COMPARATIVE STUDY OF MANGROVE COMPOSITION AND DIVERSITY IN KUDAT AND PITAS, SABAH

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SCHOOL OF INTERNATIONAL TROPICAL FORESTRY
UNIVERSITI MALAYSIA SABAH
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ABSTRACT

COMPARATIVE STUDY OF MANGROVE COMPOSITION AND DIVERSITY IN KUDAT AND PITAS, SABAH

The objectives of this study were to compare the floral diversity, species composition of mangrove plants species and compare the natural regeneration between disturbed and undisturbed mangrove forest in Kudat and Pitas, Sabah. The most common mangrove species identified were *Rhizophora apiculata, Rhizophora mucronata, Sonneratia caseolaris, Ceriops tagal* and *Avicennia marina.* A total of 120 plots were established; each with the size of 10 x 10m with total area of 12 ha. There were 3 belt transects established randomly with each of them consists of 10 subplots respectively. The highest Important Value Index (IVI) recorded in undisturbed mangrove area in Kudat was *Rhizophora apiculata* with 211.75 % while *Sonneratia caseolaris* is the highest recorded in Pitas with 92.54 %. The highest IVI recorded in disturbed area in Kudat was *Rhizophora apiculata* with 67.68 % while 91.89 % *Sonneratia caseolaris* recorded in disturbed area in Pitas. The C*j* value for disturbed and undisturbed area in Kudat was 0.68 while 0.74 in Pitas. Less similarity of mangrove species found in these areas. The C*j* value for undisturbed area in Kudat and Pitas was 0.18 while 0.12 in disturbed area in Kudat and Pitas. More similarity of mangrove species found in these areas. The number of regeneration per hectare in undisturbed mangrove area in Kudat and Pitas also recorded lower number with only 601.7 and 803.3 compared to 2358.3 and 1473.3 in disturbed mangrove area in Kudat and Pitas. The small number of regeneration in undisturbed area in Kudat and Pitas could be the shading effects created by parental canopy that prevent light from reaching the ground.

ABSTRAK

Objektif bagi kajian ini adalah untuk membandingkan diversity, komposisi spesis tumbuhan bakau dan membandingkan regenerasi semulajadi di kawasan hutan bakau terganggu dan tidak terganggu di Kudat dan Pitas, Sabah. Spesis bakau yang banyak ditemui adalah Rhizophora apiculata, Rhizophora mucronata, Sonneratia caseolaris, Ceriops tagal dan Avicennia marina. 120 plot dengan keluasan 10 x 10m dibina dengan jumlah keseluruhan plot bersamaan dengan 12 hektar. 3 jalur transek dengan 10 plot di dalamnya dibuat secara rawak di kawasan hutan bakau terganggu dan tidak terganggu di Kudat dan Pitas. Spesis bakau yang mencatatkan Important Value Index (IVI) paling tinggi di kawasan tidak terganggu di Kudat adalah Rhizophora apiculata dengan 211.75 % manakala Sonneratia caseolaris paling banyak ditemui di Pitas dengan 92.54 %. Spesis Rhizophora apiculata juga mencatatkan IVI yang paling tinggi di kawasan terganggu di Kudat sebanyak 67.68 % manakala 91.89 % spesis Sonneratia caseolaris ditemui di kawasan terganggu di Pitas. Indeks C_j di kawasan terganggu dan tidak terganggu bagi Kudat mencatatkan nilai yang tinggi dengan 0.74 dan 0.80 di Pitas. Spesis yang ditemui di kawasan ini mempunyai kurang persamaan.Indeks C_j di kawasan tidak terganggu di Kudat dan Pitas ialah 0.18 dan 0.12 di kawasan terganggu di Kudat dan Pitas. Spesis yang ditemui di kawasan ini mempunyai banyak persamaan. Regenerasi per hektar di kawasan tidak terganggu bagi Kudat dan Pitas juga mencatatkan nilai yang rendah dengan hanya 601.7 dan 803.3 manakala 2358.3 dan 1473.3 di kawasan terganggu bagi Kudat dan Pitas. Jumlah regenerasi yang kurang di kawasan tidak terganggu di Kudat dan Pitas adalah disebabkan oleh pokok-pokok matang yang menghalang cahaya daripada sampai ke permukaan tanah.

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%	Percentage
ha	Hectare
m	meter
mm	milimeter
IV	Important Value
Kg.	Kampung
RA	Relative Abundance
RD	Relative Density
RF	Relative Frequency
Sg.	Sungai

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Mangroves area occurs in the waterlogged, salty soils of sheltered tropical and subtropical shores. Mangrove swamps are found along tropical and subtropical coastlines throughout the world, usually between 30º N and 30º S latitude (Tomlinson, 1986). Mangrove forests currently occupy 14,650,000 hectare of coastline globally with an economic value on the order of USD 200,000 until 900, 000 per hectare (Alongi, 2007). The mangrove is a remarkable piece of biology which evolved from land trees to adapt to its environment. The best developed mangroves grow along humid sheltered tropical coasts for example in the delta systems of major rivers like Ganges, Mekong and Amazon (Mastaller, 1997).

According to Spalding *et al* (1997) even though mangrove forests are globally decreasing, fortunately Malaysia's mangroves can still be categorized as less encroached. Nonetheless between 1980 and 1990, the mangrove forest reserves areas have decreased at an upsetting rate of 12% per year. Mostly mangrove forest converted into agriculture, urban development, shrimp ponds farming and deforestation (Spalding *et al*. 1997).

The Forest Enactment 1968 of Sabah has classified 93% or 317,423 ha of 341,000 hectares of mangrove forests in Sabah as Permanent Forest Reserve (Class V) (Ong & Petol 2007). Class V is a type of forest supplying mangrove timber and other produce to meet the general trade demands. The Rhizophora sp. is the most commonly harvested, and the products range from firewood to fishing stakes.

Sabah Forestry Department (SFD) considered mangrove forests as conservation forests with limited utilization such as, sustainable production for pilling poles, charcoal and fuel-wood for domestic consumption over the past three decades (Ong & Petol 2007). Sabah Forestry Department now focuses its

restoration programs in mangrove reserves along the coastal areas throughout Sabah such as Sandakan, Semporna, Kunak, Lahad Datu, Kota Kinabalu (Putatan and Tuaran), Kota Belud, Tawau and Beluran districts.

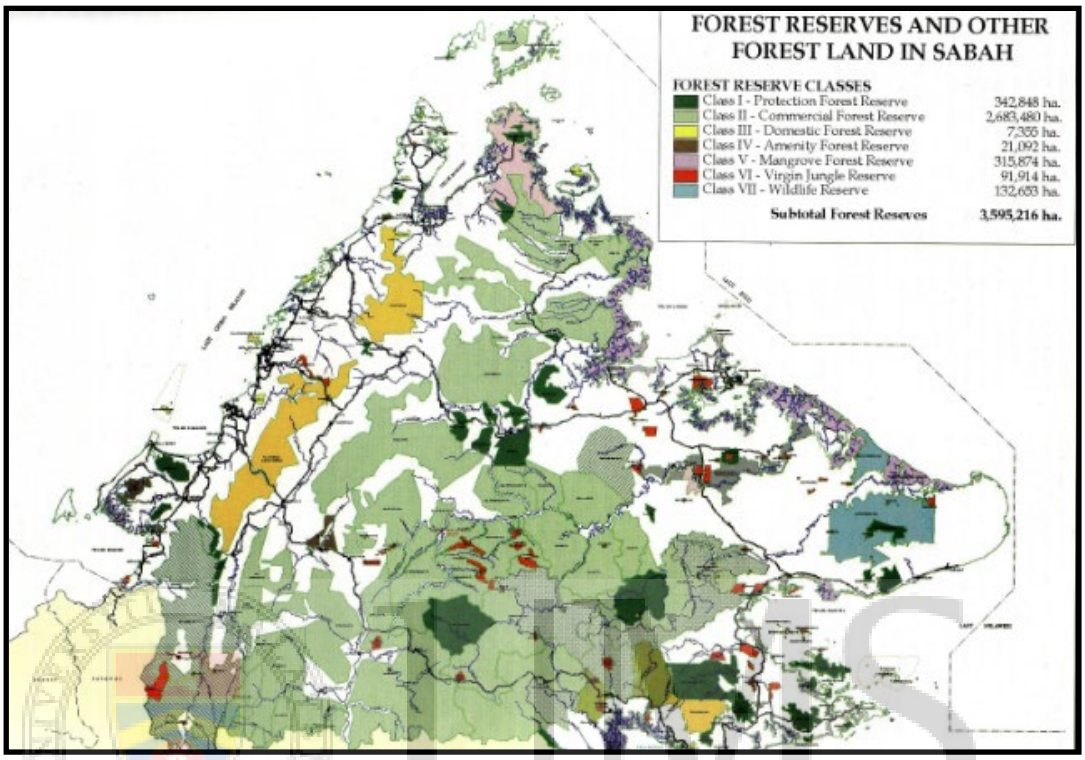

Figure 1.1: Distribution of mangroves in Sabah.

Source: (Sabah Forestry Department, 2007)

In Sabah, 45% of 341,000 ha of mangrove forests have been exploited for their timber in the past. However, approximately 40% of these disturbed mangrove forests have regenerated naturally (Ong & Petol 2007) and another 15% of disturbed mangrove areas due to agricultural sector need to be replanted or restored.

Apart from small scale extraction of mangroves for charcoal and piling poles production and mangrove clearance for shrimp ponds farming and oil palm cultivation; there is relatively little demand for mangrove timber in Sabah today. Mangroves in Sabah are now valued more for the protection they provide against coastal erosion, the habitat for all sorts of marine life and also for their biodiversity conservation function in general. Despite the functional importance of mangrove

ecosystems, their habitats are under threat due to conflict of interest on their usage.

1.2 Problem Statement

There is an urgent need to study on mangrove composition and diversity in Sabah. Sabah is lack of mangrove research compared to Peninsular Malaysia such as in State of Perak and Terengganu are though Sabah has the largest mangrove cover in Malaysia. This study was conducted at Kudat and Pitas district area which is located at Northern part of Sabah. Mangrove forests largely occur along the east coast, facing Sulu and Sulawesi seas (Sabah Forestry Department, 2007). According to Sabah Forestry Department (2007), scientific research highly need in these areas to conserve and protect the mangrove forest.

Mangrove areas that was chosen as study area and labeled as disturbed mangrove area in Kudat and Pitas had been converted into agricultural shrimp and mussels pond farming activity. According to Sabah Forestry Department (2007), agriculture is the main economic activity of Kudat district. The local community changed their economic activity from plantation to agriculture as the high demand of seafood orientated export to Taiwan, Japan and Hong Kong (Sabah Forestry Department, 2007). Due to less land that suitable for agriculture, they converted mangrove area to agriculture pond.

Kudat faced a problem where the local community and foreigners illegally settled and build their houses in the mangrove area. As a Bajau tradition, they build their house near to the coastline by using mangrove trees as the raw material. They prefer mangrove trees as the characteristic of mangrove trees that can stand on harsh condition such as salt water. Local community also preferred mangrove trees as their source of firewood. They used firewood to cook because it was cheaper as the local community in Kudat and Pitas cannot afford electric and kitchen gas.

1.3 Justification

Wetlands especially mangroves are the kidneys of Earth. They act as a sponge that clean up water by filtering out some kinds of pollutants found in the water (Mastaller, 1997). However, too much pollution generated by industry, agriculture, or urban areas can kill plants and animals living in the mangroves. Due to lack of knowledge and awareness about the important of mangrove areas, extensive losses of our original mangrove areas rapidly happened. Much of these losses were due to agriculture, urbanization, residential and industrial development.

Mostly mangrove areas in Sabah were converted to other land-uses such as agricultural, residential, aquaculture, resort and recreation site. Illegal logging and intrusion of state land also influence the composition and diversity of mangrove ecosystem. Kudat and Pitas mangrove forest have been chosen as the study area because both of these areas are mangrove areas had converted to agriculture pond and logged for firewood by local community. These areas were popular among the local people and foreigners for its scenery and recreational activity.

In the future, the information generated from this study could potentially serve as a baseline data for future conservation for mangrove areas in Malaysia. In addition, this study also can act as reference to researchers, students and gain community awareness on the important of mangroves contribution and support the mangrove management in Kudat and Pitas district.

1.4 Objectives

The main goal of this study is to support the mangrove management in Sabah especially in Kudat and Pitas due to lack of information and study had been done in Sabah. There are several objectives;

i. To compare species composition between disturbed and undisturbed mangrove areas both in Kudat and Pitas.

ii. To analyze the similarity of mangroves species between mangrove areas in Kudat and Pitas.

iii. To evaluate the natural regeneration of mangrove between disturbed and undisturbed mangrove areas both in Kudat and Pitas

CHAPTER 2

LITERATURE REVIEW

2.1 Definition of mangrove forest

The word "mangrove" dates its origin as 1613, and it is usually considered a compound of the Portuguese word "mangue" and the English word "grove". According to Marta Vannucci, the word 'mangue' derives from the national language of Senegal, and it was probably adopted by the Portuguese. The corresponding French words are "manglier" and "paletuvier" while a Spanish term is "manglar". The Dutch use "vloedbosschen" for the mangrove community and "mangrove" for the individual trees. German use follows the English. The word "mangro" is a common name for *Rhizophora* in Surinam. It is believed that all these words originated from the Malaysian word, "manggi-manggi" meaning "above the soil". The word is no longer used in Malaysia, but is used in eastern Indonesia to refer to *Avicennia* species (Kathiresan & Bingham, 2001).

Mangroves are quite old, possibly arising just after the first angiosperms (Duke, 1992). However, mangrove plants do not exhibit very primitive plant characteristics. It is believed that the first appearance of mangroves as early as 80 million years ago. *Avicennia* and *Rhizophora* were probably the first genera to evolve, appearing near the end of the Cretaceous period (Kathiresan & Bingham, 2001).

Mangroves form a unique and dominant ecosystem comprised of intertidal marine plants, mostly trees, bordering margins of tropical coastlines around the world. Mangrove forests are naturally high in number of species and are mostly found on shallow tropical coasts. According to Mitsch (1993), wetland can be divided to tidal marshes, tidal freshwater marshes, mangrove wetlands, freshwater marshes, northern peat lands, southern deep water swamps and riparian wetlands.

Mangrove wetland is an area where the tidal salt marsh gives away to the mangrove swamp in subtropical and tropical regions of the world. The word *mangrove* refers to both the wetland itself and to the salt-tolerant trees that dominate those wetlands. They are also self-generating and self-maintaining littoral plant formations often constituting a dynamic ecosystem inhabited by a complex assemblage of flora and fauna. Mangrove forests can be very productive (Clough, 1992) and, their food chains and nutrient cycles are closely linked to those of adjacent coastal waters (Alongi, 1996).

The mangrove wetland is generally dominated by the red mangrove tree that also known as *Rhizophora* and the black mangrove tree, *Avicennia*. Like the salt marsh, the mangrove swamp requires protection from the open ocean and occurs in a wide range of salinity and tidal influence.The coastal environment provides challenges which many plants would be unable to cope with. Mangrove plants demonstrate a wide range of adaptations which enable them to thrive in these demanding conditions (Tomlinson, 1986).

Specialized morphological and physiological characteristics largely define and characterize mangrove plants, such as buttress trunks and roots providing support in soft sediments, above ground roots allowing vital gas exchange in anaerobic sediments, and physiological adaptations for excluding or expelling salt (Spalding *et* al., 1997). Fewer than 22 plant families have developed such essential attributes, representing independent instances of co-evolution over millions of years to form today's mangrove habitats (Tomlinson, 1986).

The dominant plant species in mangrove wetlands are known for several adaptations to the salty wetland environment, including prop roots, pneumatophores, salt excretion, and the production of viviparous seedlings. Mangrove wetlands have been classified according to their hydrodynamics and topography as fringe mangroves, riverine mangroves, basin mangroves, and dwarf or scrub mangroves (Mastaller, 1997).

2.2 Distribution of mangroves worldwide

Mangroves are distributed circumtropically, occurring in 112 countries and territories. Total global mangrove coverage is 18 million hectares and it is just about 0.45% of world forests & woodland (Spalding *et* al., 1997) of the total mangrove coverage, 41.4% exists in South and Southeast Asia (Table 2.1). Mangroves have broader ranges along the warmer eastern coastlines of the Americas and Africa than along the cooler western coastlines (Figure 2.1). This difference in distribution is due to the presence of warm and cold oceanic currents.

Mangroves are found along tropical and subtropical coastlines throughout the world, usually between 30ºN and 30ºS latitude (Tomlinson, 1986). The best developed mangroves grow along humid sheltered tropical coasts in the Delta systems of major rivers like the Ganges, Mekong and Amazon, and coastlines protected by large land masses such as Madagascar, the Indonesian Archipelago and Papua New Guinea. There are two main centres of mangroves: the Eastern hemisphere and the Western hemisphere.

The Eastern hemisphere is Indo-West Pacific region that includes East Africa, Indo-Malesia and Australasia. The Western hemisphere is Atlantic East Pacific region that includes West America, East America and West Africa. The Eastern hemisphere is considered as a place of origin for mangroves, and hence the region is called as the Old World mangroves and the Western hemisphere as the New world mangroves. The Eastern hemisphere has more species than the Western hemisphere. The number of mangrove species is 49 in the former and 11 in the latter (Duke, 1992).

Some genera are specific to the regions. The genera like *Peliciera*, *Conocarpus*, and *Laguncularia* are present only in the new world, whereas *Osbornia* and *Camptostemon* exist only in the old world. An estimated 68 species of mangroves exist, and their distribution is thought to be related to continental drift in the long term and possibly to transport by primitive humans in the short term (Mitsch, 1993). Mangroves are distributed circum tropically, occurring in 112 countries and territories. Total global mangrove coverage is 18 million hectares and

it is just about 0.45% of world forests & woodland (Spalding *et* al., 1997). Of the total mangrove coverage, 41.4% exist in South and Southeast Asia.

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Table 2.1: Estimation of mangrove areas in major mangrove-holding countries

Country	Area in mangrove forest (km^2)	Percent of the world total
Indonesia	42,550	23.5
Brazil	13,400	7.3
Australia	11,500	6.3
Nigeria	10,515	5.8
Cuba	7,850	4.3
India	6,700	3.7
Malaysia	6,425	3.5
Bangladesh	5,770	3.2

Source: (Kathiresan & Bingham, 2001)

2.3 Distribution of mangroves in Malaysia

Malaysia has 612,580.11 hectare where 341,377 hectare or fifty-seven percent (57 %) in Sabah, 168,000 hectare (17 %) in Sarawak and 100,000 hectare (26 %) in Peninsular Malaysia (Husain & Badola, 2005). Mangroves on the west coast of Peninsula Malaysia are more widespread than the east coast. This may be due