly during this period. There is a slight increment shown in the water body and agricultural areas also. This concludes a certain amount of land use has been converted to another land use class and land cover got changed timely and most of the development programs are not considered as sustainable. During 2009, there were major developments programs carried out by local and foreign governments that are considered as the main reason to change the significant change of LU/LC changes in the Hambantota divisional secretariat division. Recommendations are aware of urban planners, decision makers, administrative offices to consider the land use changes and the effects of land degradations and deforestation. Hence results revealed a huge reduction of forest cover over the years, future construction activities and decisions should be taken in order to reduce further land degradation and deforestation, as well as necessary actions, should be taken to increase the forest cover by introducing "tree planting programs" by local government authorities

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