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APPLICATION OF REMOTE SENSING AND GIS TECHNIQUES IN MAPPING OF VEGETATION COVER CHANGE IN GAOGIONG ECOTOURISM AREA, DONG THAP PROVINCE, VIETNAM

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Abstract:

In this study, multi-temporal satellite data were used to quantify forest cover and land cover changes in the GaoGiong Park, Dong Thap province, Vietnam during 2006-2020. Four Landsat 8 satellite images were used for 2006, 2010, 2015, 2020 were taken for comparison. Normalized Difference Vegetation Index (NDVI) in combination with unsupervised classification was used. The study determined that the total area of the study area was 1,4883.33 ha in 2020ha, of whichM.cajuputi> 9years, 6-9years old and < 6 years are 1,275.47; 144ha; 55.09 harespectively; bare land and water area are 0.01 ha and 8.36 ha, with an overall accuracy of 84.83%and a kappa coefficient of 0.81.During the period of 2006 to 2020, the area of bare soil, water surface not changed significantly.The area of *M. cajuputi*>9years and <6years in 2020 increased slightly by 12.05% and 2,26% respectively, and the area of *M. cajuputi* (6-9 years) decreased by 14.39%compared to 2006. It can be seen that multi-temporal Landsat images with a 30 m spatial resolution can be used for the assessment of vegetation coverage changes with guaranteed results.

Keywords: *Landsat, Remote sensing, Gao Giong, NDVI.*

Introduction

Remote sensing options available to those concerned with wetlands management expanded considerably since the mid 1970s when aerial photography was almost exclusively used. Remote sensing satellite data have been applied to identify and study various wetland features such as tidal flats, lagoons, marshy vegetation,saltmarshes and saltpans. This data has also helped understand the spatial pattern, significance and extent, of wetlands to the local community (Bhuvaneswari et al., 2011), as well as identifying and monitoring them (Rani et al.,2011). Monitoring of wetlands status is increasingly seen as an important issue worldwide, because of their increasingly recognized role in ecosystem service provision, importance in maintaining human health and wellbeing, natural ecosystem bio-integrity, and in carbon sequestration. Medium resolution 30 m Landsat (ETM+) imagery combined with ancillary topographic and soil data have been used to map wetland and riparian systems in the Gallatin valley of

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South West Montana (Baker et al., 2006), in Uganda (Owor et al., 2007), in Trabzon city (Kahya et al.,2010), in the Nile swamps of southern Sudan (Soliman and Soussa, 2011) and in North Norfolk, UK (Sanchez et al., 2007), in the river Niger Basin (Twumasi and Merem, 2007), in the lower Mekong Basin (MacAlister and Mahaxay, 2009).

GaoGiongcajuput forest covers an area of 1,657ha. This is a typical land of the Dong ThapMuoi ecosystem, is a protective forest - a green lung for many species of birds, fish and plants to thrive, especially rare storks. The biodiversity, beautiful, wild natural landscape, fresh and cool climate,...are advantages for GaoGiong to develop ecotourism type (Vietnam Environment Magazine, 2018).According to the Institute for Tourism Development Studies (2000), GaoGiong is oneof the tourist destinations in Dong Thap province of national and regional significance. The vegetation of the GaoGiong Park is an important ecosystem as it contributes to preserve the nature while providing many be benefits. It is also used as an excellent indicator for identifying early signs of ecosystem change in the entire area. However, the past time, the forest in the buffer zone has many fluctuations in both area and quality, which lead to many consequences of ecological crises such as biodiversity loss, ecosystem degradation, causing difficulties for the local government in management. Due to the threats for GaoGiong wetland ecosystems described, it is essential to make methodological or institutional proposals for policies to protect these valuable wetlands and to make recommendations for sustainable forest land use for environmental values in the situation of the global climate change. In order for that the current status as well as past changes must be known which provi des a valuable data base on the contribution of forest ecosystems in reducing greenhouse gases. In order for that, an effective method should be used to re-evaluate the cover change occurred during the past years. Use of remote sensing is the most effective method that serves for this purpose which was also used in the present study. Therefore, the investigation and monitoring of structural change and the area change of forest vegetation has become a priority requirement or the management of GaoGiong wetland. Further the annual reports prepared on the status and situation of the forest changes by the relevant agencies, most of these reports are mainly based on traditional methods of mapping the forest. Therefore applications of Remote sensing and GIS techniques will be very helpful to resolve these problems in a short time period. Obtaining information after a thorough study on vegetation cover will partly help the Management Board of GaoGiong wetland to understand the forest resources change through different stages. This will also act as a scientific database to help management conserve wetland. For these reasons the present study was conducted in GaoGiong wetland with the objectives of identifying the present plant distribution in wetland and mapping the vegetation cover change over the years of 2006-2020 using Remote sensing-GIS techniques.

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Method

Study area

GaoGiong eco-tourism area was built in 2003 in Cao Lanh district, Dong Thap province, 150 kilometers from Ho Chi Minh city. GaoGiong ecotourism site has been dominated by M. cajuputi tree with a community of grasses and vines. The coverage of M. cajuputi forest is 99.44% and the rest consists of bare land, canals and grasslands. The green oasis-like area is divided into four zones with over 70km of canals. The forest in GaoGiong creates a wild beauty. This is the habitat of 100 species birds, such as whistling ducks, wild ducks, and tens of thousands of white egrets, making the area the largest habitat of white egrets in Dong ThapMuoi.The area receives an annual average rainfall of 1,332mm, while the average annual temperature is 27^0C. The soil is a uniform, potentially acidic sulphate, and the land is poorly drained with a peaty substrate which is saturated for almost the whole year.The area stretches from 10^o36'19''north latitudeto 105^o37' 45''east longitude (Figure1). The project area is adjacent to:

- The Northern border is adjacent to My Phong–My Hoa canal.
- The Eastern border is adjacent to GaoGiong canal.
- The Southern border is adjacent to Ba Chu canal.
- The western border is adjacent to Bay Thuoc – Gao Street.

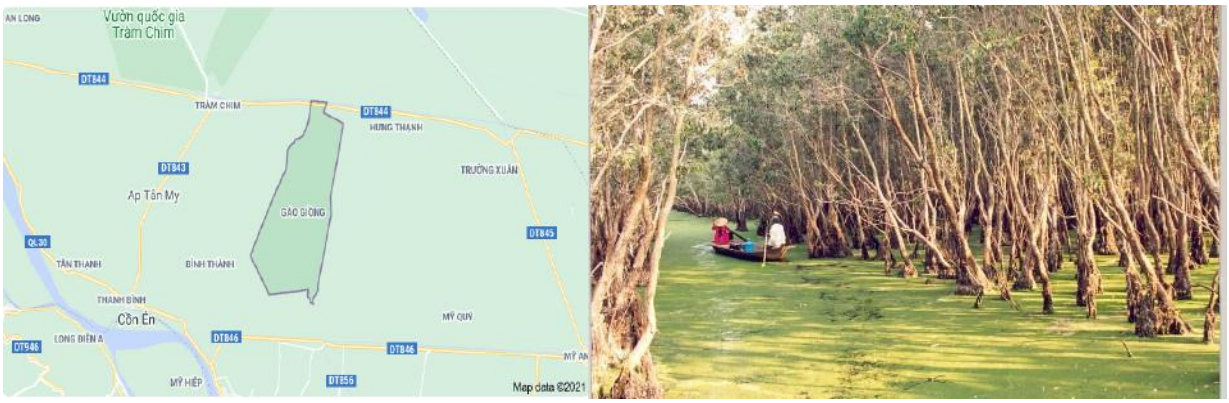

Figure 1: Location of the GaoGiong wetland

Methodology

Data and vegetation cover classification

The change in land use class was obtained from Landsat 5 and Landsat 8 on March 2006, 2010, 2015, 2020 (Table 1). The GaoGiong area was separated by using the subset tool of ERDAS 2014 for the preparation of boundary of the study area to match the satellite image for the toposheets compatible. The digitized map was projected to World Geodetic System (WGS) 1984 Universal Transverse Mercator (UTM) zone 48 N. As different dated satellite images were of different size of pixels, resampling was done

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to obtain the same pixel size in all the satellite imagery used. The identification of land use patterns and degradation of wetlands in the study area were classified using ERDAS software. Data were pre-processed in ERDAS for geo-referencing, mosaicking and sub-setting of the image on the basis of Area of Interest using land use map in 2006 on a scale of 1:50000. The satellite data were studied by assigning individual pixel signatures and differentiating the GaoGiong area into five classes on the specific of digital number value of each class. According to the objective of the study, the land use classification of the GaoGiong was divided into five types. For the five land use classes, predetermined land use type, training samples were selected by delimiting polygons around each representative site. Based on the geo referenced images, the images were interpreted by supervised classification using maximum likelihood techniques. Global Positioning System was used as bases to register the images and was geometrically corrected using ArcGIS.

Table1. Source of sensor data.

Data product	Month and year	Path	Row	Spatial resolution
Landsat 5	March, 2006	125	53	30
Landsat 5	May, 2010	125	53	30
Landsat 8	January, 2015	125	125	30
Landsat 8	February, 2020	125	125	30

Accuracy assessment

An equalized stratified random sampling was carried out in the study area to assess the accuracy of the classified land use/land cover changes. The overall accuracy and Kappa analysis was carried out to classify the accuracy level using the random points to represent different land use classes of study area. For each land use class, 178 points, based on ground truth data and visual interpretation were randomly selected and verified on the land cover map generated. The reference data and classified results were compared statistically using error matrices. In addition, Kappa test was also performed to measure the extent of accuracy of the classified images.

Results and discussions

The classification method that was used in this study was a combination of two methods of unsupervisedand supervised classification.Landsat image samples weretaken for four timeframes for the selected years 2006, 2010, 2015, 2020. Image interpretation was conducted by using unsupervised methods for five classes that are water, bare soil, M.cajuputi forest>9 years, 6-9years and <6years by combining the 5,4,3 spectrum channels and the 4,3,2 spectrum channels.The results of image interpretation in 2020, the area of GaoGiong eco-tourism area is 1,4883.33ha,very accurate with data of Dong Thap Forest Protection Department (1,492ha), in which M.cajuputi>9years, 6-9years old

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and <6 years are 1,275.47, 144ha; 55.09 harespectively; bare land and water area are 0.01 ha and 8.36 ha.

The GaoGiong park's NDVI values ranged from -0,521 to 0,713. Further, NDVI values of negative or zero were placed where there was absolutely no presence of vegetation in this study, e.g., bare soil, canals, flooded soil etc. NDVI values for canal water surface ranged from -0.521 to -0.284. It ranged for bare soil from -0.387 to 0.197. If the NDVI value decreases, the coverage density of the vegetation decreases accordingly (Table 2). The high NDVI values occur where the plants grow well and have the high density. Among them, M.cajuputi forest > 9 years had the highest NDVI value of 0.424-0.713. M.cajuputi forest 6-9 years had the NDVI value of 0.405-0.575 while it was from 0.197-0.405 for M.cajuputiforests < 6years (Table.2).

Table 2: Normalized difference vegetation index value (NDVI)

Density	Vegetation cover classes	NDVI
	Water	- 0.521 to -0.284
	Bare soil	- 0.387 to 0.197
3,740tree/ha	M.cajuputiForest < 6 years	0.197 to 0.405
4,350tree/ha	M.cajuputi forest 6-9 years	0.405 to 0.575
4,765tree/ha.	M.cajuputi forest>9 years	0.424 to 0.713

This study applied the unsupervised classification under the ISODATA algorithm to classify vegetation layers based on the variation of NDVI values. The four vegetation cover maps built for GaoGiong wetland for 2006, 2010, 2015, 2020 are given in Figure 2-5. However, according to the results, map analysis using NDVI calculation is found to have some drawbacks. For instance, the NDVI values of medium dense forest (6-9years) and high dense forest (>9years) were approximately similar. Therefore, the interpretation of these two classes was initially not accurate. However, it was corrected by field observations with the help of a high quality GPS device. Further, an error matrix was used to accurately evaluate the results of the classification. The results of accurate assessment of vegetation classification based on the actual data set for the year 2020 are shown in Table 3.

Table 3.Assess the accuracy of the Landsat image interpretation of vegetation cover classification in the GaoGiong wetland in 2020.

Class Name	Reference Totals	Classified Totals	Number Correct	Producer Accuracy	User Accuracy
Water	26	27	22	84.62%	81.48%
Bare soil	33	30	27	81.82%	90.00%
M.Cajuputi< 6 years	25	23	20	80.00%	86.89%
M.Cajuputi6-9 years	48	56	45	93.75%	80.36%

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M.Cajuputi> 9 years	46	42	37	80.43%	88.10%
Totals	178	178	151		
Overall Classification Accuracy = 84.83%					
Overall Kappa Statistics = 0.81					

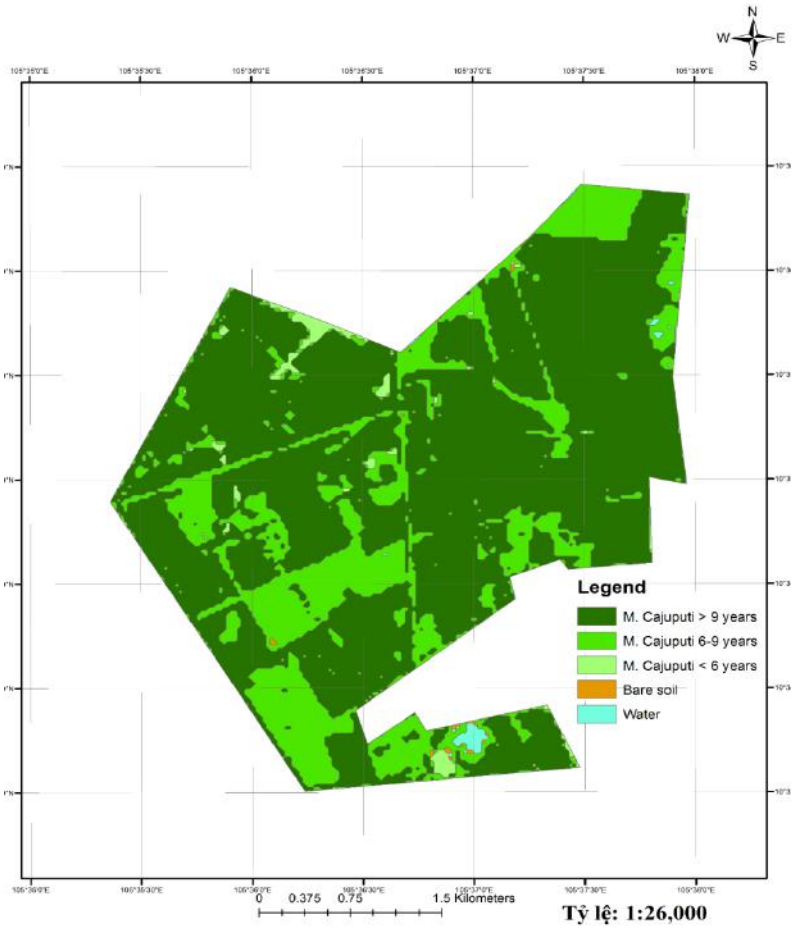

Figure 2: The vegetation cover map of the GaoGiong wetland in 2006 built by unsupervised classification.

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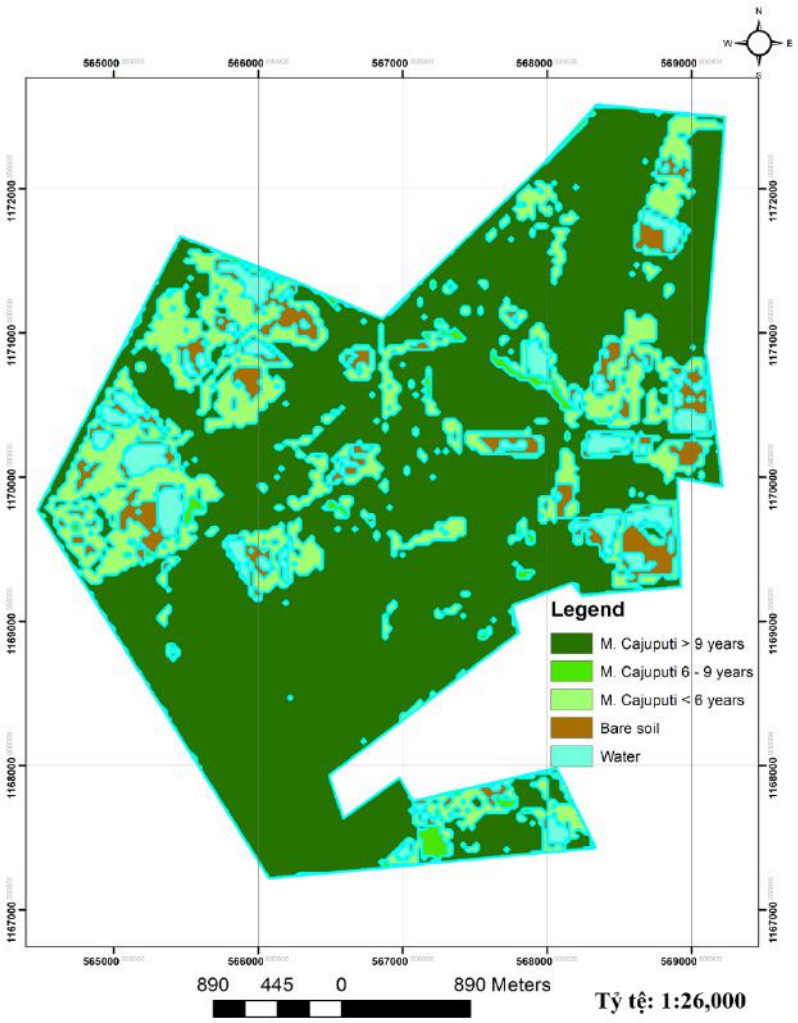

Figure 3: The vegetation cover map of the GaoGiong wetland in 2010buit by unsupervised classification.

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Figure 4: The vegetation cover map of the GaoGiong wetland in 2015buit by unsupervised classification.

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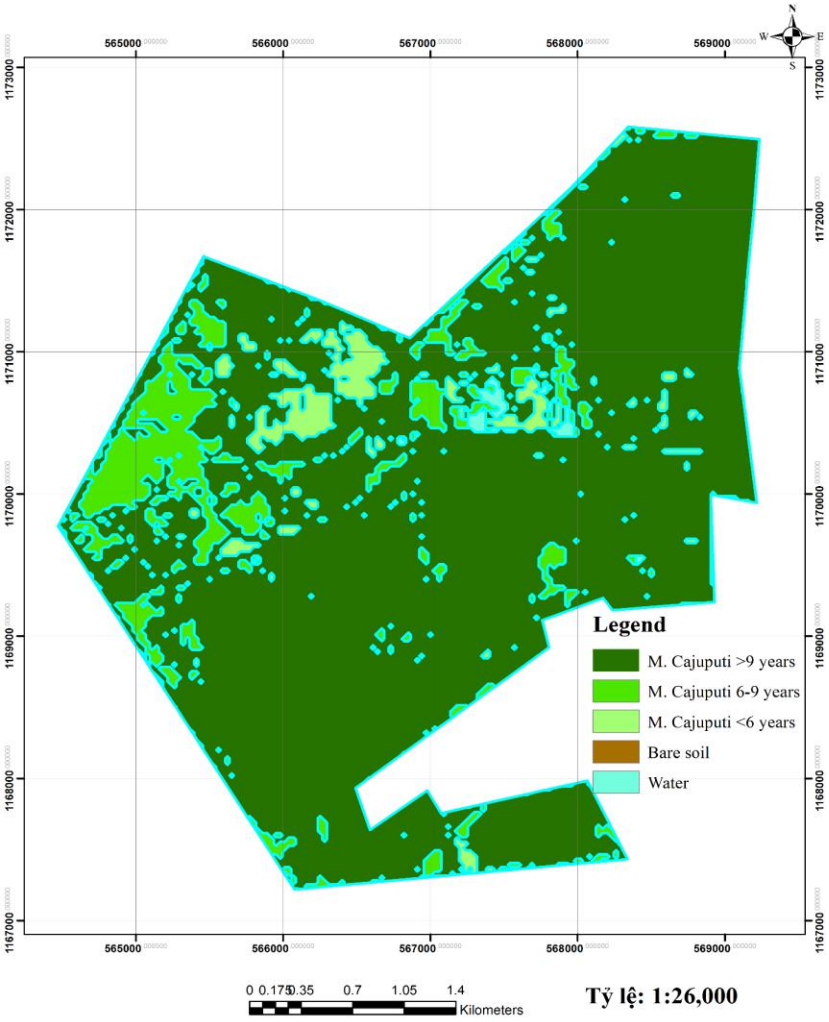

Figure 5: The vegetation cover map of the GaoGiong wetland in 2020 buit by supervised classification.

From the maps, it can be seen that, in 2006, GaoGiong wetlandwas covered entirely by plants, most of which were forests of 6-9 years old and>9 years old, while forests <6 years old were very few. In 2010, the area of >9 years and <6yearsforests were dominant, and the 6-9 years forest accounted for a very small proportion, many places was bare soil. This showed that the old forest> 9 years in the previous period had been harvested, then the Melaleuca forest at the average age of 6-9 years would be grow up and become old forest. Young forests <6 years would be replanted in areas at where forests> 9 years were exploited. By 2015, the most of M. Cajuput forest was 6-9 years and M. Cajuputiforests <6 years old was very few, particularly Melaleuca forests>9 years were not present at this stage. Local management officials showed that due to inundation, the forest lost 222.75ha and left 3-4 large vacant plots in the forest (Figure 2, 3,4,5).In 2020, because management is currently very good by local authorities,

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moreover, people's awareness of forest protection have had many positive changes. So forests always maintain an absolute coverage of 99.44% to create beautiful landscapes for visitors. That is why we do not see bare soil in the map. In short, period 2006-2020, it can be seen that the area of melaleuca>9 years and melaleuca<6 years now has increased with a very small rate (12.05% and 2.26%, respectively) compared to 2006 while melaleuca 6-9 years decreased 14.39% (Figure 6). The area of vegetation cover from 2006-2020 as follows Table 4:

Table 4: Area of vegetation cover at GaoGiong from 2006-2020.

Class Name	2006	2010	2015	2020
M.Cajuputi> 9 yeas	1.096,58	1.044,86	3,16	1,275.47
M.Cajuputi 6-9 yeas	357,91	22,03	1,356.26	144,40
M. Cajuputi<6 years	21,37	263,10	84,19	55,09
Bare soil	1,89	94,72	36,13	0,01
Water	5,62	58,66	3,62	8,36
Total	**1,483.37**	**1,483.37**	**1,483.36**	**1,483.33**

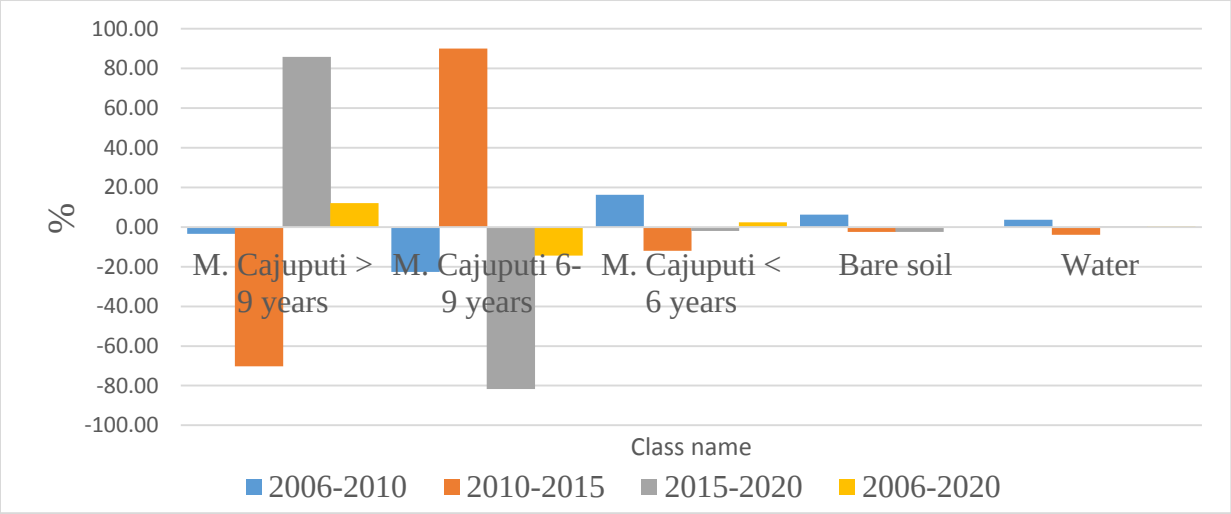

Figure 6: Change in cajuput area (%) by age level in the period 2006-2020

Conclusion

Multi-temporal Landsat images with a 30m spatial resolution can be used for the assessment of vegetation coverage changes with guaranteed results. Specifically, we have established a five-vegetation cover layer classification map with an overall accuracy of 84.83%, and a kappa coefficient of 0.81. Experimental results also showed that the combination of remote sensing and GIS technology was very effective in determining the variable area, degree of variation and the change tendency of each object. The results of image interpretation indicated that the total natural land area of

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GaoGiong wetland was 1,4883.33 ha in 2020 and there was a slight increase in Melaleuca> 9 years old and Melaleuca<6 years old, while that of 6-9 years old Melaleuca forests decreased 14% compared to 2006.

References

Bhuvaneswari et al., 2011 K. Bhuvaneswari, R. Dhamotharan, N. RadhakrishnanRemote sensing satellite data for Coastal Ecosystem and Hu man Interaction – A Case study in Tamilnadu, India Int. J. Comp. Inf. Syst., 2 (2011), pp. 77-81.

Baker, C., Lawrence, R., Montagne, C. and Patten, D. (2006). Mapping wetlands and riparian areas using Landsat ETM+ imagery and decision- tree-based models. Wetlands, 26: 465-474.

Kahya, O., Bayram, B. and Reis, S. (2010). Land cover classification with an expect system approach using Landsat ETM imagery: A case study of Trabzon. Environmental Monitoring and Assessment, 160: 431-438.

Owor, M., Muwanga, A. and Pohl, W. (2007). Wetland change detection and inundation north of Lake George, western Uganda using landsat data. African Journal of Science and Technology (AJST) Science and Engineering Series, 8: 94-106.

MacAlister, C. and Mahaxay, M. (2009).Mapping wetlands in the Lower Mekong Basin for wetland resource and conservation management using Landsat ETM images and field survey data. Journal of Environmental Management, 90: 2130-2137.

Rani et al., 2011. M. Rani, P. Kumar, M. Yadav, R.S. Hooda. Wetland assessment and monitoring using image processing techniques: a case study of ranchi, India. J. Geograph. Inf. Syst., 3 (2011), pp. 345-350.

Sanchez-Hernandez, C., Boyd, D.S. and Foody, G.M. (2007). Mapping specific habitats from remotely sensed imagery: Support vector machine and support vector data description based classification of coastal saltmarsh habitats. Journal of Ecological Infromatics, 2: 83-88.

Soliman, G. and Soussa, H. (2011). Wetland change detection in Nile swamps of southern Sudan using multitemporal satellite imagery. Journal of Applied Remote Sensing, 5(1): 053517, Doi: 10.1117/1.3571009.

Twumasi, Y.A. and Merem, E.C. (2007). Using Remote Sensing and GIS in the Analysis of Ecosystem Decline along the River Niger Basin: The Case of Mali and Niger. International Journal of Environental Research and Public Health, 4: 173-184.

TạpchíMôitrườngViệt Nam. 2018. RừngtràmGáoGiồng – Nơisinhsốngcủaloàicònhạnquýhiếm (số 6/2018). [Translate] Vietnam Environment Magazine. 2018. GaoGiongMelaleuca forest - Habitat of rare and precious storks (No. 6/2018).

ViệnNghiêncứuPháttriển du lịch (2000).Quyhoạchtổngthểpháttriển du lịchtỉnhĐồngThápthờikỳ 2001-2010 vàđịnhhướngđếnnăm 2020.HàNội. 92 trang [Translate] Tourism Development Research Institute (2000).Master plan on tourism development in Dong Thap province for the period 2001-2010 and orientations to 2020. Hanoi. 92 pages.