# MANGROVES DISTRIBUTION IN BANGGI ISLAND, SABAH.

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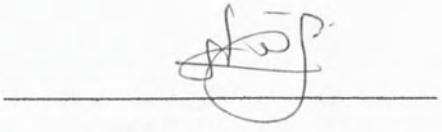

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## ABSTRACT

A study of mangroves distribution was conducted in Banggi Island using remote sensing applications and field observations. Total of 57 locations were selected as ground survey stations and observations data were applied to unsupervised and supervised SPOT 5 image. The study aims to map and quantify total area of mangroves cover at different part of Banggi Island. Result show that the mangroves in Banggi can be discriminated into 2 different groups which several mangroves genus assimilated in the same group. Effects of overlapped reflectance between each genus were minimized with additional spectral reflectance data of each genus. Each genus show significant spectral reflectance and determined as its specific spectral signature with total 87 individual leaves sampling. Global Positioning System (GPS) radius errors for each station were analyzed using distance analysis for validating the field data. The initials accuracy of unsupervised image was 10.08% and improved to 100.00% after supervised classification and ground survey data were applied in term of genus grouping.

# ABSTRAK

Kajian terhadap taburan hutan paya bakau telah dijalankan di Pulau Banggi berdasarkan kepada aplikasi *Remote Sensing* dan data kerja lapangan. 57 lokasi telah dipilih sebagai stesen kajian dan data daripada kerja lapangan telah diaplikasikan kepada imej SPOT 5 *unsupervised* dan juga *supervised*. Objektif kajian ini adalah untuk memetakan dan mengira litupan hutan paya bakau berdasarkan genus yang berlainan pada bahagian pulau yang berbeza. Keputusan kajian menunjukkan hutan paya bakau di Pulau Banggi dapat dikelaskan kepada dua kumpulan dan beberapa genus bakau yang berlainan dapat dikelaskan dalam kumpulan yang sama. Kesan pantulan spektrum yang bertindih diantara genus bakau dapat dikurangkan dengan data tambahan daripada pantulan spektrum yang spesifik oleh setiap genus bakau. Setiap genus bakau telah menunjukkan ciri-ciri pantulan spektrum yang signifikan daripada 87 persampelan secara individu. Ralat daripada GPS (*Global Positioning System*) di setiap stesen dianalisa menggunakan *Analisa Jarak* untuk pengesahan data kerja lapangan. Ketepatan awal bagi imej *unsupervised* adalah 10.08% dan diperbaiki kepada 100.00% setelah klasifikasi *supervised* dan data kerja lapangan diaplikasikan untuk pengkelasan genus.

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## LIST OF SYMBOLS

| | |
|---|---|
| N | North |
| E | East |
| W | West |
| S | South |
| °C | Degree Celcius |
| SPOT | *System Pour l' Observation de la Terre* |
| $H_2S$ | Hydrogen sulphide |
| Ref | Reference |
| Y | Yellow |
| M | Maroon |
| LG | Light Green |
| DG | Dark Green |
| R | Red |
| ~ | Almost |
| GCP | Ground control point |
| X | x-axis |
| Y | y-axis |
| NIR | Near infrared |
| SWIR | Short wavelength infrared |
| Sp. | Species |
| NDVI | Normalize difference vegetation index |

| | |
|---|---|
| $m^2$ | Square meter |
| $\pi$ | Phi |
| % | Percentage |
| • | Marker for diversity frequency- 'found' |
| Log | Logarithms |
| $\lambda$ | Lambda |
| nm | unit-Nanometer |
| µm | unit-Micrometer |

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# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction to mangroves and monitoring approach

Mangrove is a typical vegetation type occupying the intertidal areas and lower reaches of many rivers. Its support various flora and fauna, including many species that occur nowhere else. Mangroves are also very important as nursery sites for many marine organism species and for the commercially important activities.

Despite its role as one of the most important ecosystem, mangroves are vulnerable due to natural phenomenon and anthropogenic activities. Thus, monitoring the changes of mangroves in terms of its expansion or degradation is considered as essentials. Monitoring and mapping mangroves distribution may derive to better solution in managing it over time. Field observation and remote sensing application are two methods that have been used for this purpose.

Field observation is a manual in-situ observation based on dominant species and its features at stated stations. This manual mapping procedure may conclude the

distribution result based on certain dominant species in certain sections, locations or areas. The features of mangroves may become parts of the map. On the other hand, remote sensing defines as a science in obtaining information about an object (or phenomenon) through the analysis of data by devices that does not contact with the objects. It is based on electromagnetic energy reflected or emitted by that object (Gang and Agatsiva, 1992). Compare to field observation methods, remote sensing application are more cost-effective and reliable especially at large scale of area. The ability of remote sensing is part of its sensors resolution and image processing application, which make monitoring-mapping become easier. However, both methods are complimentary and needed for better mapping-monitoring result.

In remote sensing, variety of sensors has been used for studying mangroves. SPOT 5 which have improved spectral resolution of multi-band data in its sensors provide increased spectral information allowing better differentiation and also improved pixel accuracy of land cover and vegetation determination. It becomes one of the common sensors in mapping mangroves (Green *et al.*, 1998).

## 1.2 Study Area

Banggi Island located on the northern part of Sabah, in the district of Kudat that ranges from 7:10° N – 7:38° N in latitude and from 117:05° E – 117:30° E in longitude. The main temperature on this island that have tropical climate varies from

23°C - 33°C (74 – 90 degrees Fahrenheit). The mangroves of Banggi Island are among the most biologically diverse and undisturbed (Aimimuliani, 2005).

On this island, mangroves found located near the river and interspersed with coastal shrubs along the coast. The largest mangroves cover located at the eastern part of the island called 'Sadong'. There are few mangroves concessions that involved cutting of *Rhizophora* sp. and *Xylocarpus* sp. around the island mostly by villagers for building materials.

## 1.3 Objectives

The objectives of this project are:

1. To study the distribution of selected mangroves genus in Banggi Island using field observation and remote sensing methods.

2. To map and quantify the total area of mangroves coverage at the eastern, western, northern and southern parts of Banggi Island using SPOT5 (10-meter resolution) data.

## 1.4 Significances of the study

Mangroves vary in species found either in mixing or in different zonations. Its distribution is widespread on the island. Remote sensing applications found very useful for mapping purpose. However, the ability of SPOT5 sensors to discriminate between various species of vegetation may be limited (Green *et al.*, 1997). By combining the method of remote sensing and field observations, the status of mangrove distribution can be map up to its genus. In addition, the zonations of mangrove also can be determined. The result of this study may be used for future study to monitor the changes of mangroves in terms of its genus and species coverage.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Mangroves

### 2.1.1 Mangroves and its features

Mangroves are trees that have ability to live in the saline environment. It commonly spreads within tropical and subtropical sheltered area (between latitude 32°N and 38°S), with optimum temperature for growth between 25°C - 30°C (seasonal not more than 5°C) and water salinities from 10 to 30. They constituent very minor portion compare to the total marine plant community. Mangroves are one of the marine members of sub-kingdom spermatophytes. Its have complex flowering and germination system. The seeds germinate while still on the parent plant (viviparous) and produce elongated hypocotyls that later become the roots. When the seed mature, it will drop into the substrate and planting itself or disperse by the current (Stowe, 1983, Fromard *et al.*, 2004).

According to Green *et al.* (1997, 1998), the ability of mangrove to live in saline environment derive from special characteristic of its complex roots system. These roots spread and grow on soils that are usually in fine-grained form. Certain species has secondary roots growing up from the main roots into the air called *pneumatophore*. The complexities of the plants allow mangroves to live in the condition of high salt concentration and saturated soils (less oxygen, more hydrogen sulphide, $H_2S$) (Vibulsreth and Murai, 1991, Hilconda and Ernani, 1997).

Some of the mangroves have salt-excreting gland. As the roots limit the intake of salt (exclusion), the glands excrete the salt through tiny pits on the upper surface of the leaves. This two special ability allow mangroves to have solutions for better water absorption. All the adaptations are caused by its intertidal habitat (receiving high salinity from seawater and low salinity from river) which required them to tolerate. The plant itself has high osmotic pressure in their cells to withstand the salt (Ewusie, 1974). Hilconda and Ernani (1997) highlight the root characteristics as importance anchorage during storm winds. Each species have different types of roots profile in the different zonations and able to form pure stands of the same trees without mixing with others.

The major groups of genus for mangroves in Malaysia are *Rhizophora*, *Avicennia, Sonneratia, Brugeira*, *Xylocarpus*, *Ceriops*, and *Nypa*. *Rhizophora* recognized by its 'stilt' or 'prop' roots that grow out from the tree to the substrate with numerous lateral roots to provide firm anchorage in the mud. The seed grow 8 to

12 inches in length while still attach to parent tree and called *propagule*. *Avicennia* has normally roots system that penetrates into the ground, holding the tree upright. It has an extension roots with pores on it in a *pencil-like* form. These secondary roots provide them to absorb oxygen above the water surface. Usually, *Avicennia* found growing on the landward area or sheltered bay. *Sonneratia* which has almost roots system with *Avicennia* are easily recognized growing seaward. Progressing landward, *Brugeira* with *knee-like* roots prefer clay soils and highest high tides zone. It sometimes merges with *Ceriops* that occupied most landward area. Along river or in estuaries, groves of the creeping palm *Nypa*, usually found (Ikhwanuddin and Oakley, 1999).

### 2.1.2 The importance of mangroves

While inhabit intertidal zone in coastal area, mangroves play important role in reducing wave energy. The accretion of mud and the spreads of seedlings will form a bay or lagoon. Promoting deposition, mangroves will decrease the speed of current and prevent the shoreline erosion. From hydrological view, the mud banks also cause drainage to follow definite channel. These may reduce erosion act by water-flows from both land and sea (Anikouchine and Sternberg, 1981).

Moreover, beside its physical supports, mangroves provide shelter for nursery ground and habitat for various marine organisms. The roots became hiding place for creatures swimming and crawling by. It is the best place for juvenile fish to grow with

less harm from the predator. The trees itself provide a place for creatures to perch or permanently attach (Coulombe, 1984).

Their role as important habitat not only supports marine and aquatic organisms, but also huge array of terrestrial species. Their canopy is suitable for birds, bugs, reptiles and certain types of exotic animals (Porrit, 1991). According to Coulombe (1984), its decaying leaves release nutrients into the soils and enriched it. Thus, landward area with this soils allow vary species of plants to grow.

The various mangroves roles make this ecosystem suitable as a wildlife reserve. It provides food supply for human and marine community (Versoza, 1986). From economic view, Vibulstreth *et al.* (1991) stated that mangroves are valuable for firewood, charcoal and construction materials. It is based on its characteristic that is hard and strong even for a long time. Mangroves area is also suitable for culture industries especially for shrimp and mud crabs.

### 2.1.3 Problem faced by the mangroves

According to Porrit (1991), Ashton and Macintosh (2002), mangroves are increasingly disturbed by human activities for land reclamation, timbers, aquaculture and others. These activities in mangroves area return high profit especially in culture industries and timber for building materials. Their ecological benefits in balancing the

ecosystem may collapse if such activities cannot be controlled (Rasolofoharinoro *et al.*, 1998).

Its depletion may affect not only the plants and animals, but also the surrounding people. Microclimate of the area may change. The lack of mangroves vegetation may be seriously affected the production of aquaculture industries around. Offshore fisheries may affect by decomposed mangrove litter due to decreasing mangroves trees (Jinnahtul, 1989). Less mangroves vegetation may reduce freshwater flow to the area and disturb its channel. This can cause lots of small rivers to the sea, and affect local people especially villagers near the coastal area (Syed and Hussin, 2005).

Green *et al.* (1997) stated that the expansion and degradation due to all these problems need to be monitored. The effective management of this sensitive zone may require accurate data for monitoring and mapping purpose. This can be achieved using suitable field observation and remote sensing application.

## 2.2 Remote sensing and its application

### 2.2.1 Remote sensing technology

According to Gang and Agatsiva (1992), remote sensing is the science or analysis based on electromagnetic radiation (reflected, emitted, scattered, or

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