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Coastal Resource Development in Malaysia: Is There a Need for Sustainable Mangrove Forest Management?

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ABSTRACT In Malaysia, there are working plans for the conservation and management of mangroves in Matang, Perak. Pioneered by the British Administration, the Matang mangroves exemplify an example of sustainable use for timber production and fishery production without compromising the ecological and environmental values of the ecosystem. Thus, management of mangrove forests inherently involves multiple criteria approach for ranking alternatives for its sustainable use. The purpose of this study is to investigate the need for sustainable mangrove forest management in Malaysia. In this paper, first, we discuss the issues involved in proper management of mangroves in Malaysia. Subsequently, we examine the formulation of a sustainable mangrove management plan. We conclude with some recommendations for further considerations.

ABSTRAK Di Malaysia, terdapat beberapa rancangan kerja untuk memulihara dan menguruskan paya bakau di Matang, Perak. Diterokai oleh pihak pentadbiran British, hutan paya bakau Matang merupakan contoh penggunaan berterusan untuk pengeluaran kayu-kayan dan hasil laut dengan mengekalkan nilai-nilai ekologi dan persekitaran ekosistem. Maka, tidak dapat dinafikan bahawa, pengurusan hutan paya bakau melibatkan kaedah kriteria berganda untuk menyenaraikan alternatif-alternatif untuk penggunaan berterusan. Tujuan kertas kerja ini adalah untuk mempelajari keperluan pengurusan beterusan hutan paya bakau di Malaysia. Dalam kertas kerja ini, pertama, kami membincang isu-isu yang berkaitan dengan pengurusan hutan paya bakau yang sesuai di Malaysia. Kedua, kami memeriksa rumusan suatu rancangan pengurusan paya bakau yang berterusan. Akhirnya, kami mengemukakan beberapa cadangan untuk pertimbangan seterusnya.

(coastal resources, mangrove forests, management, multiple criteria, environment)

INTRODUCTION

Mangrove conservation has become an international issue. Coastal aquaculture development is often blamed for a significant proportion of mangrove destruction, and has become the subject of international debate. Mangrove forest management is based on the sciences and skills of geology, pedology, climatology, hydrology, botany, ecology, silviculture, forest technology and economics in the selection and treatment of both wood and non-wood resource. Integrated management of mangrove wood and on-wood resources depends on an understanding of the ecological and silvicultural parameters for forest management (primary production) and the biological role that the primary production from the forest plays in the mangrove food web of aquatic resources (secondary production).

Most of natural resources development planning deals with multiple objectives. These are objectives both in formulation and evaluation of alternative courses of action. The multiple objective method of analysis usually considers economic and non-economic objectives, including environmental effects of development, and attempts to simultaneously analyze such unquantifiable objectives as quality of life, sustainability of resource base and social equity, together with directly measurable economic objectives such as increasing production from a certain resource. The purpose of this study is to analyze the need for a proper management plan for mangrove forest focusing on overall

sustainable management of mangrove forest resources.

Significance of Mangroves

The mangrove swamp plays many roles in the marine environment, not only for the benefits of people, but for the plants and animals that live in these ecosystems. The significance of mangrove is as follow:

Coastline protection: assist in stabilizing coastline: breakage of wave over coastline gradually changes the shape of the coastline. Mangroves are particularly effective at trapping sediments with their extensive root systems and prevent them from being washed away.

Help assimilate wastes: sewage and storm water wastes contain nitrates and phosphates and are often pumped straight into rivers or ocean, with little treatment. Mangrove absorbs a large amount of these nutrients. Human activities such as dredging and clearing of vegetation 'reactivates' these waste products and allow them to continue to the ocean where they may damage coral reefs, sea grasses and other marine habitats. Natural processes can also reactivate the waste, but this occurs over a much longer time scale.

Trap water: water covers over 75% of the earth surface, but most of this water is salty. Mangroves species take up water and store it in aqueous tissues, releasing it gradually back to the atmosphere through transpiration processes.

Provide food: mangroves are basis of food chain of all life that lives in a mangrove swamp.

Important nursery and breeding area: mangroves are essential to maintain fishing industries. The disappearance of mangroves will almost ensure enormous reduction in fish catches.

Status of Mangroves

Mangrove Forests of the World

The mangrove forest is a special type of forest, found on coastlines or river mouths that are influenced by tides. Earliest reference of mangroves is the description of mangroves of the Arabian Gulf over 2,000 years ago by *Nearchus* and *Theophrastus*.

Survey of mangrove distribution carried out by the World Conservation Monitoring Center and the *Institute de la Carte International de la Vegetation* shows that mangroves occur in 112 countries and territories, largely confined to the regions between 30' north and south of the equator. The modern distribution pattern of mangroves is the result of a wide range of historical and contemporary factors. The total area of mangroves in the world is 181,399 sq. km. 79 mangrove species are found in the world.

On a global scale, the mangrove forests stretch from the northern most part of the world's tropical forests to its southern regions. It stretches from Florida (U.S.A) in the north down to the Argentina coast in South America, and is also dotted along the western and eastern coast of Africa and spreading to the Indian sub-continent all the way up to Ryukyu (now, known as Okinawa) in Japan. Further to the south, it reaches down to Australia, New Zealand and obviously touches the Indo-Malay area. The world's mangrove forests are only found in areas of warm oceanic currents.

Table 1. Area coverage of mangrove forests

REGION	MANGROVE AREA (sq. km)	PERCENTAGE (%)
South and South East Asia	75,172	41.4
America	49,096	27.1
West Africa	27,995	15.4
Australia	18,788	10.4
East Africa and Middle East	10,348	5.7
Total	**181,399**	**100.0**

Table 2. Total global area of different forest-type

FOREST TYPE	AREA
Temperate needle-leaf forest	13.9
Tropical moist forest	11.2
Temperate broad leaf/mixed forest	7.2
Tropical dry	0.8
Mangrove	0.2

Figures has been rounded to the nearest 100,000 sq.km

Table 3. Mangrove area in top 8 countries

COUNTRY	SQ. KM	% OF WORLD TOTAL
Indonesia	42,550	23.5
Brazil	13,400	7.3
Australia	11,500	6.3
Nigeria	10,515	5.8
Cuba	7,848	4.3
India	6,700	3.7
Malaysia	6,424	3.5
Bangladesh	5,767	3.2
Others	76,697	42.3

Table 4. Decline in mangrove coverage in South East Asia

Country	% of decline	In terms of area
Philippines	60%	4,000 sq.km to 1,600 sq.km
Thailand	55%(in 25 years)	5,500 sq.km (1961) to 2,470 sq.km (1986)
Vietnam	37%	4,000 sq.km to 2,525 sq.km
Malaysia	12%	540 sq.km (1980 to 1990)

Using this best estimated global mangrove coverage; 181,399 sq. km in Table 1 is indeed a small number compared to other forest types shown in Table 2. Most mangroves are found in the South and South East Asian regions. 23% of the mangroves occur just in Indonesia. Table 3 show that Indonesia, Brazil, Australia and Nigeria have 43% of the world's mangroves.

Mangrove Forests in Asia

Mangrove forest covers extensively in many Asian countries. These formations are considered as a major source of forestry products. Mangrove forests in Asia are rich in wild life and other non-forestry resources and constitute an important habitat for many endangered and threatened species, particularly of animals.

Areas of mangrove forest in Asia are found in Pakistan, India, Bangladesh, Myanmar, Thailand, Cambodia, Vietnam, Malaysia, Philippines and Indonesia. In addition, some mangrove forests occur in most other countries located between Arabian Peninsular in the west and Japan in the east. About two fifth of all mangrove forests in the world is in Asia.

Mangroves in Asia are sources of timber and non-timber forest products as well as several non-forestry products, which generates livelihood for large number of people. The most important product from South East Asia's mangrove forests is wood for charcoal manufacturing. Other important products include timber, fuel-wood and poles. In countries like Thailand, Malaysia and

Indonesia, large quantity of mangrove wood was harvested for wood chip. Nipa palm leaves usage, as thatching material is still extensive in most countries in the region. Mangrove waters are rich in aquatic organisms including fish, crustaceans and mollusks and are a major source of fishery resources in these countries.

In South Asia and Myanmar, the main products of the forests are timber and fuel-wood. Others include poles, raw material for paper, packing box and matchwood industries. Fishery is a very large-scale activity in the creeks and rivers within mangrove forests and is a major source of fish in the countries. A large number of people are involved in fishing, fish processing and retailing fish.

Mangrove forests form one of the major wetland types in Malaysia, covering total area of 641,000, h.a. More than half of the mangrove forest in Malaysia is found in eastern Sabah, others along the West Coast of Peninsular Malaysia and in the northern and southwestern Sarawak. About 446,000 h.a of these forests are gazetted as forest reserves with the remaining as state land forests. The term "mangrove" is a collective name for a group of plants, with more than 50 species identified such as the *Avicennia lanata* which endemic to the coast of Peninsular Malaysia. The mangrove vegetation in Malaysia is believed to have reached its optimal development.

Destruction of Mangroves

In recent years, there has been a great deal of controversy over the role of coastal aquaculture development in the destruction of mangroves. However, information on the causes of destruction is limited. A summary of the cause and effect of the destruction is given in the form of a Fish-Bone chart (Figure 1).

Mangrove forests have immense importance for many organisms and humans as have been discussed in the earlier section. The increasing human population requires more land for housing and recreation. Mangroves were the first to be cleared (because of their uselessness), filled in, used for rubbish dumps or turned into housing estates or parks. This puts mangrove forest like all tropical resources under severe pressure. They are important for many plant and animal species. Therefore, destruction of mangroves means a dramatic loss to the commercial and recreational fishing industry, the erosion of shorelines, and may put many species of plants and animals on endangered or extinct lists. Aquaculture development has been a significant cause of mangrove destruction in Asian countries during the last 30-40 years. The greater part of the destruction in many Asian countries took place prior to the development of intensive shrimp farming. Other activities include clearance for agriculture; for salt production; and for urban and industrial development; and over-exploitation for firewood and for charcoal production. From available data, major declines in mangrove coverage in South East Asia are as in Table 4.

A loss of 7,445 sq. km of mangroves in these four countries alone represents over 4% of the current global total. Looking at the importance of mangrove forests, their management against destruction is therefore extremely important. Recognizing that mangroves are valuable natural resource with distinctive diversity, high intrinsic natural productivity and unique habitat value and acknowledging that they are being converted for non-sustainable use and degraded by over-exploitation, the International Society of Mangrove Ecosystems (ISME) which was established in 1990 with its headquarters in Okinawa, Japan, has recently adopted a Charter for Mangroves [1]. The Charter contains general principles, functions and implementation (Figure 2: Appendix).

The Need for Sustainable Mangrove Forests Management in Malaysian Context

During the 6th Malaysia Plan (1991-1995) the land area under Permanent Forest Estate (PFE) increased and steps were taken to strengthen forest environmental and bio-diversity protection. The 7th Malaysia Plan [2] states that in the period 1991-1995:

"The rapid pace of development activities, poor sitting, planning and design of coastal development projects, however, has begun to give rise to problems. Economic pressures have led to the indiscriminate cutting of mangrove forest for aqua-culture, agriculture and tourist development projects and to the exploitation of coastal resources above sustainable level, especially along the west coast of Peninsular Malaysia. In addition, rapid industrial development of the hinterland has increased the organic and inorganic pollution to rivers and

coastal waters. The loss of mangrove and other wetland forests, which function as breeding grounds for a large variety of fish and prawn species, has resulted in a decline in fisheries resources."

Mangroves play an important role not only in terms of present and potential wood and non-wood forest products, but also in terms of other services provided by the mangrove ecosystem. Traditionally, the mangrove ecosystem in Malaysia has been an important resource for the human coastal communities [3]. These communities, which comprise mainly of fishermen, have been living within or at the fringes of the mangrove forests for generations. Traditional forestry and fishing utilization by these coastal communities has been coexisting harmoniously and has the minimal impact on the ecosystem.

Realizing the importance of mangroves in the country, the Forestry Department has taken steps to designate mangrove forest reserves so that they can be managed effectively based on sound management plans. The first reservation was made in 1904, where 40,000 ha of Matang Mangroves in Perak were reserved with the drawing up to the first Working Plan.

In early 1960's, there was a gradual change from traditional to conventional uses of the mangrove ecosystem. This includes excision of mangrove land for residential, agricultural and industrial purposes and clear-felling of forests for woodchip production. This is due to the increasing demand for coastal land by the growing population particularly along the west coast of Peninsular Malaysia.

They are in direct conflict with the ecologically sound multiple-use management system of the traditional coastal communities. Clearly, there is a need to formulate a national mangrove management plan to ensure rational management and utilization so that some of the conflicts in resource utilization by the various sectors can be resolved.

Distribution of Mangroves in Malaysia

Mangrove forests in Malaysia develop well in sheltered estuaries where waters are brackish, and wave and tidal conditions are conducive to mud accumulation. Along more exposed coastlines, they are confined to the protected landward side at the lee of sandbars. In total, there are about 641,000 ha of mangroves in Malaysia of which 57% are found in Sabah, 26% in Sarawak and the remaining 17% in Peninsular Malaysia (Figure 2, 3 and 4).

In Peninsular Malaysia, mangroves are found mainly on the sheltered west coast that borders the Straits of Malacca in the states of Kedah, Perak, Selangor and Johor. Major near-shore islands, which are predominantly colonized by mangroves, include the Klang islands in Selangor and Pulau Kukup in Johore. Small patches of mangroves do occur along the rocky shores and they include those found in Pulau Langkawi, Kedah; in Pulau Pangkor, Perak; and in Port Dickson, Negeri Sembilan. In the south, mangroves are found in the estuaries of the Pulai and Johor rivers, which drain into the straits of Johor. On the east coast, mangroves are confined to sheltered estuaries of the Kemaman River in Terengganu; Pahang, Bebar and remaining 7 along the straits of Johore in the south. Of the 11 states in Peninsular Malaysia, Perak has the greatest number of mangrove reserves of which 19 reserves from the Matang mangroves. Rompin rivers in Pahang; and Sedili Besar and Sedili Kecil rivers in Johore.

The total extent of mangrove forests is about 107,700 ha. Of this, about 92,300 ha (85.7%) are gazetted as forest reserves while the remaining 15,400 ha (14.3%) are state land mangroves (Table 5). There are 74 mangrove forest reserves of which 54 occurs on the west coast. Mangroves in Sabah cover a greater area than in any other state in Malaysia. The total extent is about 365,500 ha or 57% of the country's total. Whereas, total extent of mangroves in Sarawak is about 168,000 ha.

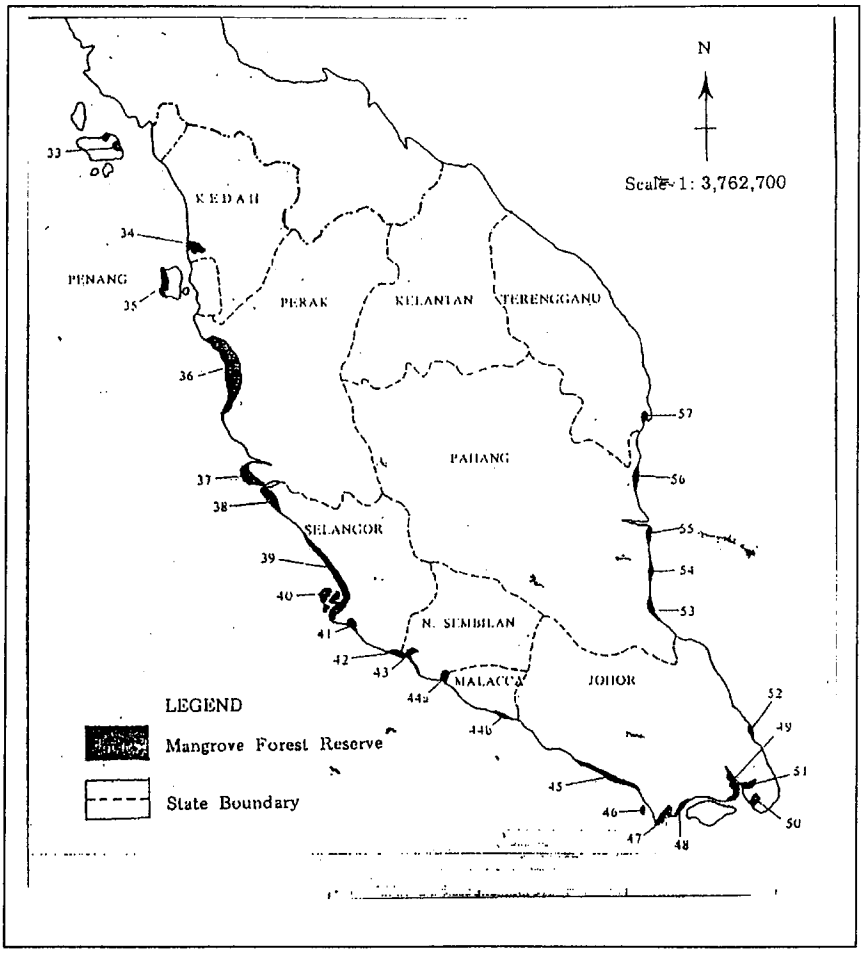

Figure 2.1. Distribution of Mangrove Forests in Peninsular Malaysia

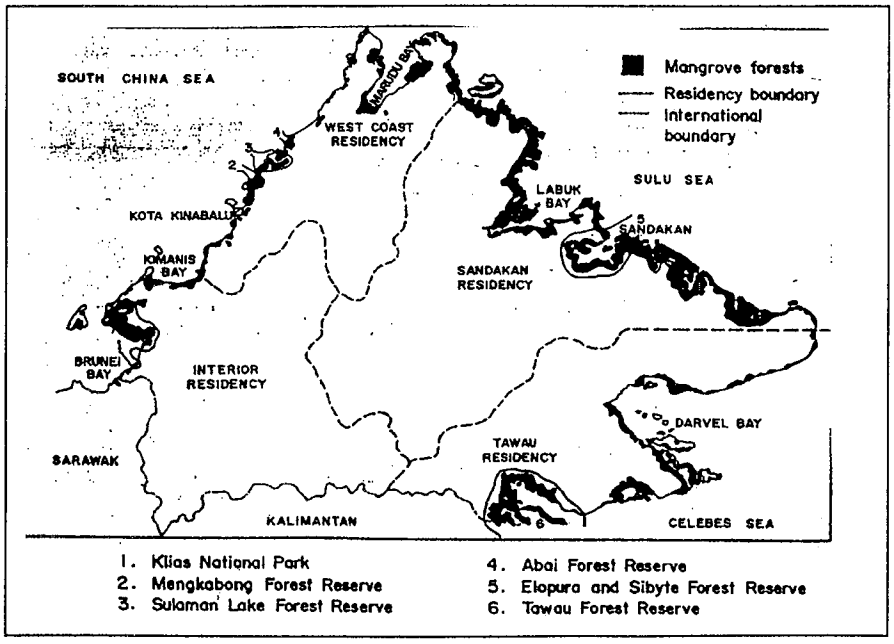

Figure 2.2. Distribution of Mangrove Forest in Sabah

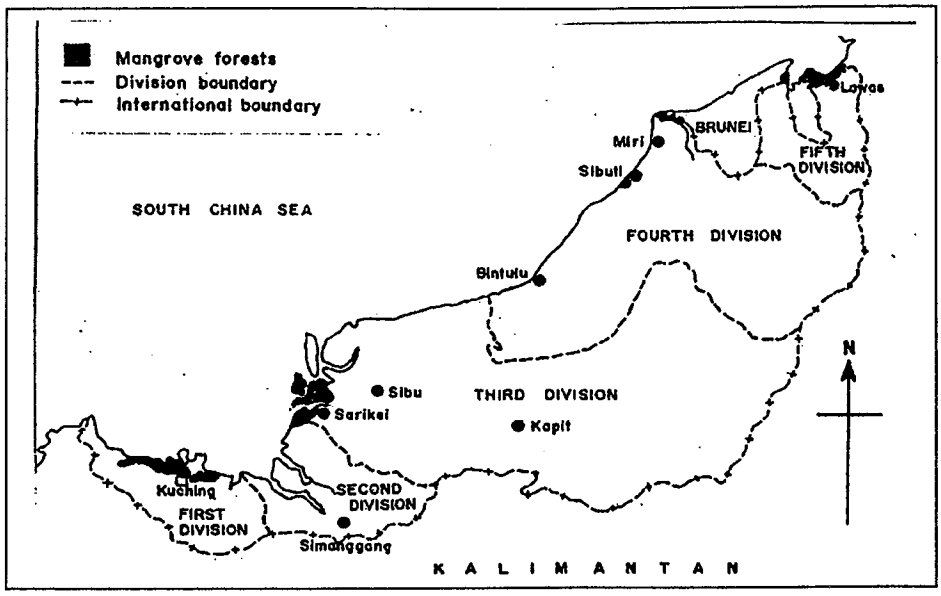

Figure 2.3. Distribution of Mangrove Forest in Sarawak

Table 5. Current extent (ha) of mangrove forest reserves and state land mangroves in Malaysia

STATE	MANGROVE FOREST RESERVES	STATE LAND MANGROVES	TOTAL
Johor	16,697	8,000	24,697
Kedah	8,034	100	8,134
Kelantan	-	20	20
Malacca	314	-	314
Negeri Sembilan	1,061	-	1,061
Pahang	2,032	450	2,482
Penang	406	100	506
Perak	40,869	2,600	43,469
Perlis	-	100	100
Sabah	316,460	49,000	365,460
Sarawak	36,992	131,000	167,992
Selangor	21,983	4,000	25,983
Terengganu	954	-	954
Total	**445,802**	**195,370**	**641,172**

Socio-Economic Significance of Mangroves

Mangrove play many role not only in the marine environment, as discussed earlier but also as precious natural asset [4] providing livelihood for many people.

Fishery

Mangroves represent life support systems for many commercial fish, prawn and crab species. The bulk of marine fishes are caught not far from the mangroves. The mangrove-associated fishery of Malaysia is estimated to be worth millions of ringgit per annum and much of it is export quality. Some of the most productive fishing grounds and cockle beds in Malaysia are located along mangrove forests that are undisturbed by human activities. Studies have shown a direct correlation between prawn yield and the extent of mangrove forests. Indiscriminate aquaculture practices have proven to be very detrimental to the mangrove environment. Uncontrolled mangrove destruction could be detrimental to the Malaysian fishing industry.

Forestry

From time immemorial, humanity has exploited the mangroves for logs and timber. These commodities have been used for the construction of houses and boats, fishing poles and traps,

scaffolding, charcoal production and handicraft products. Mangrove timber can last for a long period if submerged in water. Hence, it is ideal for making fishing gear, outriggers and boats. Mangrove wood is used for making household items such as tool handles and furniture. When harvested on a thirty-year rotational cycle, one hectare of a well-managed timber-yielding mangrove forest produces higher economic returns compared to inland forests on a longer cycle.

Food, medicine and other products

For ages, local communities have relied on the mangrove forest for consumable plants and medicinal herbs. Leaves, buds, fruits, and seeds of some species are used for human consumption. Mangrove plants also have a wide range of medicinal uses. *Rhizophora* bark is used to heal fractures, cure diarrhea and stop hemorrhages. The large and pliable leaves of the Nypa palm are used for thatching mats and 'attap' roofs, weaving baskets, and rolling tobacco into dainty cigarettes. Some mangrove vegetation, especially shrubs, fulfills the feed and forage requirements of livestock. The salt in the leaves makes them palatable for cattle and goats. The leaves of some mangrove plants are a good source of minerals for the animals.

Socio-cultural importance

Mangroves represent areas where human activities have evolved to make the best use of the available resources (socio-cultural importance). These activities include specialized fishing techniques, collection of fruit resin and other forest goods, and methods of using otherwise unproductive soils. These activities are fine examples of sustainable use of valuable natural resources.

Research and education

As mangroves have been found in the tropical coastal and estuarine ecosystems for millennium, they contain evidence of past and present geographical and ecological processes. Research may throw light on issues concerning human occupation and management of natural resources. Soil sampling in the mangroves, for instance, will enable one to understand the past, including type of topography, sedimentation patterns, tidal range and long term sea-level changes.

Ecotourism

The rustic and soothing ambience of the mangrove environment makes it an excellent retreat for people escaping the tension of city life, in other word, ecotourism. The idyllic mangrove maze, complete with its meandering rivers and rivulets, and the variety of wildlife is a treasure-trove for the photographer, bird-watcher or anyone else who wants to relax and appreciate the beauty of the Malaysian mangrove forest. Interpretive centres, planned walkways, and guidebooks are all means of allowing adults and children alike to fully enjoy their heritage.

Mangrove Development Issues In Malaysia

Between 1980 and 1990, mangrove forest reserves of Malaysia had reduced about 505,000 ha to 446,000 ha (Table 6). This accounts to a reduction of about 12% in just 10 years. Greatest loss was experienced in Terengganu, Johor, Selangor and Negeri Sembilan. In Malacca, the extent was increased from 77 ha to 314 ha. However, these figures are compiled from various publications and reports

Table 6. Area (ha) of mangrove forest reserves in Malaysia in 1980 and 1990

STATE	1980	1990	± HA	± %
Johor	25,619	16,697	-8,922	-34.8
Kedah	9,037	8,034	-1,003	-11.1
Malacca	77	314	237	+75.5
Negeri Sembilan	1,352	1,061	-291	-21.5
Pahang	2,496	2,32	-464	-18.6
Penang	406	406	-	-
Perak	40,869	40,869	-	-
Sabah	349,773	316,460	-33,313	-9.5
Sarawak	44,491	36,992	-7,499	-16.9
Selangor	28,243	21,983	-6,260	-22.2
Terengganu	2,982	954	-2,028	-68.0
Total	**505,345**	**445,802**	**-59,543**	**-11.8**

Therefore, the reliability of these figures is questionable and therefore should be used with caution. Mainly the reduction of mangrove area is due to the issues below:

Development pressures on the mangrove reserves and state land forests are the results of: increased land demand from industries, agriculture and shrimp farming, which are expected to produce higher financial returns; under-valuation of goods and services derived from mangrove lands, especially non-marketed products harvested by local communities, and off-site and non-marketed services such as habitat and shoreline protection; lack of appreciation for the essential ecological roles that mangroves play; incorrect perception that mangrove areas are a necessity for shrimp pond culture; and failure to weigh the short-term financial gain versus the long-term cost of losing the mangrove forest.

Meanwhile, in the management area, a major problem is one caused by the *conversion of mangrove areas into agricultural.* This resulted in the formation of acid sulfate soils by exposing soil, previously underwater, to the air. This highly acidic soil is of marginal value for agricultural uses, which is why some of the land reclaimed from mangroves is laying idle [5]. The same problem is faced in cases where mangrove land is converted into aquaculture ponds. There have been a number of reports of failed aquaculture projects that have been abandoned o lie idle. It is widely recognized that these activities are not compatible with sustainable management of mangrove ecosystem [6]. The economic cost of using mangrove areas for agriculture and aquaculture, therefore, would necessarily be higher, in view of the infrastructure, facilities and production practices that would be prerequisites to effective conversion.

The *increasing encroachment of agriculture and aquaculture activities* on areas designated by law as Permanent Forest Reserves has diminished the latter's resources for sustained forestry management. Between 1960 and 1986, more than 20% of mangroves have already been removed for these purposes. Although the *prescribed harvesting system* is clear-felling, this is observed only in mangrove forests fringing the rivers, as the gathering and transportation of logs in South Johore are highly dependent on the tides. Thus, in mangrove forests that are further inland and beyond the reach of tides, the areas are selectively logged for commercial species only.

A total of 164 ha of seaward mangroves in South Johore have already been eroded. *Coastal erosion* may be caused by [1] the bundling of mangroves for agricultural purposes, which prevents the inflow of freshwater and sediments from the rivers, thus changing the physical conditions necessary for the survival of mangroves; and [2] strong wave actions, particularly during the monsoons. The loss of mangroves affects the *health of marine capture fisheries.* To the local communities, this means a reduction in fish, shrimp and shellfish catch.

From the legal aspect, there is no single law that specifically addresses the ecological dimension of mangrove management. This is probably because the laws for forest management were established at the time when the environmental functions of mangroves were not yet well defined or even understood.

Mangrove Management and Conservation

In order to conserve and manage this valuable coastal resource, guidelines for the sustainable utilization of mangrove forests must be developed. Below are some suggestions for the wise use of these resources by the Asian Wetland Bureau [4].

Retaining protective mangrove buffers along coastlines and rivers will prevent erosion. Rather than using concrete banks and rock walls as a mean of stabilizing shorelines, the cultivation of mangroves along erosion-prone coasts is more practical, cheaper and longer-lasting especially after considering cost and other environmental factors.

Logging in mangrove forests must be within sustainable limits. Strip felling, i.e. maintaining strips of mangrove trees between stretches where trees are felled, is a good practice. These strips will ensure the viability of the logged forest by maintaining the diversity of species and allow rapid and healthy regeneration. Apart from being places of refuge for the animals that are displaced by logging activities, these strips also guarantee the maintenance of ecological values of the mangrove forest. Additionally, by acting as a seed and seedling resource, the mangrove strips may also aid in replanting efforts.

Mangrove areas can be protected as national parks or wildlife parks for *in-situ* conservation. In Peninsular Malaysia a bird sanctuary has been set up in Kuala Gula, in Matang Forest Reserve, Perak. Kuala Gula is stopover site for a large number of migratory birds from as far as Northern China and Siberia *en route* to their wintering grounds in Papua New Guinea, Australia and New Zealand. This area is also home to the endangered Milky and Lesser adjutant storks. Kuala Selangor Nature Park in Selangor, the first Mangrove Park of its kind in Malaysia, was established as a cooperative effort between Malaysian Nature Society (MNS) and the State Government of Selangor to conserve the rich natural heritage of plants and wildlife within it. The park provides facilities for nature education and recreation. Thousands of tourists, students and people from all walks of life visit the park for various recreational and educational activities.

Mangrove areas can be managed as fishery reserves. This facilitates the organized management of fish and prawn stocks. Here, environmentally sensitive commercial aquaculture and fishing activities may be controlled.

There should be better enforcement of the National Forestry Act that mandates permits for any clearance of mangroves regardless of the acreage, or for removal of its resources. Permits can be given after considering the justification of their removal, assessment of the potential impacts due to clearance, and benefits to the local folks.

In some cases, land, which has already been cleared and abandoned, or under utilized, might better be utilized, thus reducing demand on the new mangrove areas. Plantations or paddy fields that are no longer productive can be given second life, without destroying or disturbing the remaining mangrove forests of Malaysia.

Historical Review of Management Regimes

In Malaysia [7] too, there is a direct conflict with ecologically sound multiple-use management system of the traditional coastal communities. In South Johore itself, there has been a total loss of 4,884 ha mangrove forest reserves over a period of 26 years. In the past, the main pressures on the mangroves of South Johore were those concerning the conversion of their sites for agricultural purposes. Lately, however, there is an increasing demand to use mangrove areas for industrial and tourism development. In [8], he stated that in Johore, a working plan was prepared by A.C.F. Walker in 1941 for some of the forest reserves but was not enforced (due to Japanese occupation) until 1947. However, by that time the plan was not so applicable. After that few working plan were implemented and revised. The present management plan is derived from Edington's (1953). Furthermore, he stated that one of the great concerns is the upsurge of mangrove forest conversion for shrimp pond culture since this has resulted in substantial loss of forests.

In order to overcome this, the Malaysia Working Group on mangroves has drawn up some guideline for brackishwater pond culture. They recommended use of mangrove areas already reclaimed, followed by dryland and stateland mangroves that are often unproductive for forestry use.

Lim [9], in his paper has emphasized that in the case of Merbok Mangrove, the authority must consider formulating intensive mangrove management plan and the extent of aquaculture development. Table 7 show the mangrove management system in Merbok. Lim [9] has questioned whether mangrove management in Merbok should be intensified, particularly adapting the management plan of Matang and to what extent the aquaculture activities be encouraged even though it cannot be argued that the mangrove ecosystem has contributed much to the well-being of the local residents.

Table 7. Merbok mangrove forest management system, 1996

CHARACTERISTICS	DETAILS
Date gazetted	29 Mac 1951
Productive forest area	2606.2 ha
Unproductive forest area	1430.8 ha
Total area	4037.0 ha*
Number of compartments	14
Number of charcoal kilns owners	15 licensed
Logging system	Clear felling with buffer zone
Major timber species	Rhizophora sp.
Replanting	Practiced
Rotation	30 years
Annual coupe	100 ha

There are some notable examples of long-term management (e.g., Matang Forest Reserve (MMFR)), but many also face severe pressures for conversion to aquaculture scheme and for land reclamation [10] and [11]. In this case, some of the objectives for sustainable utilisation of MMFR are the production of quality greenwood for the charcoal manufacturing industry and poles for construction industry on a sustained yield basis; the protection and conservation of biodiversity; the preservation of roosting and breeding ground for resident and migratory water birds; the preservation of habitat for mammals and reptiles; the reservation of sufficient areas for research, eco-tourism and education, and the maintenance of balance ecosystem for the preservation of breeding ground for marine fauna and the continuing practice of non-destructive aquaculture activities within the mangrove forest. Some of the strategies include developing new silviculture techniques, establishing plantation and encouraging co-existence of non-destructive aquaculture activities adjoining and within the MMFR [12]. With these objectives and management strategies, three important aspects are; sustainable utilisation is possible with government commitment through its reservation efforts, sustainable management of MMFR has been able to sustain local socio-economic livelihood and local villagers showed higher degree of agreement on development activities provided that the use of the mangrove ecosystem resources was minimal.

It cannot be argued that MMFR is one of the well-managed forests in Malaysia. As a result, it only lost only 250 hectares that were excised for settlement expansion and infrastructure facilities but never for agriculture or aquaculture activities as experienced by mangrove forests all over the world. These areas represent only 0.6% of the total area of 40,151 hectares [13].

The largest tracts of mangrove surviving are in Perak (Matang, Kuala Sg. Perak), Selangor (Klang Islands, Banjar Utara, Banjar Selatan) and Johor (Pulau Kukup, Tanjung Piai, Gelang Patah), all of which face potential or existing conflicts over conversion. Sarawak is in a similar position to Peninsular Malaysia in that the State has lost considerable mangrove areas (e.g., around the mouth of Sungai Sarawak). The largest remaining areas are in First Division (Sungai Sarawak, Sungai Sadong) and in Sixth Division (the entire delta region of the Sungai Rajang, although much of this is disturbed). Sabah, since the control of wood chipping from mangroves in 1985, has retained mangroves in good condition under protection within forest reserves. The largest remaining areas are in the large deltas on the east coast.

Developing a Management Plan for Mangroves

National Mangrove Management Plan of Malaysia

In Malaysia, there is no policy for the mangrove forests per se. Therefore, in the context of management and conservation of mangroves, the National Forestry Policy (1978) applies [14]. In Peninsular Malaysia, mangrove forests are managed on the principle of sustained yield management in accordance with the Forest

management Policy and Strategy of the National Forest Policy approved by the National Forestry Council in 1977 and later endorsed by the National Land Council in 1978. In East Malaysia, mangrove management is based on the Forest Policy of Sabah and Sarawak.

The National Forest Policy is aimed at ensuring conservation, management, utilization and development of the country's valuable forest resources in an orderly manner. It is also aimed at generating maximum benefits for the people from the utilization of these resources on sustained yield basis in-line with the aspirations of the New Economic Policy.

General Outline

In Asia and the Pacific region alone, mangrove areas are estimated to cover about six to eight million hectares. However, non-sustainable utilization, overexploitation of resources and conversion to other land uses principally for fishponds, human settlements, infrastructure development, mining and paddy cultivation are drastically reducing this resource base at a very alarming rate.

These increasing conversional operations have become a major management issue. Mangrove areas are considered wasteland, where, financial returns will be higher if they are transformed for other uses. This perception fails to recognize the essential functions of these resources in maintaining the coastal ecosystem. The economic cost of combating the adverse environmental effects of conversion is not likewise considered. This is only a reflection of the lack of a comprehensive policy for the management or use of mangrove resources. General objectives and alternatives of mangrove management plan is given in the following section.

Objectives of Mangrove Management Plan

General objective is resource conservation and mangrove land allocation to sustain the benefits of the resource over a long period of time and for a greater number of people. In other words, to achieve optimal multi-purpose or multiple uses of mangrove resources that can be sustained over time without degrading the ecosystem. Therefore, the key to the management of mangrove resources is optimal sustained utilization. In almost all countries in Asia and Pacific, mangrove forests have been managed on sustained yield basis [15].

Major goals of mangrove forest management are as below:

Economic objective: to produce and sustain maximum volume of wood for conversion to charcoal, fine-wood, poles, wood chips, etc. for local use and export purposes; *social objective:* to provide livelihood and employment to the traditional inhabitants dependent on the forest resources; *environmental objective:* to maintain the protective role of river and coastal mangrove against erosion and storm surges; and to protect and preserve critical breeding and feeding mangrove habitats of coastal fishes and wildlife.

The ultimate goal of managing mangrove resources, the economic considerations aside, is to exploit and/or conserve to the fullest the natural energies and resources available for any given site as to produce maximum carrying capacity for the production of the desired products and services. In this respect, a careful examination of the site conditions (terrestrial and aquatic) and the collection of all relevant information regarding the objectives for managing the mangroves, will prove to be a worth while investment both in time and effort. Secondly, but equally important, is the full assessment of the socio-economic benefits and environmental impact of managing these mangrove resources.

In short, mangrove areas can be considered as units for management where natural resources can be exploited to optimize economic returns while ensuring that damage or degradation of these resources is held to a minimum and the sustainability over time of such resources is achieved.

Alternatives of Mangrove Management Plan

Utilization and management of mangrove ecosystems can be broadly divided into two categories, sustainable and non-sustainable. Sustainable uses are those that maintain the basic ecological functions of the mangrove ecosystem and adjacent ecosystems do not degrade environmental quality, and provide long-term socioeconomic benefits to future generations. Examples of sustainable use include national or nature parks, conservation reserves, the provision of nursery areas and maintenance of fisheries

stocks, and management of sustained timber production over a number of rotations.

Non-sustainable uses consist of conversion of mangrove areas for aquaculture, agriculture, urban and industrial development and other activities that result in over-exploitation, degradation or destruction of mangrove areas.

In summary, there are three management alternatives for mangrove areas. Mangrove areas can be preserved or closed for exploitation [7]; utilized at sustainable levels, or converted into other forms of land uses, e.g., fishpond, salt beds, human settlement, paddy cultivation, etc. These three alternatives, namely, preservation, utilization and conversion are mutually exclusive. In practice, ecological and economic considerations cannot be separated in evaluating management alternatives for mangroves.

Preservation

If preservation of mangroves is determined to be a desirable objective, then future options/alternatives still remain open.

These alternatives include using the mangroves for one or a series of sustainable forms of use for ecological reasons, or converting the mangroves. However, this imposes opportunity costs in the form of lost revenues from developing one of a number of nondestructive mangrove uses or even the revenue from total conversion to a use such as a fishpond. Direct costs of preserving mangroves (such as for policing) may, however, be small. These alternatives safeguard many of the off-site and on-site, non-marketed and marketed values at relatively small cost.

Preservation in natural state could be in the form of nursery grounds, wildlife habitat, feeding/breeding grounds, coastal zone protection, land builder, research areas or aesthetic values.

Conservation

A wide variety of single purpose activities may be able to occupy the same area of mangroves at the same time or at different periods without causing damage to the system (utilizing the resources). Areas with adequate resources could be used as production areas for timber, non-timber, fishery and other products at sustainable levels for conservation purposes. Utilization had to be done with great care because it can lead to irreversible economic or ecological results if pushed too far.

Conversion

The conversion of a mangrove system generally so alters the condition of the mangrove ecosystem that all other potential uses are foreclosed. Irreversibility can take the form of biophysical conditions that cannot be reversed or that would be so costly to reverse as to be unacceptable. The value of mangrove uses is lost and represents a cost that must be subtracted from the benefits attributed to the conversion process. The inputs required to bring about the conversion (land, labor, and capital) are likely to be very much higher than either preservation or sustained management.

A hierarchy of general objectives and alternatives of a mangrove management plan as discussed above is shown in Figure 3 (appendix).

RECOMMENDATIONS

From this study, we would like to highlight some of our recommendations.

There is an urgency to develop a comprehensive management plan for mangrove resources in Malaysia.

Despite the various regimes, mangroves are still being degraded for its resources. Matang Mangrove Forest Reserves (MMFR) is one of the most well-managed mangrove forests. The question arises whether mangrove management be intensified, adapting the management plan of MMFR. Even though other mangrove forests use these guidelines, there is a need for a national plan for sustainable use of all mangrove forests. There is a need for a national plan for sustainable land use and look at long-term people's welfare simultaneously.

A need to construct an integrated framework for action

As quoted in the Integrated Coastal Management (ICM), " ...a process that unites government and community, science and management plan, sectoral and public interests in preparing and implementing an integrated plan for the protection and development of coastal ecosystem and resources." An integrated framework will bring together decision makers at all level.

Linking science to management

Scientific community should conduct research on priority management issues. It is often argued that the ecologists fail in communicating their knowledge to decision makers and therefore have limited influence. It is important to link science to management in order to have effective and efficient mangrove management.

Economic valuation of the mangrove resources in Malaysia

Absence of proper evaluation on mangrove forests results in the undervaluation of the mangrove forests. Which, in turn send the wrong signals to the market. Therefore, various parties further degrade the resource knowing it will not be reflected in the price. Therefore, there is need for proper valuation of the forests for the society to know the actual economic value of the mangroves.

Smart Partnership

Apart from these, synergetic public-private partnership has to be forged to manage, use and conserve mangroves; ensure a functional coordination among concerned agencies. Lastly, but not least, we recommend educating the coastal commutes that they are obliged to support sustainable use of the mangrove and they should understand the importance of conservation, development and community participation.

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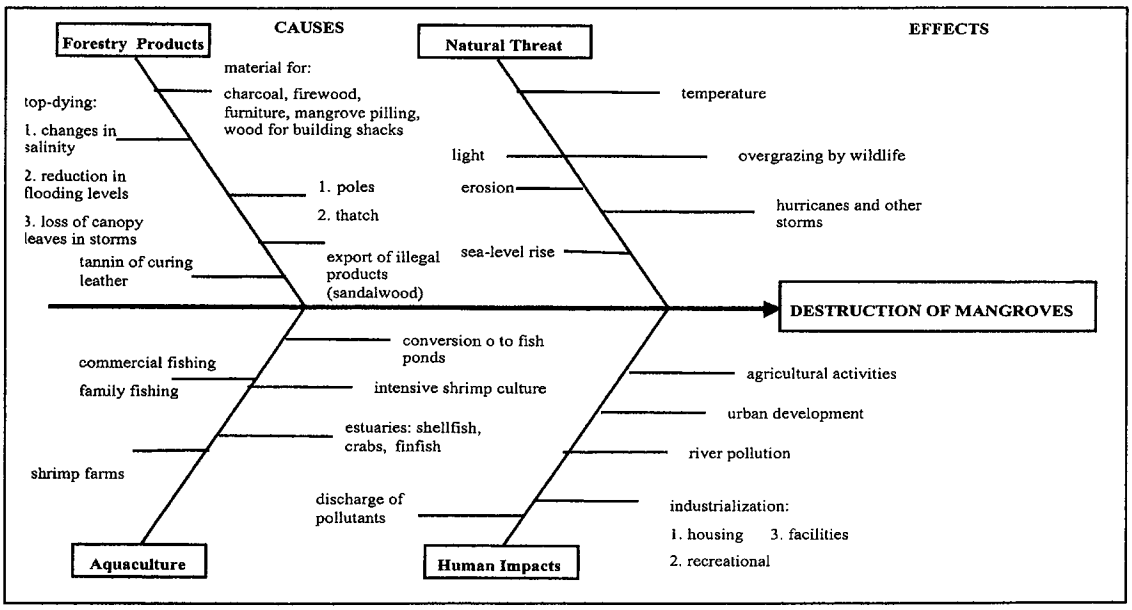
Appendix 1. Cause and Effect Diagram (also known as a Fish –Bone Chart) for Destruction of Mangrove Forests



Appendix 2. The Mangrove Charter

The International Society for Mangrove Ecosystems (ISME), which was established in 1990 with headquarters in Okinawa, Japan, recently adopted a Charter for Mangroves. The Charter will complement the World Charter for Nature proclaimed by the General Assembly of the United Nations on 28 October 1982. ISME recognizes that mangroves are a valuable natural resource with distinctive genetic diversity, high intrinsic natural productivity and unique habitat value. In addition to being a forest ecosystem and nursery ground for aquatic animals, mangroves play an important role in coastal protection and in the reduction of coastal erosion. As mangrove ecosystems are being degraded by non-sustainable use and over-exploitation, the ISME

Executive Committee felt that it is essential to formulate a Charter for Mangroves. The Charter contains provisions for general principles, functions and implementation which are summarized below:

I: General principles

Mangrove ecosystems shall be preserved and managed to achieve sustainable development, i.e., sustainable productivity with the integrity of other ecosystems with which they co-exist. Acquisition and dissemination of knowledge on structure, function and management of mangrove ecosystems shall be encouraged by all possible means, including international research and technical cooperation.

II: Functions

Decisions on management of mangrove ecosystems shall be based on biological components and physical characteristics of each specific area; the need of people; significance of the resource to coastal stability; and fisheries, education, recreation and aesthetic values. Also taken into consideration are rehabilitation and compensation mechanisms to mitigate the impact of non-sustainable use. Regulatory measures are necessary for the wise use of mangroves.

III: Implementation

Resources, programs and administrative structures should be provided to achieve sustainable use of mangrove ecosystems. All parties including individuals should fully cooperate to achieve sustainable mangrove ecosystem management. ISME believes that the adoption of this Charter will benefit all countries. Through awareness and also through conservation by wise use, this precious human heritage will continue to provide benefits for future generations.

Appendix 3. Mangrove Resources Management Plan