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Mangrove Accretion and Depletion Monitoring using Remote Sensing Application in Ramsar Convention site of Tanjung Piai, Malaysia

Nursyafikah Hamid[1], Rohayanti Hassan[1], Hishammuddin Asmuni[1], Razib M. Othman[1], Noor Hidayah Zakaria[1], Johanna Ahmad[1], Sim Hiew Moi[1], Nor Azizah Sa'adon[1]

[1]Department of Software Engineering, Faculty of Computing, Universiti Teknologi Malaysia, 81310 UTM Skudai Johor, Malaysia
nursyafikah_hamid@hotmail.com, rohayanti@utm.my, hishamudin@utm.my, razib@utm.my, noorhidayah.z@utm.my, johanna@utm.my, hiewmoi@utm.my, azizahsaadon@utm.my

ABSTRACT

Monitoring mangrove accretion and depletion is crucial especially in coastal region of tropical country. Particularly where major destruction by natural disasters and water pollution occurred that caused critical changes over short period of times. In many recent study, mangrove changes pattern is mostly dependent on the satellite image processing quality measurements and applications. At which the applications are still lacking in monitoring mangrove changes in mainland of Southeast Asia especially to assess mangrove densities. This research attempts to explore the temporal changes for three types of mangrove densities which are high, medium and low for the mangrove forests in southernmost tip of mainland Eurasia, Tanjung Piai. Medium resolution SPOT-5 for years of 2008, 2011 and 2013 were used to assess the mangrove changes supported by medium resolution RapidEye image for year of 2013. Gazette and topography map were also utilized to accurately validate the area of Ramsar site for mangrove forests to be assessed. Accuracy assessment for temporal changes achieved an average kappa of 0.94 and average of 95.95 percent of accuracy value using support vector machine learning classification algorithm. Over the 5 years period, the high density of mangrove extent increased by 49.83 percent from 13.29 percent to 26.49 percent. Medium density area depleted by 45.18 percent from 6.53 percent to 3.58 percent and low density area are also depleted as much as 81.99 percent, from 26.49 percent to 4.77 percent. This research confirmed that these mangroves constitutes the Ramsar site which brings international importance of wetland area were experiencing significant changes for every 3 years and over because of its rough coastal environment as collision point of three main straits. The study recommends continual observations and conservation in the Tanjung Piai mangrove extent using SPOT-5 image to establish trends in mangrove distributions and improvements of ecosystem services for global outreach benefits.

KEYWORDS

SPOT-5, RapidEye, mangrove extent, mangrove density, accretion, depletion.

1. Introduction

Mangroves population was derived as an ecological term that refers to a diverse aggregation of several densities layers in group of trees and shrubs. These vegetation layers form a dominant vegetation communities in the tidal saline wetlands along a coastal area (Lee and Yeh, 2009). Its presence in the tropical and subtropical region (Li et al., 2013; Lee and Yeh, 2009) are considered among the most productive ecosystems in the world (Myint et al., 2008). Provide abundance benefits to local communities and ecological services especially in stabilizing the coastline area to reduce the rough impact of natural disasters such as tsunamis (Li et al., 2013) and monsoons which frequently occurred in Southeast Asia region. In Malaysia, Tanjung Piai mangrove forests on the other hand is located at the southernmost tip of Mainland Eurasia. It has been designated as one of the Ramsar site out of four Ramsar area in Malaysia. As for the global recognition, Ramsar site is recognized as wetland area which has an international importance (Seto and Fragkias, 2007). Its unique and strategic location has become an attractive pit stop to forage for various unique bird species such as Lesser Adjutant Stork, Mangrove Pitta, Mangrove Blue Flycatcher, Buffy Fish-Owl as well as migratory shorebirds and mangrove birds. Migratory birds mostly are depending on the mangrove area for their seasonal migrations. Wetlands are important bird habitats and Tanjung Piai is especially significant because it hosts the globally threatened lesser adjutant stork, known locally as *burung botak*. In fact, the site is the only place in the peninsula where the storks are known to roost. This species is said to number only 5,000 worldwide, and Malaysia is home to about two percent of this population. There are also seven species of mammals of conservation value both locally and globally, which include the flying fox, dusky leaf monkey, long-tailed macaque and the smooth otter. The presence of fireflies at the Tanjung Piai mangroves is another significant factor that helps boost the touristic appeal of the site. Despite the significance of mangrove forests of in Malaysia, specifically in Tanjung Piai, comprehensive and reliable information on their distribution extent is still lacking. So by extending the monitoring techniques of Tanjung Piai mangrove forests for temporal years, would tremendously help in wetland assessment that is comprehensive and regionally consistent for future reference locally and globally.

The main components of mangrove forests in tropical and subtropical regions are mainly green vegetation and shrubs that grows distinctively along the coastline area, brackish estuaries or delta habitats (Suratman and Ahmad, 2012). It naturally grows in several layers based on mangroves specific species. Based on Malaysian Nature Society, the mangroves trees along the Tanjung Piai mangrove forests coastline area are thought to comprise of 20 true mangrove species (species which exclusively grows in mangrove habitats) and 9 associated flora species. In depth, the mangrove species Tanjung Piai mangrove forest are typical of a Rhizophora mucronata-Bruguiera parviflora species which is important ecologically for its intrinsic function in coastal protection against strong winds and sea currents, and Avicennia Officianalis. Most of the high density mangrove area are covered with Bruguiera mangrove genus where the mangrove site consists of 526ha of coastal mangroves. Alongside of the numerous mangroves advantages towards the ecosystems, Tanjung Piai mangrove forests are critically exposed to the accretion and depletion effects especially toward each of the mangrove density level that will cause an ecosystem disturbance. Thus, in order to facilitate the conservation activity of large area for abundance mangrove species in Tanjung Piai, monitoring techniques is claimed to be the most suitable technique to be used (Bortels et al., 2011). Monitoring changes for each of present mangrove species that live in several vegetation layers gives a close perspective in analyzing pattern of mangrove changes in each species. Thus, the problem of lacking in comprehensive, large area studies can be solved by monitoring (Rogan, et al., 2002). In addition, with the variability of seasons and climate change impacts, monitoring global crop and natural vegetation conditions has become highly relevant particularly in insecure areas (Eerens et al., 2014) like Tanjung Piai mangrove forests.

Difficult penetration into thick mangrove forests as well as laborious intensive task for mangrove analysis used by conventional methods (Lee and Yeh, 2009) slowed down the overall process of monitoring. From this issues, rapid progress of remote sensing approach has brought major advantages into density layers mangrove changes detection. Hence, make it possible to analyze the temporal distribution of mangrove species using vast types of remote sensing image especially medium spatial resolution satellite image. In addition, remote sensing has become a standard tool to analyze large scale tropical mangrove forests mainly because, remote sensing technique allow large information to be gathered from the area would otherwise be logistically or practically hard to survey (Vaiphasa et al., 2005). In order to monitor vegetation changes effectively, rapid and accurate mapping of vegetation species are required. Thus, remote sensing imagery like SPOT-5 provides many advantages and has beens frequently used for long-term environmental changes monitoring (Coulibaly and Goïta, 2006). Using remote sensing imagery will not only save times and cost, however it can also increase the possibility of classifying the vegetation distribution through spectral and color analyses (Roberts et al., 2003; Kokaly et al., 2003). Multispectral remote sensing imagery was widely adopted to identify different land cover classes as well as wetlands area to help monitor the condition of natural habitats efficiently for future conservation planning (Tiner et al., 2004).

Mapping vegetation using remotely sensed image needs a proper consideration and precise techniques and processes. Expansion of various remote sensing imagery availability extend the horizon of choices in determining the most suitable data source. Satellite imagery are known for their distinct differences on spectral and spatial resolutions, number of bands, and temporal characteristics. Thus, they are suitable for difference purpose of vegetation mapping and analysis (Xie et al., 2008). Generally, the overall process of vegetation mapping and analysis needs to develop a classification process with proper feature extraction based on pixel spectral colors or values at first for classifying vegetation cover from remote sensed image. From the process, discernible spectral characteristics have to be identified which later be translated into vegetation type in image interpretation process. A good point value in vegetation mapping by using remote sensing technology is the spectral radiances of visible red (RED) and near-infrared (NIR) in addition to others (Xie et al., 2008). Hence, these region of radiance can essentially be incorporated into the vegetation indices (VI) that are directly related to the intercepted fraction of photosynthetically active radiation. These effects of VI could help to identify precisely the density condition of vegetation distribution specifically for mangrove area in Tanjung Piai. From various type of remote sensed imagery, SPOT imagery like SPOT-5 are said to be capable of mapping vegetation at community and species level for mapping various land cover types (Xie et al., 2008).

Since remote sensing approach has been widely used to monitor temporal changes of wetland area distributions at various spatial variation, various techniques has been utilized using available satellite images. For example, Nguyen et al. (2013) utilized three SPOT and a Landsat TM images to assess the spatial-temporal changes in the extent and width of fringe mangrove and changes in adjacent land-use which covers the area of Giang coast, Vietnam. In the study of Lee and Yeh (2009), all dataset were pre-processed using geo-referencing methods without major image quality enhancement followed by classification process using Maximum Likelihood classification (MLC) mangrove vegetation in the Danshui River estuary in Taipei, Taiwan. Based on the study, all imageries were pre-processed though geo-referencing based on high resolution aerial imagery followed by two stages vegetation analysis which are vegetation extraction using Normalized Difference Vegetation Index (NDVI) and classification of mangrove and non-mangrove area using MLC. Different from our study, we utilized two types of medium spatial resolution satellite imagery for assessing mangrove accretion and depletion changes in 5 years' time. The remote sensing source that we used in this study included SPOT-5 imagery for year of 2008, 2011 and 2013 and RapidEye imagery for year of 2013. In this study, image enhancement process took place at the early stage of image processing to accentuate the spectral radiance of NIR and visible red band of both types of imagery. Then, classification process of mangrove area were undergone for 5 types of classes which are high density mangrove, medium density mangrove, low density mangrove, water and developed area class. Lastly, mangrove distribution map is elaborate to analyze the temporal changes of mangrove accretion and depletion for Tanjung Piai mangrove forests.

This paper is structured as follows: Section 2 describes the experimental datasets and study area, Section 3 outlines the image processing stages taken, while Section 4 discusses and analyzes the mangrove distribution from vegetation mapping stage. Finally, Section 5 concludes the paper and provides recommendations for future research.

2. Materials and Methods

2.1 Study area

This study focuses on the large wetland area of mangrove forests at the Tanjung Piai National Park, Johor, Malaysia. It is a cape which is located at the southernmost tip of Peninsular Malaysia, thus making it the most southern point of mainland Eurasia (the combined continental landmass of Europe and Asia). As shown in Fig. 1, its unique location make it a collision point between 3 main straits which are, Tebrau Strait, Malacca Strait and Singapore Strait. Hence, the Tanjung Piai mangrove forests is vulnerable to rough monsoon effect produced from the strait's collision. The location is approximately situated 90 kilometer south of the Johor Bahru City Centre and 1 kilometer off-shore from the main land town of Kukup and Sungai Pulai. Further, the Tanjung Piai natural reserve has been gazette into a National Park and Ramsar List of Wetlands of International Importance. Popularly known as the Ramsar Convention, the convention of wetland is an inter-governmental treaty adopted in 1971 in the Iranian city of Ramsar. To be listed in the Ramsar List of Wetland of International Importance, a wetland area has to fulfil several important criteria by the Convention of Wetlands. Basically, the criteria are based on the characteristics of the wetlands and the wetlands must be representative as rare or unique area and important for conserving biological diversity, that is, if the site has plants or animals that are under threat, indigenous, endemic or support a large population of water birds. Tanjung Piai mangrove forests has been declared as a national park by the Johor Government on September 12, 2001 and currently being as one of the eco-tourism sites. The visitor's center was built on land that had been cleared and used by the locals, while the campsites were built among the mangrove trees. All the boardwalks were built along the edge of the forests for visitor's amenities. In addition for the natural benefits, the walkways at the state park are built around the mangrove forest, thus minimizing the falling of mangrove trees due to any ecosystem impacts. Tanjung Piai mangrove forests supports many threatened and vulnerable wetland-dependent mangrove species as well as birds' species. Bruguiera mangrove genus covers most of the high density area in Tanjung Piai mangrove forests.

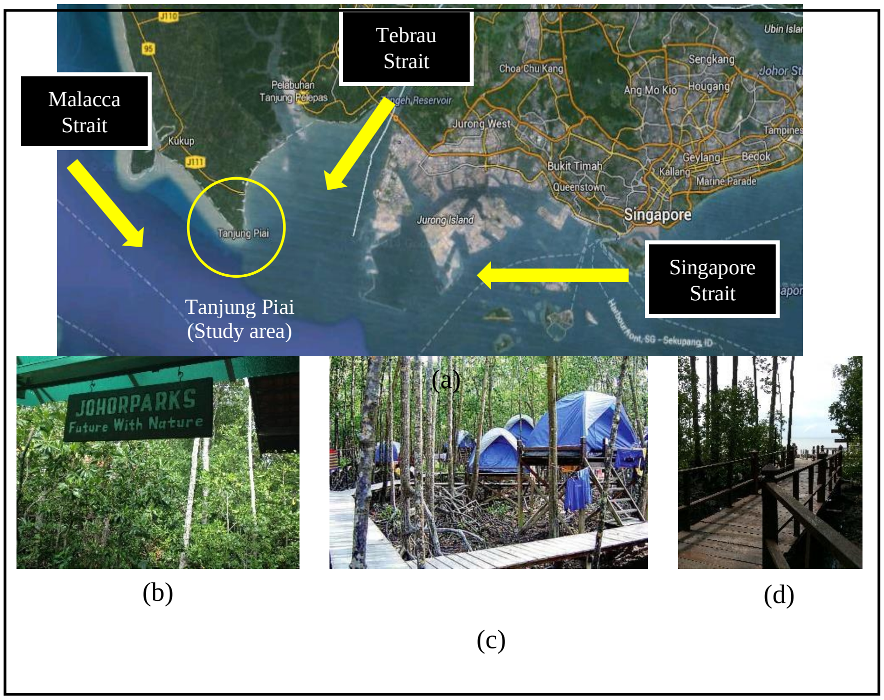


Fig. 1 (a) Tanjung Piai as collision point (b) Visitor's Centre (c) Campsite (d) Boardwalk

2.2 Data sources

Two kinds of medium resolution satellite images were used to derive mangrove and non-mangrove vegetation area for year of 2008, 2011 and 2013: (1) SPOT-5 (date 2008.12.31, 2011.2.14, 2013.5.6) and (2) RapidEye (date 2013.5.25). Imageries were geo-referenced according to the World Geodetic System 84 (WGS84) for its horizontal datum. Both area of interest area size are below 600×600 pixels size. Gazette map of Ramsar convention site for Tanjung Piai is used as reference to delineate and validate the exact area of Tanjung Piai Ramsar convention site. Besides that, topography map of year 2003 is also used as reference to delineate and validate the mangrove area in Tanjung Piai mangrove forests and for selecting the training areas for imagery analysis. To register all imagery for comparison, ground control points were chosen from both imageries. Most of the control points are positioned at distinctive positions such as bridge, buildings and three types of mangrove density area which are high, medium and low density. Hand-held GPS was applied in the field, and the coordinates were collected and input to the imagery used.

2.3 Methods

Two satellite imageries are used to extract the mangrove and non-mangrove area at the Tanjung Piai mangrove forests. 3-layer image enhancement stages and single classification process were applied in this study. Followed by the classified map elaboration for mangrove quantification. For primary analysis, both imageries are processed and enhanced using pan-sharpening method and 3-layer color manipulation approach for image enhancement process. Next, Support Vector Machine classification (SVM) was used to define the mangrove and non-mangrove area from the extracted vegetation area. Fig. 2 illustrates the overall process of this study.

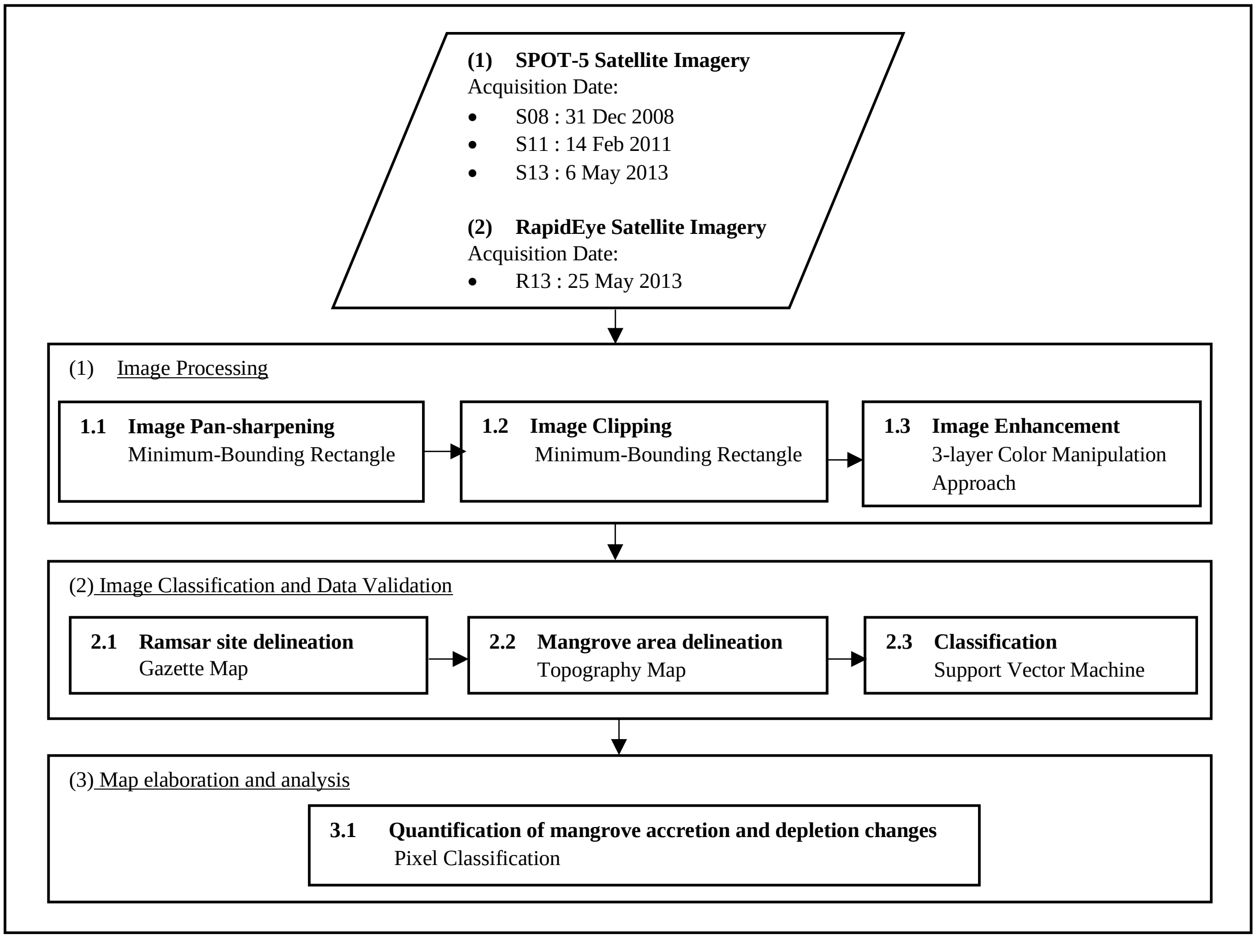


Fig. 2 Overall process of imagery analysis process

2.4 Image Processing

SPOT-5 imagery comes with a low resolution multispectral image which has specific spectral information and high resolution panchromatic image which lack of spectral information. These 2 type of images of SPOT-5 were merged using an ESRI algorithm with red band weight 0.15, green band weight 0.45, shortwave infrared band weight 0.35 and NIR band weight 0.05. This pan-sharpening process produced a higher spatial resolution image to improve the delineation process of vegetation and non-vegetation area. It is desirable to increase the spatial resolution of multispectral image by using the spatial information of panchromatic while retaining the maximum fidelity of spectral information (Shi et al., 2014). On the other hand, RapidEye only come in single medium resolution multispectral image, hence it does not require the pan-sharpening process.

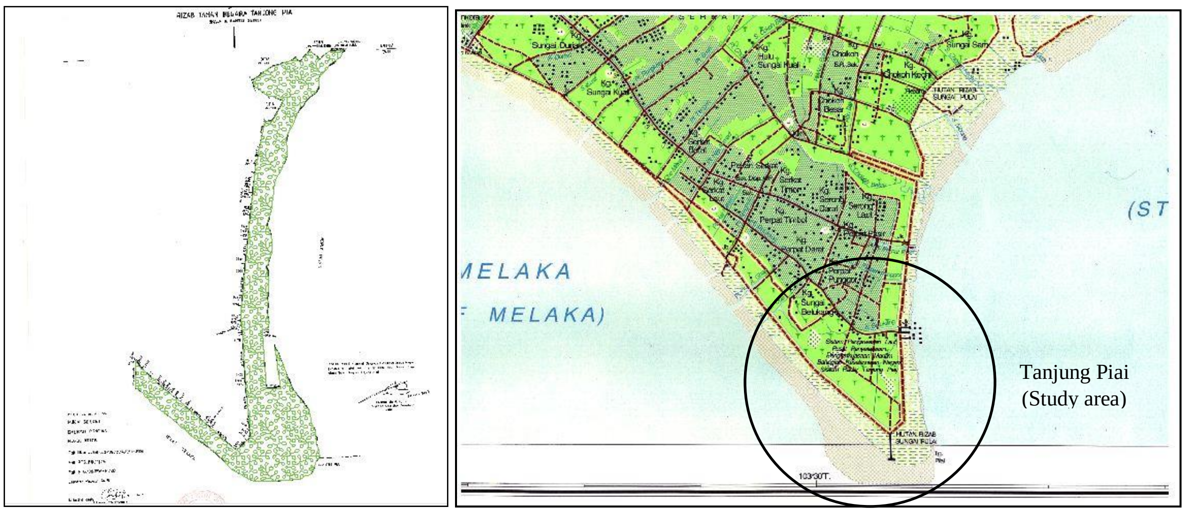
Image samples by area for S08, S11, S13 and R13 were derived through image clipping process in ArcMap 10.1 software by using a minimum-bounding rectangle technique. Images are all clipped below 600×600 pixels size for easier mangrove area delineation process in the next step to focus on Tanjung Piai southernmost tip area only.

Generally, image contrast and brightness enhancement are used to mainly restore and improve the color of single pixel in a digital image for better visual interpretation. In this stage, all datasets were enhanced using 3-layer color manipulation approach to improve pixel colors. This output will improve the extraction process of training data. In the first layer, vegetation and non-vegetation area were extracted using linear decorrelation stretching, Normalized NDVI calculation and NDVI integration into composite image respectively. The overall process of first layer is basically to enhance and manipulate the pixel color of raw images to produce five different classes which are high density vegetation, medium density vegetation, low density vegetation, developed area and water. In the second layer, appearance of shadow is reduced in order to produce sharper image. A High Frequency Emphasis Filter (HFEF) was used on all datasets. The scaling factor used in the HFEF better amplify the high frequency components in terms of contrast and sharpness. Lastly in the third layer, the color of each pixel of all datasets used were improved in terms of brightness. Histogram Equalization (HE) technique were applied to the NIR and RED band of the satellite imagery.

HE was proved to be the most simple and effective technique to improve the image appearance of digital images (Khan et al, 2014). It stretches and flattens the dynamic range of the image's histogram to achieve overall contrast enhancement. The process is followed by Enhanced NIR and RED band integration into a RGB composite image.

2.5 Image Classification and Data Validation

The needs of delineate Ramsar convention site from the satellite imagery ensure an accurate analysis for the area of interest (AOI). Exact area of Tanjung Piai mangrove forests is extracted out by using Ramsar site gazette map. The polygon of Ramsar area was traced precisely by using feature creation in ArcMap 10.1 software. Then, the traced polygon is used to clip the image samples of S08, S11, S13 and R13. In order to achieve a relevant analysis for area of mangrove within the Ramsar convention site. A Ramsar gazette map is vital to prove the correct location of the Ramsar site. Fig. 3(a) shows the gazette map used for the delineation process.



(a) (b)

Fig. 3 (a) Ramsar Convention site gazette map for Tanjung Piai (b) Topography map showing Tanjung Piai as the study area

After the process of delineation of Ramsar site, a delineation process of mangrove area from the clipped image of Ramsar site is produced. This process is to ensure approximately only the mangrove area is analyzed and quantified for accurate analysis of mangrove changes. A polygon for mangrove area is traced from the topography map and is clipped onto the Ramsar area image samples. All image samples undergone this process for temporal changes analysis purposes. Mangrove area need to be delineated from the non-mangrove area for better count of mangrove species without misclassification on non-mangrove area. Fig. 3(b) shows the topography map used to extract the mangrove area for Tanjung Piai mangrove forests.

SVM classification was considered the most suitable classification tool when relatively small samples are taken into consideration (Shao and Lunetta, 2012). In addition, SVM classifies data with greater accuracy, minimizes the error on the training data extracted and has greater ability to generalize (Gautam et al., 2008). In this study, we adopted SVM to quantify the temporal changes of mangrove accretion and depletion which covers the area of Tanjung Piai mangrove forests using different remote sensors. SVM was performed for 5 classes of data feature which area high density mangrove, medium density mangrove, low density mangrove, developed area and water. NIR and RED band of image samples for SPOT-5 and RapidEye image are used to facilitate the mangrove area classification process. Radial basis function (RBF) for kernel type and threshold value of 0.60 were used for the classification process.

3. Results and Discussion

3.1 Imagery processing for vegetation extraction

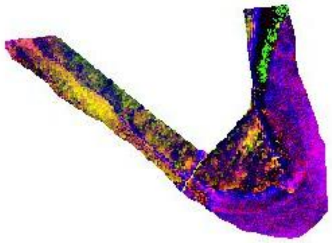
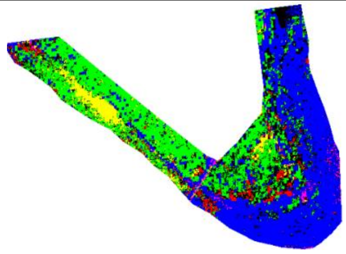
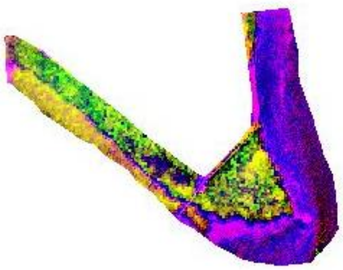
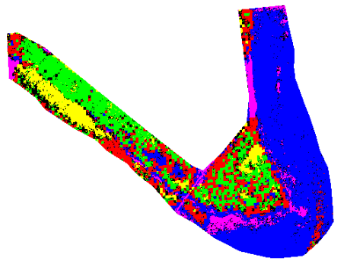
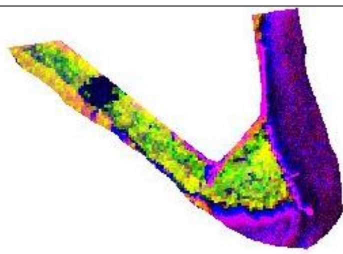
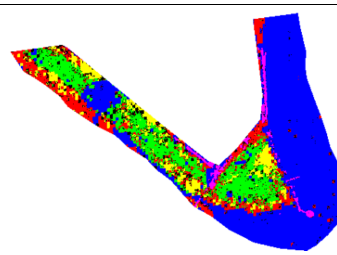
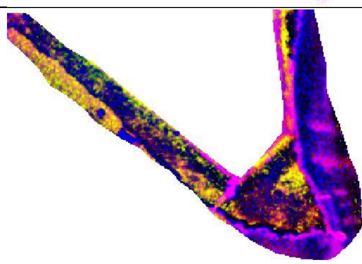
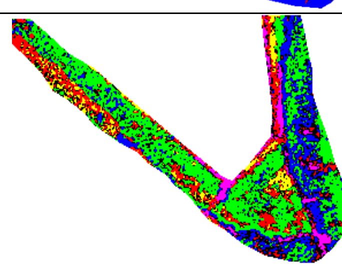
This study focuses on the accretion and depletion changes on three types of mangrove densities which are high, medium and low density at the Tanjung Piai mangrove forests. Therefore, all datasets were enhanced to produce a significant pixel colors to be able to differentiate mangrove area throughout its density level. Table 1 illustrates the imageries after the enhancement process to extract mangrove from non-mangrove area as well as the classification results. Extracted class features were validated using ground truth coordinate point collected by a hand-held GPS to ensure the enhanced image possess the same characteristics as actual mangrove situation. Good imagery processing stage guaranteed a high quality pixel color for mangrove tree identification.

From the enhanced images, five classes which are high density mangrove, medium density mangrove, low density mangrove, developed area and water were extracted based on its specific pixel color. Distinct pixel colors helps to better distinguish the broad class features especially in various density of large mangrove area. Capabilities of multispectral images to produced significant pixel color upon image enhancement process improves the overall process in mangrove changes quantification. In addition, the enhanced imageries ease the overall classification process. The enhanced image produced a digital image with specific color assignment as follows: green color indicating high dense trees or closed canopy, bright yellow representing shrubs of medium to dense tree coverage, golden yellow showing less dense tree coverage or soil, while dark blue and magenta indicating water and developed area respectively. From observations in Table 1, S08 and R13 produced darker and inconsistent pixel colors probably due to very low quality of contrast and brightness from its raw images. These problems may cause by unpleasant weather conditions when the images were captured by the satellite sensors. Nonetheless, it does not give much effects on the mangrove classification process.

In SVM classification process, threshold of 0.06 is the most suitable parameter value for classifying mangrove population area depth into its density since medium resolution satellite imageries are used. Kappa and accuracy were calculated in order to prove the analytical analysis in determining the changes analysis of mangrove area in Tanjung Piai mangrove forest. The high analytical accuracy demonstrated the multispectral digital imagery were highly feasible for analyzing composite image for mangrove analysis. However, analyzing the density of vegetation using digital image specifically for mangrove analysis require a very high quality of spatial resolution of satellite image. Hence, by using only medium spatial resolution satellite image, optimum results can be obtained by using proper image enhancement techniques for vegetation analysis. In this study, the highest overall accuracy was achieved by S13 which is SPOT-5 imagery for year 2013. Kappa and accuracy value obtained were considered very high with 0.98 and 98.35 percent respectively. This is due to high image brightness and contrast quality level obtained at enhanced image level. As seen in Table 1, S13 produced the most desirable pixel color which enable easier extraction of features classes in mangrove. In conjunction for high feasibility to interpret a digital image for mangrove density analysis up to three types of density level, a satellite image need to be in its optimum and suitable level for the contrast and brightness quality. Therefore, a good quality of image contrast and brightness will produce better output for mangrove analysis based on density level like in S13 image.

On the other hand, both S08 and S11 obtained a good value of kappa and accuracy. For S08, the kappa value is 0.78 and accuracy value is 84.03 percent, and for S11, the kappa value is high which is 0.96 and for accuracy value is, 96.75 percent. This is due to optimum level of contrast and brightness level achieved in which produced high intensity of pixel color. Hence, feature classes especially mangrove densities are easier to be extracted to produce better classification results. Conversely, R13 dataset which is RapidEye imagery for year 2013 achieved the lowest kappa and accuracy value of 0.70 and 75.93 percent respectively. This is the effects of lower spatial resolution possessed by the RapidEye image compared to SPOT-5 imagery. However, the enhanced image of R13 still produced similar pixel colors with S13 which indicate the same image characteristics of same year. In conclusion, the image enhancement process was feasible enough for vegetation density classification and that the method was robust enough to adopt in large and inaccessible areas. In addition, for relatively few samples taken for mangrove density classification process, SVM produced a desirable results and having high performance in a way to ensure accurate mangrove changes quantification results.

Table 1 Imageries enhancement and classification results

Image Area	Enhanced Image	Classified Image	Kappa	Accuracy
S08			0.78	84.03%
S11			0.96	96.75%
S13			0.98	98.35%
R13			0.70	75.93%

Legend

Enhanced	**Classified**	**Area**
		High Density Mangrove
		Medium Density Mangrove
		Low Density Mangrove
		Developed Area
		Water

3.2 Mangrove accretion and depletion changes analysis

The clipped area of interest for each image are all based on Topography and Gazette map which approximately determine the mangrove area within the Ramsar convention site of Tanjung Piai. Table 2 lists the total percentage of mangrove area based on densities which covers the study area. The percentage of mangrove covers were calculated based on pixel count after being classified. The total percentage of mangrove area and non-mangrove area were illustrated in Table 2.

Table 2 Percentage of mangrove area for all datasets

Category	Area Percentage (%)			
	S08	S11	S13	R13
High Density Mangrove	43.96	18.87	13.03	26.45
Medium Density Mangrove	12.17	9.68	7.09	8.40
Low Density Mangrove	3.33	18.73	14.73	20.91
Developed Area	1.26	4.49	7.09	4.40
Water	16.92	20.59	29.66	4.40

The mangrove accretion and depletion changes were observed and analyzed. The analysis shows that the mangrove densities at Tanjung Piai mangrove forests changed dramatically from 2008 to 2013. The dramatic changes can be seen throughout five years duration. From analysis, the depletion of high density mangroves took place in each of the years with rate of as much as 70.36 percent. As mentioned before, the unique location of Tanjung Piai mangrove forests itself as collision point gave tremendous effects resulted from rough tide effects. Hence, high density mangrove area located mostly at the extent of mangrove forests which act as barrier for the shoreline area were highly affected by the rough environment. Rhizophora mucronata-Bruguiera parviflora which is important ecologically for its intrinsic function covers most of density level of mangrove area in Tanjung Piai. Hence, based on the analysis of high density mangrove, this species is proven to experience a huge depletion process from 2008 to 2013. This consequences may results in shoreline erosion which probably will demolish the presence of mangrove forests itself as southernmost tip of mainland Eurasia.

Medium density areas of mangroves experienced a depletion process at the rate of 41.74 percent from 2011 to 2013. Most of the medium density area were covered by the Avicennia Officianalis mangrove species. The roots of Avicennia Officianalis is pencil-like pneumatophores emerge above ground from long shallow underground roots. This root types of mangrove become a main factor of sedimentation process of natural ecosystem. Besides, the root systems of the plants keep the substrate firm, and thus contribute to a lasting stability of the coast. Hence, the depletion medium density species of mangrove in Tanjung Piai gave critical effects to the coastline stability. Avicennia species grow in areas endowed with high sunlight, hot and dry conditions and the species are well adapted to arid zones, and therefore it acts as an important shield from solar UV-B radiation. This ability of mangroves makes the environment free from the deleterious effects of UV-B radiation (Moorthy & Kathiresan, l997). In addition, Avicennia Officianalis were valued as timber source as well as the other economic benefits due to its hard tree trunks. Thus, it is assumed that the depletion of this mangrove species which covers medium density area of the mangrove forests certainly gives huge ‘green-house’ impacts.

Low density mangrove areas were found to have undergone an accretion process at the rate of 342.34 percent throughout the 3 year period but experienced a slight depletion changes towards year of 2013 at the rate of 21.36 percent. The accretion process of low density mangroves area probably resulted from replanting efforts by the mangrove conservation team at Tanjung Piai National Park itself. However, replanting effect were informed to have only small success due to rough effects of high tides and oil-spill from the ship port nearby. Besides that, the effects from depletion consequences from high density mangrove species also contributes to the increasing number of low density mangrove population. Based on biologist at the Tanjung Piai National Park, most of mangrove species would only achieved a three centimeters diameter size in 15 years’ time. This situation presume that, a long period of time a are required to developed a strong matured mangrove species which will stand rough environment effects. Therefore, replanting efforts which contributes much of the low density area of Tanjung Piai mangrove forests is undeniably hard to achieve. Results from Table 2 are also shown that, with the increment of developed area from year 2008 to 2013 has become one of the contributing factors for drastic depletion of mangrove ecosystem in Tanjung Piai.

4. Conclusion and Recommendations

In the study, we found that, there were huge loss of mangrove population especially in high and medium mangrove densities which comprise of Avicenna and Bruguiera mangrove genus and increment in low density mangrove population. The drastic changes in mangrove population of Tanjung Piai mangrove forests in such a short period of time (5 years) is because of rough weather factors from the unique position of Tanjung Piai itself, as well as environment pollution. Rapid development of urban area is also one of the main factors that affects the huge loss experienced by the mangrove population. Therefore, there is a need on long term preventive approach to prevent the cause of mangrove population degradation especially towards the specific mangrove density that contributes to various ecosystem benefits. While the mangrove conservation efforts continues, there is always a need of immediate action plan and with real dedication from all responsible parties. As Tanjung Piai being gazette as one of the Ramsar convention site with international importance, there are plenty of efforts taken by the Malaysia's government to save the mangrove forests from further destructions. However, more awareness of the protection law need to be considered since the ecosystem of mangrove gives large benefits to environmental benefits. Specific conservation planning on mangrove densities need to be seriously considered to attain much more significant advantage on individual mangrove species ecosystem benefits.

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