DETECTING CHANGES OF MALAYSIAN MANGROVES EXTENT USING LANDSAT TM IMAGERY

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Abstract : Mangrove forest plays an important role in conserving the environmental goods and services although it covers only small portion of the earth surface. Besides providing a wide range of goods and services for coastal environment, it also contribute to the socio-economics aspects of local communities and income to some states through production of poles for construction industry and logs for charcoal production.Thus, monitoring the mangrove forest is very essential as it gives supporting information needed to assess the status and manage the mangrove resources. This study aims to detect changes of Malaysian mangrove forest using Landsat TM imagery as it is the most cost effective method in monitoring over large areas. Two series of mangrove forest of 2005 and 2010 were compared to detect changes using object-based classification method. The results showed that a total of mangrove forest in 2005 and 2010 are 605,856.91 ha and 600,314.85 ha respectively. There are changes in mangrove forests over the observed period and it is estimated about 5,542.06 ha loss of mangrove forest. The changes could be due to several factors such as the extent of suspended sediment that leads to the increase of mangrove forest, while human activities such as logging, land conversion and urbanization have decreased the total forested area dominated by mangrove. This study indicates the importance and effectiveness of monitoring the mangrove forest through the use of remote sensing technology to estimate, evaluate, and monitor mangrove forest resources, carbon sequestration, and also to support sustainable forest management.

Keyword : Mangrove, Changes, Landsat TM

Introduction

Mangrove forest is one of the forest types that available in Malaysia alongside other forest types such as dipterocarp, peat swamp and plantation forest. This forest can be found along the coastal lines of peninsular Malaysia and Sabah and Sarawak. Mangrove forest contributes about four percent (551,187.00 ha) of the total forested area of 13,778,517.00 ha in 2010 and 82 percent of mangrove forest resides in Sabah and Sarawak (Dept of Statistics, 2010). Although it only contributes small percentage of the total forested area, this area is among the most productive and biologically complex ecosystems on Earth as compared to other forest types. Not only giving an economic values to the country by logging activities to produce charcoal and other use, mangrove forest plays an important role to the environment. Mangrove forest acts as a buffer between the land and the sea, not only preventing

erosion but it acts as catalyst in reclaiming land from seas. It also provide protection and shelter against extreme weather events such as tsunami, carbon storage, and providing a habitat for wide varieties of animal and plant species.

Globally, mangrove forest around the world decreased from year to year (FA0, 2007). Various drivers of mangrove destruction such as land conversion to aquaculture, agriculture expansion, wood extraction, urbanization and other intrusive developments have leads to the loss of the mangrove forest throughout the world. The loss of biodiversity such as the extinction of mangrove species and loss of other benefits provided by mangrove forest will happen in the future if continuous monitoring and management of mangrove forest not be done. Continuous monitoring of mangrove forest will provide better management of mangrove forest and reducing the drivers that caused the loss of the mangrove forest.

Remote sensing technology is an effective method in monitoring mangrove forest as it provides data to the user periodically. It also very effective in monitoring in a large scale as remote sensing data can cover wide area. Thus, this study is aims to map the distribution of mangrove forest of Malaysia for year 2005 and 2010 and to detect changes between that period through the use of Landsat TM imagery.

Methodology

The data used in this study is Landsat TM data of year 2005 and 2010. A total of 44 Landsat TM imagery were used in this study to map mangrove forest throughout Malaysia. All Landsat TM imagery were provided by APFNet and freely downloaded from the internet. Other data that was used in this study is landuse and ground information for the use of classification and accuracy assessment of mangrove forest.A combine methods of object-based classification and visual interpretation methods were used in this study for accurate mapping and estimation mangrove forest. Each image was processed separately and the results of the classified images were then combined to produce mangrove forest map of year 2005 and 2010. The accuracy assessment of the classified images is assessed after the classification process was done. The methodology implemented in this study is shown in Figure 1.

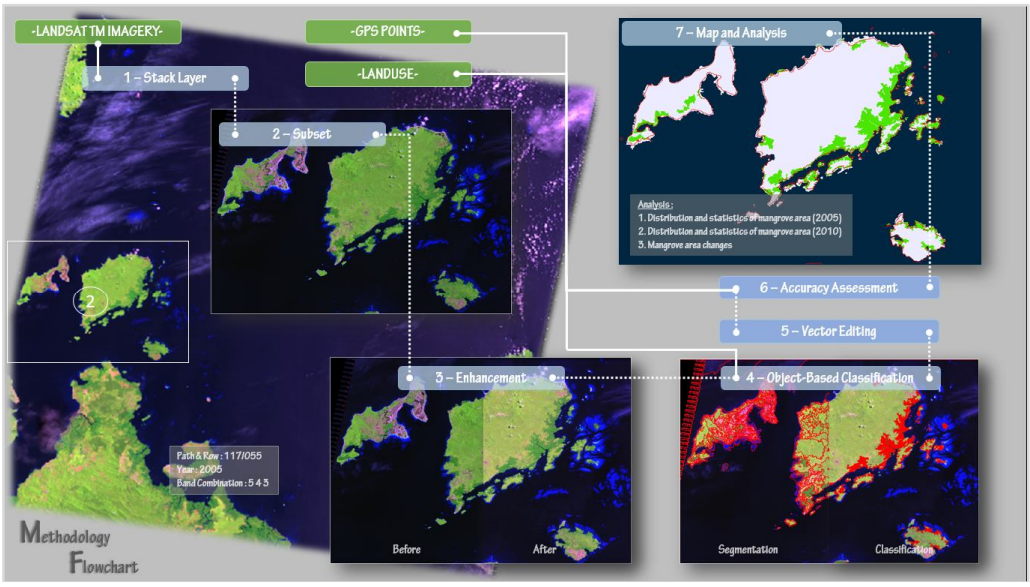

Figure 1: Methodology flowchart

Result and discussion

Remote sensing technology provides a cost effective ways in mapping the mangrove forest.Based on this study, it is estimate that the total mangrove forest of Malaysia for year 2005 and 2010 derived from Landsat TM imagery is about 605,856.91 ha and 600,314.85 ha as shown in Table 1.

Table 1: Statistics of mangrove forest of Malaysia

State	Area (Ha)		Difference
	2005	2010	
Peninsular	106,982.96	106,272.02	710.94
Sabah	362,401.98	358,906.41	3,495.57
Sarawak	136,471.97	135,136.42	1,335.55
Total (Ha)	**605,856.91**	**600,314.85**	**5,542.06**

In 2010, Sabah contributes to 59.8% of the total mangrove forest of Malaysia followed by Sarawak (22.5%) and peninsular (17.7%). Table 1 also shown that the total mangrove forest is decreased about 5,542.06 ha (0.91%) from 2005 to 2010. When comparing the results of this study with the Department of Statistics Malaysia (2013), it shown that the difference is around 48,000.00 ha, which is 8% more that reported by Department of Statistics Malaysia. The results of this study also compaed with other researchers that use remote sensing data to map mangrove forest and their results is almost same from the result of this study (Hamdan et. Al., 2010). The use of moderate resolution data may be cause of an overestimate of mangrove forest. The use of higher resolution data such as SPOT images can improve the detection of magrove area thus can provide better estimation of mangrove forest.However, both statistics shown that the mangrove forest is decreased from 2005 to 2010. The distribution of mangrove forest of both years is shown in Figure 2 and Figure 3.

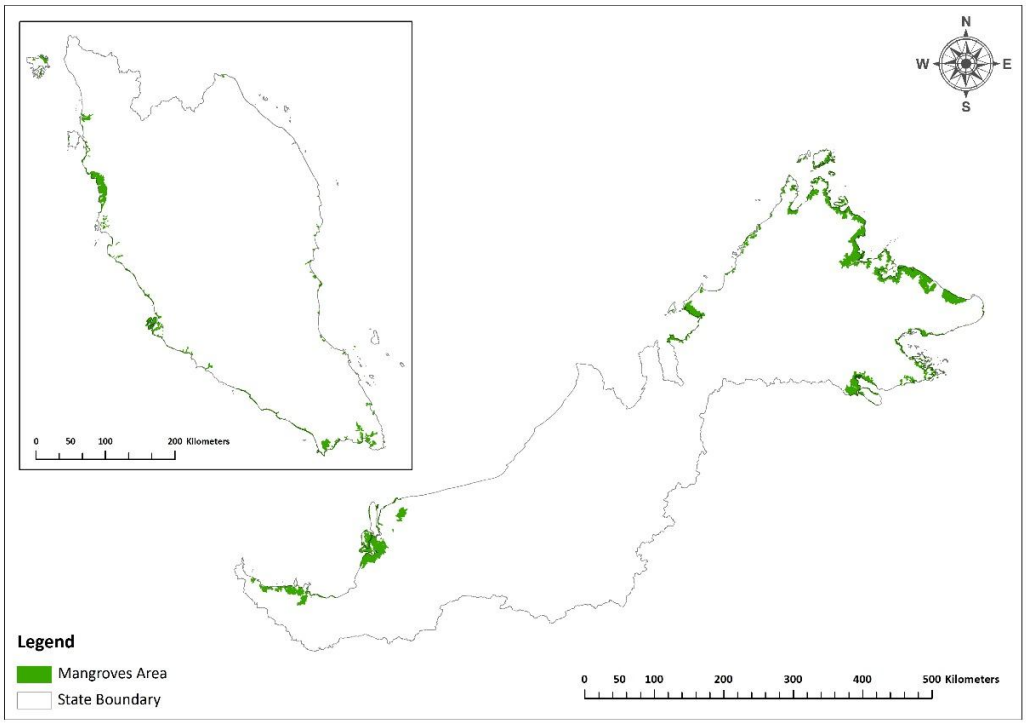

Figure 2: The distribution of mangrove forest of 2005

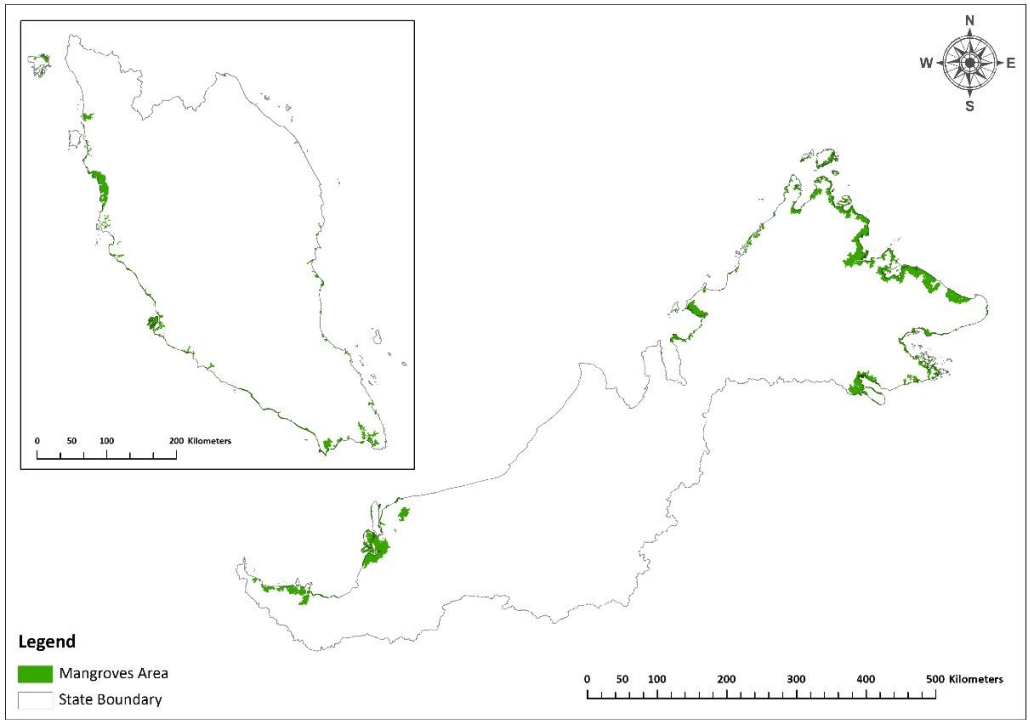

Figure 3: The distribution of mangrove forest of 2010

As the time passed, there are changes in mangrove forest from year 2005 to 2010. Table 2 shown the changes of mangrove forest btween 2005 and 2010 for peninsular, Sabah and Sarawak. Overall, a total of 598,962.64 ha (98.86%) of mangrove forestin 2005 is maintain as mangrove forest in 2010. The efforts of states and federal government in protecting mangrove forest have shown that almost 99% of the mangrove forest is still maintain as mangrove forest.

Table 2: Statistics of mangrove forest changes of Malaysia

Changes/State	Peninsular	Sabah	Sarawak	Total (Ha)
Mangrove to Mangrove	103,496.64	360,752.44	134,713.14	**598,962.22**
Mangrove to Non Mangrove	3,486.33	1,649.55	2,038.43	**7,174.31**
Non Mangrove to Mangrove	3,230.38	606.17	432.84	**4,269.39**

Only 7,174.31 ha (1.18%) of total mangrove forest in 2005 was degraded or converted to other land use. Several factors such as logging activites, urbanization and land conversion to aquaculture activities contributes to the degradation of mangrove forest.This study also shown that there are an increasing of mangrove forest,which about 4,269.39 ha, from year 2005 to 2010. Most of these area are logged and mudflat area. The restoration restroration of logged area and the extension of mudflat along the coastal lines which help mangrove trees to expand and contributes to the extension of mangrove forest.

Conclusion

Remote sensing technology provides a cost effective ways in mapping the mangrove forest. Based on this study, it is estimate that the total mangrove forest of Malaysia for year 2005 and 2010 derived from Landsat TM imagery is about 605,856.91ha and 600,314.85ha respectively. It has been found that the mangrove forest in Malaysia has decreaseabout 0.51% between 2005 and 2010. Accurate mapping and estimation of mangrove forest can be achieved by using higher resolution satellite images such as SPOT, WorldView, Quickbird and others. This study has shown that the use of Landsat TM images can be used to map and estimate the extent of mangrove forest and these data can further be used for monitoring and management towards sustainable forest management and reducing the loss of mangrove forest.

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References

Food and Agriculture Organization of The United Nations (FAO), 2007. *The world's mangroves 1980-2005*.

Department of Statistics Malaysia, 2013. Environmental statistics time series Malaysia 2013. http://www.statistics.gov.my/portal/download_Environment/files/Environmental_Statistics_Time_Series_Malaysia_2013.pdf

Hamdan, O., Khali Aziz, H., and Shamsudin, I., 2010. Kajian perubahan hutan paya laut negeri Selangor, *FRIM Reports,* No 91. 25pp