# Implementing MTEN's Recommendation: Identification Mapping and Reclassification of East Coast Mangrove Forest Using Aerial Photography, Remote Sensing and Geomorphological Techniques

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Key words:Mangrove forest ,Remote Sensing, Aerial Photographs,Geomorphology,Mapping

## Introduction

The National Economic Action Council (MTEN) in its National Economic Recovery Plan- Agenda for Action under Forest Issues (MTEN, 1998) recommends that:

"3. Mangrove and Nipah Forests at river estuaries should be classified as Soil Reclamation Forest because of the erosion control function they serve and their sensitivity to disturbance".

If the recommendation by MTEN, as stated above, is to be seriously implemented, a proper study must first be conducted to address some implementation problems that may arise. Some of the implementation problems envisaged are: Land is under State jurisdiction; not all mangrove areas can play a role in soil reclamation and the control of erosion and inaccurate information concerning mangrove (Acreage, Status & Vegetation diversity).

In Peninsular Malaysia, the total extent of mangrove forests is about 103 203.11 ha. Of the total, about 88,406.61 ha or 85.6% of the mangrove forest in Peninsular Malaysia are gazetted as Permenant Forest Reserve (PFE) while the remaining 14, 796.5 ha (14.4%) are Stateland Mangrove (Chan et al, 1993). The mangrove forest areas are found mainly on the West Coast (Johor, Negeri Sembilan, Malacca, Selangor, Perak, Kedah, Penang and Perlis) compared to smaller mangrove areas occur on the East Coast (Pahang, Terengganu and Kelantan). The total extent of mangrove forest in the East Coast is about 6777 ha. Of the total, 4640 ha are located in Pahang, 1987 ha in Terengganu and the remaining 150 ha in Kelantan (Shaharudin et a, 2001).

Most of the mangrove forests in the East Coast are found in small area and fragmented along the riverbanks and river mouths rather than right along the coast. Although mangrove forest areas in the East Coast are less extensive, they still contribute signification to the ecological and environmental value functions in the coastal and estuarine areas. Realising the important of mangrove forests, by using aerial photography, Remote Sensing and Geomorphological techniques were conducted for the East Coast of Peninsular Malaysia to identify, mapping and reclassification of mangroves area.

## Materials and Methods

### Aerial Photography Analysis

Both black and white panchromatic photography of areas covered by the study will be analyzed using mirror and pocket stereoscopes in the laboratory and field respectively. Topographic maps will be used in aiding the interpretation of aerial photos in the field. Based upon texture and tone of the photo images, the mangrove forests will be classified. Tones refer to shades of gray as seen on a black and white aerial photographs and can be classified into light medium and dark. Texture, on the other hand, refers to structure of individual objects visible on aerial photos and can be classified into coarse, medium and fine. The classifications based on the aerial photos will be used to produce a provisional mangrove forests type map.

### Remote Sensing Analysis

For remote sensing images recent Landsat TM image will be used using digital image processing software. Image enhancement with band combination of channel 4, 5, 3 (RGB) will be done to make visual interpretation. Classification of image using Maximum Likelihood Classifier will be carried out to determine the classification for land use and land cover following Land and Survey Mapping Department land use classification scheme (Ministry of Agriculture Malaysia, 1992). The mangrove forests land cover class will be further investigated if it could be classified into level III. Ground sampling will be done to confirm the accuracy of the classification as needed to provide a better understanding of the spectral signature of various types of land use/cover in the study area.

### Geomorphological and environmental assessments.

Topographic maps will be used initially to determine the location of the mangrove area in relation to estuaries and sea. In the field the shear strength of mangrove soil will be measured using shear vane In addition, the density of roots at different plots using normal line transects will be determined to assess its ability to mitigate impact of currents and waves. The general status of the mangrove area will also be assessed in the field to ascertain whether it is in a degraded or pristine condition. Sediment markers will also be buried at each plot to assess the sediment trapping ability of each mangrove area.

### Reclassification

Based on all the work that are completed above, a reclassification of mangroves in accordance to their function will be done and special emphasis will be given to mangroves that fulfills the role of erosion control and soil reclamation.

## Results and Discussion

Generally, there are two categories of mangroves found in the various states in Peninsular Malaysia; mangrove forest reserves and stateland mangrove forests. Mangrove forest reserves are gazetted as permanent reserved forest (PFR) under the National Forestry Act and managed by Forestry Department for sustainable forestry production. Until now the stateland mangrove forest on the East Coast, which are small and fragmented in size have not been fully studied. Mostly these mangrove forests occur in small area and often fragmented along many rivers and estuaries in the state of Pahang, Terengganu and Kelantan.
Pahang
The coastline of Pahang Darul Makmur has a total of 2,600 hectares of gazetted mangrove forests (Jabatan Perhutanan Negeri Pahang, 2000). Most of the mangrove communities were distributed in sheltered areas over 6 major rivers namely: Sg. Kuantan, Sg. Bebar, Sg. Miang, Sg. Pontian, Sg. Rompin, Sg. Pahang Tua, Sg. Penor and Sg. Endau. In addition, small fragments were also observed scattered in Sg. Chendor, Sg. Dua, Sg. Kempadang, , Sg. Ular, Sg. Balok and Sg. Cherating.
The mangroves vegetation was mainly dominated by the species of *Rhizophora, Avicennia* and *Sonneratia*. Other forest types were *Nypa, Excoecaria sp.* and *Xylocarpus sp*. These species mainly found further inland and usually associated with dryland vegetation such as *Hibiscus* and *Planchonella*. Portions of the mangrove areas have been designated by the State Forestry Department as a permanent forest reserve (PFR) and restricted only for conservation purposes.
Satellite imagery also has the advantageous to overcome the limitation of manpower and time restrictions for large scale survey of mangrove ecosystem. Remotely sensed data in mangrove mapping application could be used for updating the existing mangrove forest map and consequently providing an efficient management plan for such natural resources. For example, the PFR compartments of Kuantan district that were designated in this area since 60's only covered portions of mangrove area especially for the Rhizophora dominated stand. This is because during that time, the terms of mangroves were only emphasized on the Rhizophora species and therefore other forest types were not considered for gazettment. From the classification analysis, it was clearly showed that most of the compartments are located in the Rhizophora forest. In order to protect and conserve larger area, more mangrove areas detected from this automated classification were suggested for gazettement purposes. The degraded mangrove areas were also identified from the classification map. The mangrove areas in some compartments are no longer existing and now converted to housing and jetty areas.
Terengganu
The coverage of mangrove forest along riverbanks and estuaries at Sungai Kemaman, Sungai Kijal, Sungai Kerteh, Sungai Paloh, Sungai Cukai, Sungai Kemasik, Sungai Batu Tampin and Sungai Penunjuk were 177.9 ha, 70.68 ha, 35.7 ha, 28.71 ha, 23.6 ha, 10.0 ha, 6.73 ha and 4.38 ha, respectively. Generally exclusive species of mangrove tree could be identified from combination of their characteristics root, leaves, flower, fruit and stem. The mangrove forests in this classes is tipically made up of six major families: Rhizophoraceae (Rhizophora, Bruguiera, Kandelia and Ceriops), Verbenaceae (Avicennia), Lythraceae (Sonneratia), Combretaceae (Lumnitzera), Euphorbiaceae (Excoecaria) and Palmea (Nypa).
Kelantan
So far, there are no mangrove areas have been gazetted as forest reserve in state of Kelantan compared to states of Pahang (2,364 ha) and Terengganu (1295 ha). In total, there are only 150 ha of stateland mangrove forests were recorded in the state of Kelantan (Shaharudin et al, 2001). There are no accurate figures available for distribution of mangrove forest in Kelantan because no information was compiled by any specific agencies. The management of Kelantan Forestry Department was only focus to the inland forest for sustained timber production.
However, the detail preliminary survey showed that more stateland mangrove forests are present in state of Kelantan especially along the Tumpat Delta. Analysis by aerial photograph shows that a total of 744.83 ha mangrove forests situated in Tumpat Delta. These stateland mangrove forests are under the jurisdiction of State Government and not managed by Forestry Department. Illegal cutting and conversion to other uses are the main stresses that affect the mangroves of Tumpat Delta. The ground survey shows that they have a high diversity species of mangrove forests. In total, there are 10 exclusive and 17 non-exclusive mangrove species reported to be occurring around the Tumpat Delta.

## Conclusions

There are many information of mangrove forests of the East Coast and more accurate interpretation could be obtained by using Aerial Photograph, Remote Sensing and Geomorphological techniques. For the Pahang mangrove the use of remote sensing technique is more practical because it was proved to give a good discrimination of species composition for application in mangrove forest management especially at operational level. For the input data, Landsat TM satellite are much more preferable for vegetation monitoring and mapping especially at regional and local scales because of it higher image resolution, sharper spectral separation and cost effectiveness.

The classification of mangrove forest types using aerial photograph and geomorphological techniques were suitable and practical for management planning in Terengganu and Kelantan mangrove forests. The diversity of the species vegetation, uniqueness and function of mangrove can be utilized to convince the respective state governments that some area of mangroves, although alienated as forest reserves for erosion control can still be utilized in the development of the eco-tourism industry.

## Benefits from the study

From the study, the three East Coast States: Pahang, Terengganu and Kelantan gain information on the details and location of stateland mangrove forest. Previously these stateland mangroves where not mapped and therefore no management plans were formulated for these stateland mangroves. For the mangroves forest resources of Pahang, Terengganu and Kelantan, information on the mangrove forest types was made available to the responsible agency. That is the State forest department.
The State agency also benefited through the availability of information for formulating mangrove forest management plan, e.g the mangrove forest type distribution, the extend of each forest type and etc.

## Patent(s), if applicable: None.

## Stage of Commercialization, if applicable:
none

## Project Publications in Refereed Journals

1. Sulong I, Mohd Lokman H, Razak Z, Kamaruzzaman Y, Vijender PRJ, and Zoo Fadly H. 2001. Study on the Distribution of Mangrove Forest by Remote Sensing of Kemaman District, Terengganu. Malay. For. 64(1): 35-43.

2. Sulong I, Mohd-Lokman H, Kamaruzzaman Y, and Seng A. 2001. Aerial Photo-interpretation of Mangroves in Tumpat Kelantan. Malay. For. (In press)

3. Mohd-Suffian I, and Sulong I. 2001, "Comparative study vegetation indices for the mangrove vegetation mapping". Paper presented at the Second International Conference on the Straits of Malacca. The Bayview Beach Resort, Penang. 15-18 Oct. 2001.

## Project Publications in Conference Proceedings

1. Norani Abdul Samad. 1992. Practical application of plant diversity for pest management in chilli ecosystem. In: Proceedings of the Persidangan Ekologi Malaysia 1, 1992; p127-132.)

2. Sulong Ibrahim. 2001. "Assessment of mangrove forest distribution in Kuantan River using unsupervised classification and ground truthing" Paper presented at Regional Symposium on Natural Resource Management, Kuching, Sarawak. (15-19 October 2001)

## *Graduate Research*

| Name of Graduate | Research Topic | Field of Expertise | Degree Awarded | Graduation Year |
|---|---|---|---|---|
| Mohd. Tarmizi Khalid | Classification and Distribution of Mangrove Forest Using Aerial Photograph and Remote Sensing Techniques. | | Bachelor Science (Marine Science) | 2001 |
| Razak Zakariya | Remote Sensing and GIS Application for Land Cover Changes in the Management of Coastal Area (Mukim Kuala Kuantan) (Chairman) | | Bachelor Science (Marine Science) | 2001 |

**IRPA Project number01-02-04-0395**
**UPM Research Cluster:AFF**