MANAGEMENT OF MANGROVE ECOSYSTEM IN INDONESIA[1]

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A. Introduction

The biological resources of the mangrove ecosystem which are believed to be highly productive are not only able to provide various valuable forest products, but also maintain estuarine water quality as a habitat for many commercially important species of fish and prawns. For tropical countries, the mangrove is one of the important natural resources for the development sector in order to enhance human welfare through resource exploitation and environmental stability. Therefore, an adequate balance must be sought between the environmental benefits of the marginal mangroves and the productive role of these ecosystems on a sustained management basis (FAO, 1982).

As such, the mangrove forests should be managed to obtain the main objectives of mangrove forest management, *i.e.* to minimize the destruction or conversion of the mangrove forests, to utilize the mangrove resources on sustained-yield basis, to preserve the unique flora and fauna, to establish a mangrove protection forest and recreational forest, and to avoid or minimize environmental degradation (Soerianegara, unpublished report).

The mangrove resources in Indonesia involve the flora, fauna and land resources which are needed for supporting many kinds of human needs. In Indonesia, the mangroves developed well along the inner facing coast lines of most of the large islands. They are composed of trees (at least 47 species), shrubs (5 species), herbs and grasses (9 species), and parasites (2 species). It must be noted that the mangrove species composition varies from one island to another. In addition to the flora, the mangrove fauna in Indonesia consisted of *Gastropoda* (50 species), *Bivalvia* (6 species) and *Crustacea* (34 species). The marine fauna component is generally more prevalent than the terrestrial and tend to be dominated by *Gastropoda* and branchyurans. Besides the sedentary fauna, there are a number of species

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that use the mangrove ecosystems only as temporary habitat, whether it is for spawning, nursery, or shelter, *e.g.* many species of shrimp have been shown to be mangrove dependent (Macnae, 1974).

According to the latest information, the mangrove vegetated area in Indonesia is amounted to 3.2 million hectares (Bakosurtanal, 2009). On the other hand, Ministry of Forestry (2007) reported that potential area to be planted by mangrove (including mangrove vegetated area) is estimated at 7.8 million hectares (30.7% in good condition, 27.4% moderate-destroyed, 41.9% heavy-destroyed) as shown on Table 1. The destroyed of them are caused by several kind of causes, mainly by conversion to the other uses.

Table 1. Mangrove vegetated area and potential area to be planted by mangrove (including mangrove vegetated area) in Indonesia

No.	Province	Area of Mangroves (ha)	
		Bakosurtanal 2009	RLPS –MOF 2007
1	Nanggroe Aceh Darussalam	22,950.321	422,703.000
2	North Sumatera	50,369.793	364,581.150
3	Bengkulu	2,321.870	0.000
4	Jambi	12,528.323	52,566.880
5	Riau	206,292.642	261,285.327
6	Kepulauan Riau	54,681.915	178,417.549
7	West Sumatera	3,002.689	61,534.000
8	Bangka Belitung	64,567.396	273,692.820
9	South Sumatera	149,707.431	1,693,112.110
10	Lampung	10,533.676	866,149.000
11	DKI Jakarta	500.675	259.930
12	Banten	2,936.188	1,180.484
13	West Java	7,932.953	13,883.195
14	Central Java	4,857.939	50,690.000
15	East Java	18,253.871	272,230.300
16	D.I. Yogyakarta	0	0
17	Bali	1,925.046	2,215.500
18	West Nusa Tenggara	11,921.179	18,356.880
19	East Nusa Tenggara	20,678.450	40,640.850
20	West Kalimantan	149,344.189	342,600.120
21	Central Kalimantan	68,132.451	30,497.710
22	South Kalimantan	56,552.064	116,824.000
23	East Kalimantan	364,254.989	883,379.000
24	North Sulawesi	7,348.676	32,384.490
25	Gorontalo	12,315.465	32,934.620
26	Central Sulawesi	67,320.130	29,621.560
27	South Sulawesi	12,821.497	28,978.300
28	South East Sulawesi	44,030.338	74,348.820
29	West Sulawesi	3,182.201	3,000.000
30	North Maluku	39,659.729	43,887.000
31	Maluku	139,090.920	128,035.000
32.33	Papua and West Papua	1,634,003.454	1,438,421.000
Total		**3,244,018.460**	**7,758,410.595**

Recently, while large portions of the mangrove forests have been commercially exploited, the mangrove areas as land resources have been converted to other uses (agriculture, fishery, urbanization, mining and salt ponds) which often raised conflict of interest among users. In some places, over-exploitation and the reclaiming of mangrove areas may result in a degradation and disappearance of mangroves. Consequently, the management and utilization planning program involving mangrove resources must seek a balance between the economic and ecological viewpoints. To achieve this, the current status of the mangrove resource management and utilization should be known in order to identify the kind of important resources, resource users and the problems involving mangroves. As a result the planning program to solve the problems involving mangrove resources could be determined wisely.

B. Management of Mangroves Ecosystem in Indonesia

According to Soemodihardjo and Soerianegara (1989), in Indonesia there are at least five ministries that are directly or indirectly involved in determining the mangrove resource allocation and management. They are the Ministry of Forestry, the Ministry of Marine and Fishery, the Ministry of Home Affairs, National Land Bureau (BPN), and the Ministry of Life Environment. However, the Ministry of Forestry has the major authority to manage the mangrove resources. Of the other three ministries, the Ministry of Marine and Fishery has the foremost concern with the mangrove resources for the well-known important contribution of the mangrove to the coastal fishery. The authority of the Ministry of Home Affairs and BPN is concerned with the agrarian or land use aspects and the Ministry of Life Environment with the well-being of the environment as a whole.

Mangrove resource management in Indonesia is involved with the management of the mangrove forest exploitation, mangrove resource protection and mangrove rehabilitation (mangrove afforestation or reforestation).

The management of the mangrove forest exploitation in Indonesia is controlled by two major kinds of regulations. The first controls the silvicultural practices in the mangrove harvesting and the second controls the leasing arrangements for allocating the mangrove forest consessions.

1. Silvicultural Practices

For the first time, Kantor Besar Dinas Kesehatan Rakyat, through a regulation No. 669/c, dated January 7, 1933 advocated a law to regulate the mangrove harvesting. Based upon this regulation, it was prohibited to cut mangroves within three kilometers from a village in order to control the mosquito populations. Later, a regulation incorporating the silvicultural guidelines was enacted through regulation No. 13062/465/BIR, dated July 1, 1938 in order to control the development of the mangrove forest in Cilacap, Central Java. According to this regulation, the forest should be divided into three management areas such as follows:

(1) Mangrove production forest, where Rhizophora formed the main species. In this area the clear cutting would be practiced leaving 60 to 100 seed trees (mother trees) with a minimum diameter of 20 cm per ha to facilitate the regeneration of the clear-cut areas;
(2) Mangrove considered unsuitable for production; and
(3) Protection forest areas along the coast and river bank where Avicennia and the other mangroves formed the dominant vegetation.

Unfortunately, the application of this regulation to the other mangrove forests in Indonesia was interrupted by World War II and the other mangroves formed the dominant vegetation.

The research and experimentation continued after World War II, however, the standardized mangrove management regulation in Indonesia was not put into the official law until 1978. In order to evaluate the effect of the application of the 1938 regulation on the regeneration of different mangrove species, Versteegh (1952) did research on the methods of regeneration of the various commercial species which had largely been ignored in Indonesia. Based upon his experimental results obtained in a mangrove forest of Bengkalis, Riau, he recommended that clearcutting system was only suitable for areas frequently flooded by tides and an artificial as wel as a natural regeneration of commercial species must be made. He introduced the working plan through an Area Method with a 30-year cutting cycle and leaving 64 seed trees/ha having a circumference of 45 cm distributed in a regular spacing throughout an over-logged area to manage a mangrove forest in Bengkalis. According to this method, the mangrove forest was divided into sub-blocks of 120 ha each where 4 ha of it (1/30 of sub-block) should be felled every year. But, Vesteegh's recommendations appeared not to have had much impact until the late 1970's. Instead a follow up study of the Cilacap

mangrove forest led to the adoption of the 1938 regulation and the Standard Clear-Cutting System as a silvicultural practice was recommended by the Forest Research Institute in 1956 through recommendation was the main thrust of mangrove management in Indonesia until 1978.

In 1972, a Modified Clear-Cutting System which is also called Stripwise-Selective-Felling System was recommended by the Forest Planning and Production Division of the Directorate General of Forestry with the suggestions as follows (Wiroatmodjo and Judi, 1979):

(1) No logging activity is allowed within 50 m of the coastal limit of a mangrove or within 10 m along a river bank;
(2) Logging is allowed in 50 m wide strips at right angles to the coast line, while 20 m wide strips have to be left between the harvested areas to provide seeds for the natural regeneration;
(3) Only trees with a DBH (diameter at breast-height) of 7 cm up can be cut in the production strips;
(4) If the natural regeneration in a large area is inadequate, enrichment planting with 2 x 3 m spacing must be carried out;
(5) Logs should be removed by rafting, boats and artificial canals; and
(6) A rotation is set for 20 years.

This system was implemented by the mangrove forest concessionaries, however, it has never been written into the official law.

From the ecological viewpoint, this silvicultural system may cause the fish, shrimps and the other marine organisms accumulate in certain areas, *i.e* in unharvested strip areas, so that predators (birds, snake, etc.) may prey them easily (Kusmana, 1991). Consequently, this silvicultural system may cause the decreasing of fish and shrimp production which could be taken by the fishermen. To improve the management system of the mangrove forest, the Government of Indonesia (*c.q.* Directorate General of Forestry) introduced the new silvicultural system which is called Seed-Tree Method through a Decree No. 60/Kpts/Dj/I/1978. The silent points of this system are as follows:

(1) Felling rotation is set for 30 years, where an annual working plan is divided into about 100 ha felling blocks and each felling block itself must be divided into about 10 to 50 ha compartments depending on the forest condition. The felling rotation can be modified by

concessionaires based on the habitat condition, ecological reasons and forest management objectives after getting an agreement from the Directorate General of Forestry;

(2) Before felling, the trees in the compartments must be inventorized using a systematic strip sampling with a strip width of 10 m and distance between strips about 200 m. The inventory of the concession must be carried out by the concessionaires. Based on the results of this inventory, the Directorate General of Forestry will determine wether the forest is suitable for felling or thinning, and determine the limit of the annual allowable cut;

(3) Trees to be cut must have a diameter of at least 10 cm at 20 cm above the highest prop-roots or buttress. Only axes, machettes and mechanical saws are used for felling the trees;

(4) Cutting can only proceed in those areas where 40 seed trees of commercial species with a minimum diameter of 20 cm and spaced at 17 m from each other per hectare can be left for seed and seedling production. Clearcutting is permissible if about 2,500 seedlings/ha which are distributed with a distance of 2 m or less from each other over the whole area are available. Only species of Rhizophora, Bruguiera and Ceriops may be counted as seed trees. Also in order to improve the tree growth, thinning should be undertaken at a period of 15 to 20 years after the first felling, if more than 1,100 trees/ha in this secondary forest are available;

(5) Logs must be transported by raft, boat or wooden carriage through the rivers, artificial canals, or railroads where the distance between canals and railroads must not be less than 200 m and the slash must be removed from the felling areas;

(6) The hoarding log area is limited to about 0,1 ha in every 10 ha felling area;

(7) Regeneration studies must be carried out to determine the effectiveness of the cutting and regeneration cycle; and

(8) The protective green belt is determined about 50 m along the coast line and 10 m along the river bank, waterways and main roads.

2. Leasing Arrangement of the Mangrove Forest Exploitation

The issuance of the leasing permit to exploit a mangrove forest is clarified in two categories depending on the extent of the mangrove area to be leased. Prior to 1970, the provincial government had the authority to issue all the permits, regardless of the extent of the mangrove area to be leased. However, in 1970 the Government of Indonesia (*c.q* Directorate General of Forestry) based upon *Undang-undang Pokok Kehutanan* (Basic Law

of Forestry) No. 5, 1967 enacted *Peraturan Pemerintah* No. 21, 1970 which altered the leasing process. According to this regulation, the Minister of Agriculture, acting on behalf of the central government, had the authority to issue the licence for leasing a mangrove forest greater than 100 ha 30-year lease period. But, from 1983 to 2002 the permission for leasing the forests is enacted by the Minister of Forestry. This regulation also permitted the provincial government to grant a two-year lease for a mangrove area of equal to or less than 100 ha. The shift of the major responsibility from the provincial to the central government for leasing a mangrove area greater than 100 ha was aimed at stimulating and facilitating foreign investment in the mangrove resources. Starting from 2003, the leasing of mangrove forest exploitation was only enacted by the central government (*c.q.* Ministry of Forestry). Now, there are three mangrove forest concession companies in Indonesia, *i.e* PT. Bintuni Utama Murni Wood Industry in Papua (± 85,000 ha), PT. BIOS (± 10,100 ha) and PT. Kandelia Alam (± 18,180 ha) in West Kalimantan.

3. Mangrove Resources Protection

Mangrove resource protection entails the designation of a proportion of an undisturbed mangrove area for a natural conservation and green belt (buffer zone) along the coast or river bank.

The mangrove forest ini Pulau Rambut and Pulau Dua (West Java) were designated as wildlife reserves for bird sanctuaries. While there are five Biosphere Reserves in Indonesia, there currently is no Biosphere Reserve specifically dedicated to the mangrove. Nevertheless, Tanjung Puting (Kalimantan) and Bali Barat (Bali) National Parks include substantial areas of mangrove.

Because of the important function of mangroves in the coastal ecosystem, at 1990's the government of Indonesia (*c.q.* Directorate General of Forest Protection and Nature Conservation) has proposed a number of areas bearing mangroves as nature reserves. Among them, the mangrove areas at Muara Gembong, Muara Cimanuk, Muara Sedari and Muara Kamal (north coast of West Java) have been nominated as protected areas because they serve as feeding grounds for the birds residing in Pulau Rambut (north of Jakarta). Recently, there are at least 17 mangrove-beared wildlife protection areas in Indonesia (Table 2).

Table 2. Mangrove-beared wildlife protection areas in Indonesia

No.	Location	Total Area (ha)	The main protected wildlife
1	Berbak, Sumatera	8,500	*Crocodilus* spp.
2	Kuala Langka, Sumatera	1,000	*Crocodilus* spp.
3	Kuala Jambuaye, Sumatera	3,000	*Crocodilus* spp.
4	Muara Angke, Jawa	15	*Egretta* spp.
			Haleyon spp.
			Arhinga spp.
5	Muara Cimanuk, Jawa	7,100	*Ibis* spp.
6	Muara Mauk, Jawa	1,000	*Bubulens ibis*
7	Pulau Sepanjang, Madura	2,430	*Ibis cinereus*
			Haleyon spp.
			Ciconia epsicopus
8	Teluk Kelumpang, Kalimantan	13,750	*Nasalis larvatus*
9	Pamuka, Kalimantan	10,000	*Nasalis larvatus*
10	Muara Kendawangan, Kalimantan	150,000	*Nasalis larvatus*
11	Tanjung Putting, Kalimantan	11,000	*Nasalis larvatus*
			Arhinga sp.
			Ibis cinerus
12	Muara Kahayan, Kalimantan	150,000	*Nasalis larvatus*
13	Teluk Adeng dan Teluk Apar, Kalimantan	128,000	*Crocodilus* spp.
14	Gunung Lorentz, Papua		*Crocodilus* spp.
			Haleyon sp.
			Ciconia episcopus
15	Pulau Dolok, Papua	105,000	*Crocodilus* spp.
16	Bali Barat, Bali		Jalak Bali
17	Ujung Kulon, Jawa		Badak

In Indonesia, due to the lack of a scientific data base, the width of the mangrove green belt was determined arbitrarily. For example, in 1975 the Directorate General of Fishery through an Instruction No. H.I/4/2/1975, dated November 22, 1975 obliged a mangrove green belt of 400 m wide along the river bank. Because of this contrasting condition, the Minister of Forestry and the Minister of Agriculture issued a joint decree (SKB Menteri Pertanian dan Menteri Kehutanan No. KB 550/246/Kpts/4/1984 dan No. 082/Kpts-II/1984, 30 April 1984) involving the width of a mangrove green belt of 200 m wide.

Through Surat Edaran No. 507/IV-BPHH/1990, the Ministry of Forestry (*c.q.* Directorate General of Forest Utilization) suggested that the width of the green belt should be set at about 200 m along the coast line and 50 m along the river bank. Recently, according to the ecological studies related to organic matter production of the mangrove forest and the productivity of the fish and shrimps, Soerianegara *et al.* (1986) suggested that the width of the green belt should be set at 130 × the largest tidal range. The result of this study was stated on the Presidential Decree (Keppres) No. 32/1990 (article 27) that the width of mangrove green belt is about 130 × annual average of the different between the highest and lowest tides.

4. Mangrove Forest Rehabilitation

Along the north coast of Java in which many land-hungry people live, the mangroves are being degraded and the problems involving land tenure of the mangrove areas have raised a conflict of interest among users. Although the mangrove reforestation or afforestation of newly formed land in the prograding coast is often hindered by human encroachment, since the 1960's Perum Perhutani (State Forest Coorporation) has eagerly rehabilitated the mangrove areas in this region. Soemodihardjo and Soerianegara (1989) reported that on the north coast of Java before the land reaches an elevation above the sea surface at low tide, the land-hungry people would already lay claim of ownership or at least of land use right for the new land by sticking wooden posts onto the sea floor to mark the border line. Thus, newly formed land will directly be converted to brackish water fish ponds. In order to find out the best way for saving the existing mangrove forest without ignoring the needs of the land-hungry people who live in the surrounding areas of mangroves, Perum Perhutani advocated a *tambak tumpangsari* which is also called *hutan tambak* or *tambak empang parit*. *Tambak tumpang sari* (forest-canal fish pond system) is made up of many smaller units in which each unit consists of a canal of 2 to 5 m wide and 1 m deep enclosing a rehabilitated mangrove stand in the middle. The proportion between the canal fish pond and the forest may vary; for example the proportion of the fish pond to the forest is 20% to 80% in Cikeong (Ujung Karawang) and 40% to 60% in Cilacap (Kusmana *et al.*, 1989). But, the optimal proportion is 18% fish pond and 82% forest (Al-Rasjid, 1971). The species raised in the *tambak* are usually bandeng (*Chanos chanos*), mujair (*Tilapia mosambica*), udang windu (*Panaeus monodon*) and udang putih (*Panaeus merguiensis*). Widiarti and Effendi (1989) reported that a tambak-farmer in Blanakan and Cangkring villages (northern part of West Java) has an income of about Rp. 101,420 to Rp. 166,780 in a mnth, through cultivating the species of the above-mentioned fish.

In addition to the *tambak tumpangsari* approach program, a mangrove rehabilitation in the north coast of Java is also being carried out by reforesting a degraded mangrove or afforesting new formed land (*tanah timbul*) in the coastal area. Soemodihardjo and Soerianegara (1989) reported that about 20,000 ha of the degraded mangrove on the north coast of West Java have been rehabilitated using mainly *Rhizophora* spp. and *Avicennia* spp. The survival rate ranged from 60% to 70% and currently the age of the trees ranged from 1 to 16 years. In addition, about 105 ha of the degraded mangrove forest have been reforested using *Rhizophora* spp. and *Bruguiera* spp. in Cilacap.

It is to be noted that in East Java, the initiative of the mangrove rehabilitation came from the coastal villagers themselves. Their activity was highly appreciated by the government of Indonesia which honored them the *Kalpataru* award.

In Riau (Sumatra), PT Bina Lestari has carried out the reforestation of the over-logged mangrove areas. It was reported that by 1988/1989 about 256 ha of over-logged mangrove forest had been reforested using *R. apiculata* and *B. sexangula* with a spacing of 2 x 2 m (PT Bina Lestari, unpublished data). Because of the severe *A. aureum* infestation in the plantation area, it seems that the survival rate of these seedlings is not high, that is, less than 60%.

In Jakarta, Marine and Agriculture Bureau joined with the others (Faculty of Forestry IPB, Jasa Marga, Bank Mandiri, Pertamina, Perusahaan Gas Negara, United Tractor, PT. Garuda Indonesia, etc.) rehabilitated destroyed mangrove area surrounding Sedyatmo higway using Guludan Technique introduced by Kusmana at 2008. *Rhizophora* spp. seedlings were used for this mangrove rehabilitation project with totaled of more than 100.000 seedlings.

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