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DISTRIBUTION AND CURRENT STATUS OF MANGROVE FORESTS IN INDONESIA

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ABSTRACT

Indonesia as archipelagic country more than 17,504 islands with the length of coastline estimated at 95,181 km bears mangroves from several meters to several kilometers. They grow extensively along the inner facing coastlines of most of the large islands and estuarine. They consist of various community type, either mix or pure stands, mainly distributed in the five big islands (Jawa, Sumatra, Kalimantan, Sulawesi, Papua). At the year of 2009, Agency of Survey Coordination and National Mapping (Bakosurtanal) of Indonesia reported the existing mangrove forest area in Indonesia of about 3,244,018 ha, however Directorate General of Land Rehabilitation and Social Forestry, Ministry of Forestry (Ditjen RLPS MoF) of Indonesia at 2007 reported about 7,758,411 ha of mangrove area in Indonesia (including existing vegetated mangrove area). It was further reported that those mangroves were 30.7% in good condition, 27.4% moderate-destroyed, and 41.9% heavy-destroyed. There are at least five ministries responsible for mangrove resource allocation and management in Indonesia, in which Ministry of Forestry has the major authority. Nowadays, two Bureau of Mangrove Forest Management, National Mangrove Working Group and Local (Provincial and Regency/City) Mangrove Working Group as well as the Presidential Decree (PerPres) No. 73/2012 regarding National Strategy of Mangrove Management have been setup to strengthen the sustainable mangrove forest management. Nowadays, Indonesian Government has leased \pm 85,000 ha mangrove forest in Bintuni - Papua and \pm 28,280 ha in Batu Ampar - West Kalimantan to three forest concessioner companies to be harvested using seed tree method silvicultural systems. To enhance the conservation sound as noticed on Presidential Decree (Kepres) No. 32/1990 the width of mangrove green belt in any coastal area should be set up about $130 \times$ annual average of the different between the highest and lowest tides. In Indonesia some mangrove forests have been destroyed by various causes, mainly conversion to other uses. In order to recovery the destroyed mangroves, Indonesian Government (c.q. Ministry of Forestry and Ministry of Marine and Fishery) collaborated with stakeholders (domestic and international) executed rehabilitation as well as restoration those destroyed mangroves, either in or outside state forest area.

Keywords: Current status of mangrove forest, mangrove forest distribution, mangrove management, Indonesia

A. Introduction

Indonesia with its wide range of natural habitats, rich plant and animal resources and high numbers of island endemic species, is recognized as a major world center for biodiversity (Department of Forestry, 1997). It was further reported that although only covering 1.3% of the world's total area, it is home to 10% of the flowering plants, 12% of the mammals, 16% of the reptiles and amphibians, 17% of the birds and 35% of the fishes of the world. Besides, Indonesia covers huge territorial waters supporting the broad variety of coastal habitat including mangroves.

The mangrove ecosystem as an interface between marine and terrestrial are believed to be highly productive. It is 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, crabs, molluscs 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 (FAO, 1982). Therefore, the mangrove forests should be managed to obtain the main objectives of mangrove forest management, namely 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).

Indonesia, as an archipelagic country comprising more than 17,504 islands (28 big islands and 17,475 small islands), has an extremely long coast line. The over-all length of the Indonesian coast is estimated to 95,181 km (DKP DKI Jakarta, 2009) with large variety of climate and physical environment. A substantial proportion of this coastal area bears mangroves of various extents, from several meters to several kilometers.

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 and estuaries. They are composed of trees, shrubs, herbs and grasses, epiphytes and

parasites (Kusmana, 1993). Those various kinds of mangrove flora have been supporting the daily life needs for local people living surrounding mangroves.

For centuries the Indonesian people have traditionally utilized mangroves, mainly for firewood, charcoal, tannin, dyes, food and beverages, medicine, pole and timber. The main genera used are *Rhizophora*, *Bruguiera*, *Ceriops*, *Avicennia*, *Nypa* and *Oncosperma* (Soegiarto, 1984). At the beginning, the fishing and charcoal making are generally the basic economic activities in the mangrove areas. However, in the following period a commercial scale of mangrove exploitation in Indonesia has been begun with a production of logs, charcoal and chip-woods. In the same time, the increasing of population growth and economic development in this country resulted in the destruction even disappearance of many mangroves through conversion of them to fishponds, industrial estates, transportation and recreation infrastructure, resettlement, tin mining, agricultural activities, and other uses.

The multiple role of the mangroves as a renewable resources in the coastal area in relation to serving valuable forest products and environmental services for the coastal population is well recognized in Indonesia, so that degraded mangroves must be rehabilitated and mangrove plantation should be established in some intertidal areas to enrich land productivity as well as environmental quality of the ecosystem.

B. Mangrove Area and Distribution

Recently, mangrove forest in Indonesia grow at the coastal area belonging to 257 regencies/cities. Based on the remote sensing approach, at the year of 2009 Bakosurtanal reported that mangrove vegetated area in Indonesia is amounted to 3.2 million hectares. On the other hand, at 2007 Directorate General of Social Forestry and Land Rehabilitation (Ditjen RLPS) Ministry of Forestry (MoF) 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. They are more developed in the five big islands, i.e. Java, Sumatra, Kalimantan, Sulawesi and Papua.

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

No	Province	Areas of Mangroves (ha)	
		Bakosurtanal (2009)	Ditjen RLPS – MoF (2007)
1	Nanggroe Aceh Darussalam	22,950.321	422,703.000
2	North Sumatra	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	Kepualaun Seribu	54,681.915	178,417.549
7	West Sumatra	3,002.689	61,534.000
8	Bangka Belitung	64,567.396	273,692.820
9	South Sumatra	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	Bali	1,925.046	2,215.500
17	West Nusa Tenggara	11,921.179	18,356.880
18	East Nusa Tenggara	20,678.450	40,640.850
19	West Kalimantan	149,344.189	342,600.120
20	Central Kalimantan	68,132.451	30,497.710
21	South Kalimantan	56,552.064	116,824.000
22	East Kalimantan	364,254.989	883,379.000
23	North Sulawesi	12,445.712	32,384.490
24	Gorontalo	12,315.465	32,934.620
25	Central Sulawesi	43,746.508	29,621.560
26	South Sulawesi	12,821.497	28,978.300
27	South-east Sulawesi	65,506.924	74,348.820
28	West Sulawesi	3,182.201	3,000.000
29	North Maluku	39,659.729	43,887.000
30	Maluku	139,090.920	128,035.000
31	Papua and West Papua	1,634,003.454	1,438,421.000
	Total	3,244,018.460	7,758,410.595

Source: Center for Marine Natural Resources, Agency of Survey Coordination and National Mapping, Republic of Indonesia (Bakosurtanal) (2009)

It is reported that 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.

C. Mangrove Flora

Soemodihardjo *et al.* (1993) reported that there are about 157 species of flora growing in mangroves in Indonesia consisting of 52 species of trees, 21 species of shrubs, 13 species of lyana, 7 species of palms, 14 species of grasses, 8 species of herbs, 3 species of parasites, 36 species of ephyphites and 3 species of ferns (Table 2).

Table 2. Mangrove flora in Indonesia (Soemodihardjo *et al.*, 1993)

Fern		Herb	
Pteridaceae	<i>Acrostichum aureum</i>	Acanthaceae	<i>Acanthus ebracteus</i>
	<i>Acrostichum speciosum</i>		<i>A. ilicifolius</i>
Blechnaceae	<i>Stenochlaena palustris</i>		<i>A. volubilis</i>
Epiphyte		Aizoaceae	<i>Sesuvium portulacastrum</i>
Adiantaceae	<i>Vittaria</i> sp.	Asteraceae	<i>Pluchea indica</i>
Aspleniaceae	<i>Asplenium nidus</i>	Chenopodiaceae	<i>Tectocornia australica</i>
Davalliaceae	<i>Davallia</i> sp.	Araceae	<i>Colocasia esculenta</i>
	<i>Humata parvula</i>		<i>Cryptocorina ciliata</i>
Cycads		Cyperaceae	<i>Cyperus compactus</i>
Cycadaceae	<i>Cycas rumphii</i>		<i>C. compressus</i>
Polypodiaceae	<i>Cyclophorus cinnamoneous</i>		<i>C. javanicus</i>
	<i>Drymoglossum heterophyllum</i>		<i>C. malacensis</i>
	<i>Drynaria</i> sp.		<i>Fimbristylis ferruginea</i>
	<i>D. rigidula</i>		<i>Scirpus grossus</i>
	<i>D. sparsisora</i>		<i>Thoracostachyum sumtranum</i>
	<i>Nephrolepis acutifolia</i>	Poaceae	<i>Chloris gayana</i>
	<i>Phymatodes scolopendria</i>	(Gramineae)	<i>Cynodon dactylon</i>
	<i>Ph. Sinuosa</i>		<i>Dyplachne fusca</i>
	<i>Platicerium coronarium</i>		<i>Paspalum scrobiculatum</i>
Schizaeaceae	<i>Lygodium laxum</i>		<i>P. vaginatum</i>
			<i>Phragmites karka</i>
			<i>Sporobolus virginicus</i>
Epiphyte		Pandan	
Asclepiadaceae	<i>Dischidia benghalensis</i>	Pandanaceae	<i>Pandanus tectorus</i>
	<i>D. rafflessia</i>		
	<i>D. mommularia</i>	Palma	
	<i>Hoya</i> sp.	Palmae	<i>Calamus erinaceus</i>
Orchidaceae	<i>Aerides odorata</i>	(Araceae)	<i>Licuala</i> sp.
	<i>Anota violaceae</i>		<i>Livistonia saribus</i>
	<i>Bulbophyllum xylocarpi</i>		<i>Nypa fruticans</i>
	<i>Cymbidium</i> sp.		<i>Oncosperma tigillarium</i>
	<i>Dendrobium aloifolium</i>		<i>Phoenix paludosa</i>
	<i>D. callybotrys</i>		
	<i>D. pachyphyllum</i>	Lyana	
	<i>D. prostratum</i>	Asclepiadaceae	<i>Cynanchum carnosium</i>
	<i>D. rhyzophoreti</i>		<i>Finlaysonia obovata</i>
	<i>D. subulatum</i>		<i>Gymmanthera paludosa</i>
	<i>D. teretifolium</i>		<i>Sarcolobus banksii</i>
	<i>Oberonia laeta</i>		
	<i>O. rhizophoreti</i>	Asteraceae	<i>Wedelia biflora</i>

Table 2 (Continued)

Malastomalaceae	<i>Prachycentria constricta</i>	Leguminosae	
	<i>Plethiandra sessifolia</i>	- Caesalpinioideae	<i>Caesalpinia bonduc</i>
Rubiaceae	<i>Hydnophytum formicarum</i>		<i>C. crista</i>
	<i>Myrmecodia</i> sp.	- Papilionoideae	<i>Aganope heptaphylla</i>
Parasite			<i>Dalbergia candenatensis</i>
Loranthaceae	<i>Amyema grafis</i>		<i>D. menoides</i>
	<i>A. mackayense</i>	Rhanaceae	<i>Derris trifoliata</i>
	<i>Viscum ovalifolium</i>	Verbenaceae	<i>Smythea lancaeta</i>
Anacardiaceae	<i>Gluta velutina</i>		<i>Clerodendron inerme</i>
Apocynaceae	<i>Voacanga grandiflora</i>		<i>E. indica</i>
Bataceae	<i>Batis agillicola</i>	Flocourtiaceae	<i>Scolopia macrophylla</i>
Chenopodiaceae	<i>Halosarcia indica</i>	Guttiferae	<i>Calophyllum inophyllum</i>
Euphorbiaceae	<i>Glochidion littorale</i>	Lecythideaceae	<i>Barringtonia asiatica</i>
Goodeniaceae	<i>Scaevola sericea</i>		<i>B. racemosa</i>
Leguminosae		Leguminosae	
- Papilinoideae	<i>Desmodium embellatum</i>	- Caesalpinioideae	<i>Cynometra iripa</i>
Lythraceae	<i>Aegiceras corniculatum</i>		<i>C. ramiflora</i>
	<i>A. floridum</i>	- Mimosaceae	<i>Pithecelobium umbellatum</i>
	<i>Ardisia elliptica</i>		<i>Serianthes</i> spp.
Myrtaceae	<i>Osbornia octodonta</i>		<i>Pongamia pinnata</i>
Plumbaginaceae	<i>Aegialitis annundata</i>	Malvaceae	<i>Hibiscus granatum</i>
Rubiaceae	<i>Ixora timorensis</i>		<i>Thespesia populnea</i>
	<i>Scyphiphora hydrophyllaceae</i>	Meliaceae	<i>Xylocarpus granatum</i>
Rutaceae	<i>Paramygnia angulata</i>		<i>X. mekongensis</i>
Sapindaceae	<i>Allophyllus cobbe</i>		<i>X. moluccensis</i>
Tiliaceae	<i>Brownlowia argentata</i>	Moraceae	<i>Ficus microcarpa</i>
	<i>B. tersa</i>	Myristaceae	<i>Myristica hollrungii</i>
Verbanaceae	<i>Prenma obtusifolia</i>	Rhizophoraceae	<i>Bruguiera cylindrica</i>
Tree			<i>B. exaristata</i>
Apocynaceae	<i>Cerbera manghas</i>		<i>B. gymnorrhiza</i>
	<i>C. odollam</i>		<i>B. hainessi</i>
Avicenniaceae	<i>Avicennia alba</i>		<i>B. parviflora</i>
	<i>A. eucalyptifolia</i>		<i>B. sexangula</i>
	<i>A. marina</i>		<i>Ceriops decandra</i>
	<i>A. officinalis</i>		<i>C. decandra</i>
Bignoniaceae	<i>Dolichandrone spathaceae</i>		<i>C. tagal</i>
Bombaceae	<i>Camptostemon philipinense</i>		<i>Kandelia candel</i>
	<i>C. schultzei</i>		<i>Rhizophora apiculata</i>
Celastraceae	<i>Cassine viburnifolia</i>		<i>R. mucronata</i>
Combretaceae	<i>Lumnitzera littorea</i>		<i>R. stylosa</i>
	<i>L. racemosa</i>	Sapotaceae	<i>Pouteria obovata</i>
	<i>Terminalia catappa</i>	Sonneratiaceae	<i>Sonneratia alba</i>
Ebenaceae	<i>Diospyros littorea</i>		<i>S. caseolaris</i>
			<i>S. ovata</i>
		Sterculiaceae	<i>Heritiera littoralis</i>
			<i>H. globosa</i>

Source: Soemodihardjo *et al.* (1993)

Furthermore, Kusmana (1993) reported that there are approximately 202 mangrove plant species comprising of 89 species of tree, 5 species of palm, 19 species of liana, 44 species of soil herbs, 44 species of epiphyte, and 1 species of fern. Out of the total 202 species, 43 species are true mangroves and the rest are associate mangrove. About 166 are found in Java, 157 in Sumatra, 150 in Kalimantan, 142 in Papua, 135 in Sulawesi, 133 in Maluku and 120 in Lesser Sunda Islands. The distribution of mangroves within the main islands of Indonesia can be seen in Table 3.

Table 3. Distribution of major and minor mangrove species in the main islands of Indonesia

No	Species	Island						
		Java	Bali&LSI*	Sumatra	Kalimantan	Sulawesi	Maluku	Papua
1	<i>Aegiceras corniculatum</i>	+	+	+	+	+	+	+
2	<i>Aegiceras floridum</i>		+			+	+	+
3	<i>Avicennia alba</i>	+	+	+	+	+	+	+
4	<i>Avicennia lanata</i>				+	+		
5	<i>Avicennia marina</i>	+	+	+	+	+	+	+
6	<i>Avicennia officinalis</i>	+	+	+	+	+	+	+
7	<i>Bruguiera cylindrica</i>	+	+	+	+	+	+	+
8	<i>Bruguiera gymnorhiza</i>	+	+	+	+	+	+	+
9	<i>Bruguiera parviflora</i>	+	+	+	+	+	+	+
10	<i>Bruguiera sexangula</i>	+	+	+		+	+	+
11	<i>Ceriops decandra</i>	+	+	+	+	+	+	+
12	<i>Ceriops tagal</i>	+	+	+	+	+	+	+
13	<i>Dolichandrone spathacea</i>	+					+	
14	<i>Excoecaria agallocha</i>	+	+	+	+	+	+	+
15	<i>Heritiera littoralis</i>	+	+	+	+	+	+	+
16	<i>Kandelia candel</i>			+	+			
17	<i>Lumnitzera littorea</i>	+	+	+	+	+	+	+
18	<i>Lumnitzera racemosa</i>	+	+	+	+	+		+
19	<i>Nypa fruticans</i>	+	+	+	+	+	+	+
20	<i>Osbornea octodonta</i>	+	+			+	+	+
21	<i>Phoenix paludosa</i>			+				
22	<i>Pemphis acidula</i>	+	+					+
23	<i>Rhizophora apiculata</i>	+	+	+	+	+	+	+
24	<i>Rhizophora lamarckii</i>		+	+			+	+
25	<i>Rhizophora mucronata</i>	+	+	+	+	+	+	+
26	<i>Rhizophora stylosa</i>	+	+	+	+	+	+	+
27	<i>Scyphiphora hydrophyllacea</i>	+	+	+	+	+	+	+
28	<i>Sonneratia alba</i>	+	+	+	+	+	+	+
29	<i>Sonneratia caseolaris</i>	+	+	+	+	+	+	+
30	<i>Sonneratia ovata</i>	+		+	+	+	+	+
31	<i>Xylocarpus granatum</i>	+	+	+	+	+	+	+
32	<i>Xylocarpus moluccensis</i>	+	+	+	+	+	+	+
33	<i>Xylocarpus rumphii</i>	+	+				+	+

Note : + present

* Lesser Sunda Islands (LSI)

Source : Kusmana (1993)

D. Mangrove Fauna

According to Soemodihardjo *et al.* (1993), Kartawinata and Waluyo (1977), Budiman and Darnaedi (1984), and Mustafa *et al.* (1979), there are about 118 species of marine fauna associated with mangroves in Indonesia consisting of 48 species of Gastropoda, 9 species of Bivalvia and 61 species of Crustacea (Table 4).

Table 4. Mangrove fauna in Indonesia

GASTROPODA		Amphibolidae	<i>S. fragilis</i> (Lamarck)
Potamididae	<i>Terebralia palustris</i> (Linnaeus)	Cerithidae	<i>Cerithium morum</i> Lamarck
	<i>T. sulcata</i> (Born)		<i>C. patulum</i>
	<i>Telescopium telescopium</i> Linnaeus		<i>Clypeomorus granosum</i>
	<i>T. mauritsi</i> Butot	Melangenidae	<i>Melangena galeodes</i> Lamarck
	<i>Cerithidea djadjarensis</i> (Martin)	Trochidae	<i>Monodonta labio</i> (Linnaeus)
	<i>C. alata</i> (Philippi)	Assimineidae	<i>Syncera breviculata</i> (Pfeiffer)
	<i>C. obtusa</i> (Lamarck)		<i>S. javana</i> (Thielf)
	<i>C. quadrata</i> Sowerby		<i>S. nitida</i> (Pease)
	<i>C. weyersi</i> Datzenberg		<i>S. woodmasoniana</i> (Nevill)
	<i>C. cingulata</i> (Gmelin)	Stenothyridae	<i>Stenothyra glabrata</i> (A. adams)
Ellobiidae	<i>Cassidula aurisfelis</i> Bruguire	Muricidae	<i>Chicoreus adustus</i>
	<i>C. lutescens</i> Butot		<i>Drupa margariticola</i>
	<i>C. mustelina</i> Deshayes	Nassariidae	<i>Nassa olivacea</i>
	<i>C. triparietalis</i> (Martens)		<i>Alectrion taenia</i>
	<i>C. sulculosa</i> (Mussou)	BIVALVIA	
	<i>Auriculastra subula</i> (Quoy et Gaimard)	Corbiculidae	<i>Polymesoda coaxans</i> Gmelin
	<i>A. elongate</i>		<i>P. expansa</i> (Mousson)
	<i>Ellobium aurisjudae</i> Linnaeus	Verenidae	<i>Gafrarium tumidum</i> Roding
	<i>E. aurismidae</i> (Linnaeus)	Anomiidae	<i>Enigmonia aenigmatica</i> (Chemnitz)
	<i>E. polita</i>	Ostreidae	<i>Crassostrea cucullata</i> Born
	<i>E. tomatelliforme</i> (Petit)	Chamidae	<i>Chama fragum</i>
	<i>Phytia plicata</i> (Ferussac)	Mytilidae	<i>Brachyodontes bilocularis</i>
	<i>P. trigona</i> (Troschel)	Spondylidae	<i>Spondylus hystrix</i>
	<i>P. pantherina</i>	Arcidae	<i>Anadara artiquata</i> Linnaeus
	<i>Melampus singaporensis</i> (Pfeiffer)	CRUSTACEA	
	<i>M. pulchellus</i> Petit	Grapsidae	<i>Sarmatium incidum</i>
	<i>M. semisulcatus</i> Mousson		<i>S. crassum</i>
Littorinidae	<i>Littorina scabra</i> (Linnaeus)		<i>M. crassipes</i>
	<i>L. carinifera</i> (Menke)		<i>Sesama taeniolata</i> White
	<i>L. intermedia</i> Philippi		<i>S. meinerti</i> De Man
	<i>L. melanostoma</i> Gray		<i>S. edwardsii</i>
	<i>L. undulata</i> Gray		<i>S. bataviana</i> De Man
Neritidae	<i>Nerita planospira</i> Anto		<i>S. moeschi</i>
	<i>N. Albicilla</i> Linnaeus		<i>S. cumolpe</i> De Man
	<i>N. chameleon</i>		<i>S. smithi</i> H. Milne-Edwards
	<i>Neritina violaceae</i> (Gmelin)		<i>S. bocourti</i> A. Milne-Edwards
	<i>N. turrita</i> (Gmelin)		<i>S. fasciata</i> Lancherter
	<i>N. bicanaliculata</i>		<i>S. palawensis</i>
	<i>N. zigzag</i> Lamarck		<i>S. videns</i> De Hans
	<i>N. variegata</i> Lesson		<i>S. onychophora</i> De Man
	<i>N. auriculata</i> Lamarck		<i>S. rousseauxi</i> H. Milne-Edwards
	<i>Clithon corona</i> (Linnaeus)		<i>S. erythrodeactylum</i> Hess
	<i>C. ovalaensis</i>		<i>S. longipes</i> (Krauss)
Thiaridae	<i>Melanoides riqueti</i> (Grateloup)		<i>Metapograpsus latifrons</i> (White)
	<i>M. tuberculata</i> (Muller)		<i>Uca vocans</i> Linnaeus
Amphibolidae	<i>Salinator burmana</i> (Blanford)		<i>U. lactea</i> (De Haan)

Ocypodidae	<i>U. signatus</i> (Hess)	Ocypodidae	<i>O. arenaria</i> De Man
	<i>U. consobrinus</i> (De Man)		<i>O. cardimana</i>
	<i>U. anulipes</i> (H. Milne-Edwards)		<i>Ilyoplax delsmanni</i> De Man
	<i>U. dussumieri</i> (H. Milne-Edwards)		<i>Tyloplax indian</i>
	<i>U. triangularis</i> A. Milne-Edwards	Portunidae	<i>Scylla serrata</i> (Forsk.)
	<i>U. marionis</i>	Gegarcinidae	<i>Cardisoma carnifex</i> (Herbst)
	<i>U. coartatus</i>	Thalassinidae	<i>Thalassina anomala</i> Herbst
	<i>U. rosea</i>	Alpheidae	<i>Alpheus crassimanus</i> Heller
	<i>Macrophtalmus convexus</i> Stimpson		<i>A. bisincisus</i> De Man
	<i>M. telescopicus</i> Owen	Paguridae	<i>Caenobita cavipes</i> Stimpson
	<i>M. tridentatum</i>	Balanidae	<i>Balanus</i> spp.
	<i>M. definitus</i> Adam et White		<i>Clibanarius</i> spp.
	<i>Ocypoda ceratophthalmus</i> (Phallas)		

In 1984, Ecology Team of Faculty of Fishery of IPB reported 45 species of fishes live in mangrove of Segara Anakan-Central Java. They are dominated by *Mugil* sp., *Sillago* sp., *Johnius* sp., *Trachiphalus* sp., *Cynoglossus* sp., *Setipine* sp. and *Leiognathus* sp. The common fish species of commercial interest in Indonesia are mullets (*Mugil* sp.), milkfish (*Chanos chanos*), tilapia (*Chichlidae* spp.), snappers (*Lutjanidae* spp.) and sea bass (*Lates calcarifer*). The most common fish is perhaps the mudskippers (*Periophthalmus* spp.), which is endemic to the mangroves.

In Indonesia, terrestrial mangrove fauna consists of 16 species of mammals, 49 species of reptiles, 6 species of amphibian and 76 species of birds (LPP Mangrove 2000) as shown on Table 5.

Table 5. Species of terrestrial mangrove fauna in Indonesia

NO.	ITEMS	SPECIES	COMMON NAME
AVES			
1		<i>Alcedo caeruleus</i> (L)	Small blue Kingfisher
2		<i>Halcyon cyanoventris</i> (L)	Javan Kingfisher
3		<i>Todirhampus chloris</i> (L)	White Collared Kingfisher
4		<i>Todirhampus sanctus</i> (L)	Sacred Kingfisher
5		<i>Pelargopsis capensis</i> (L)	Stork-billed Kingfisher
6		<i>Alcedo meninting</i> (L)	Blue-eared Kingfisher
7		<i>Anas gibberifrons</i> *	Grey Teal
8		<i>Anhinga melanogaster</i> (L)	Oriental Darter
9		<i>Collocalia fuciphaga</i>	Edible-nest Swiftlet
10		<i>Collocalia esculenta</i>	White bellied Swiftlet
11		<i>Apus affinis</i>	House Swift
12		<i>Apus pacificus</i>	Fork-tailed Swift
13		<i>Ardea cinerea</i>	White bellied Swiftlet
14		<i>Ardea purpurea</i>	Purple Heron
15		<i>Egretta garzetta</i> +	Little Egret
16		<i>Egretta intermedia</i> (L)	Plumed Egret

NO.	ITEMS	SPECIES	COMMON NAME
17		<i>Nycticorax nycticorax</i>	Black-crowned Night Heron
18		<i>Ardeola speciosa</i>	Javan Pond Heron
19		<i>Butorides striatus</i>	Little Heron
20		<i>Bubulcus ibis</i>	Cattle Egret
21		<i>Artamus leucorhynchus</i>	White-breasted Wood Swallow
22		<i>Lalage nigra</i>	Pied Triller
23		<i>Caprimulgus affinis</i>	Savannah Nightjar
24		<i>Aegithina tiphia</i>	Common Iora
25		<i>Mycteria cinerea</i>	Milky Stork
26		<i>Streptopelia chinensis</i>	Spotted Dove
27		<i>Treron vernans</i>	Pink-necked Pigeon
28		<i>Macropygia emiliana</i>	Red Cuckoo Dove
29		<i>Geopelia striata</i>	Peaceful Dove
30		<i>Crypsirina temia</i>	Racket-tailed Treepie
31		<i>Cacomantis merulinus</i>	Plaintive Cuckoo
32		<i>Centropus nigrorufus</i>	Sunda Coucal
33		<i>Centropus bengalensis</i>	Lesser Coucal
34		<i>Dicaeum trochileum</i>	Scarlet-headed Flowerpecker
35		<i>Hirundo tahitica</i>	Pacific Swallow
36		<i>Hirundo rustica</i>	Barn Swallow
37		<i>Lanius schach</i>	Long-tailed Shrike
38		<i>Motacilla flava</i>	Yellow Wagtail
39		<i>Rhipidura javanica</i> (L)	Pied Fantail
40		<i>Cyornis rufigastra</i>	Mangrove Blue Flycatcher
41		<i>Muscicapa sibirica</i>	Asian Brown Flycatcher
42		<i>Nectarinia jugularis</i> (L)	Olive-backed Sunbird
43		<i>Nectarinia calcostheta</i> (L)	Copper-throated Sunbird
44		<i>Anthreptes malacensis</i> (L)	Brown-throated Sunbird
45		<i>Anthreptes singalensis</i> (L)	Ruby-cheeked Sunbird
46		<i>Oriolus chinensis</i>	Black-naped Oriole
47		<i>Parus major</i>	Great Tit
48		<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant
49		<i>Phalacrocorax niger</i>	Little Cormorant
50		<i>Picoides macei</i>	Fulvous-breasted Woodpecker
51		<i>Picoides maluccensis</i>	Brown-capped Woodpecker
52		<i>Lonchura punctulata</i>	Scaly-breasted Munia
53		<i>Lonchura leucogastroides</i>	Javan Munia
54		<i>Passer montanus</i>	Eurasian Tree Sparrow
55		<i>Psittacula alexandri</i>	Moustached Parakeet
56		<i>Loriculus galgulus</i>	Blue-crowned Hanging-Parrot
57		<i>Cacatua alba</i>	White Cacatoo
58		<i>Pycnonotus aurigaster</i>	Sooty-headed Bulbul
59		<i>Pycnonotus goiavier</i>	Yellow-vented Bulbul
60		<i>Amauornis phoenicurus</i>	White-breasted Waterhen
61		<i>Porphyrio porphyria</i>	Purple Swampphen
62		<i>Calidris ferruginea</i>	Curlew Sandpiper
63		<i>Tringa hypoleucos</i>	Common Sandpiper

NO.	ITEMS	SPECIES	COMMON NAME
64		<i>Prinia familiaris</i>	Bar-winged Prinia
65		<i>Prinia polychroa</i>	Brown Prinia
66		<i>Orthotomus sepium</i>	Olive-backed Tailorbird
67		<i>Orthotomus ruficeps</i>	Ashy Tailorbird
68		<i>Orthotomus sutorius</i>	Common Tailorbird
69		<i>Gerygone sulphurea</i>	Golden-bellied Gerygone
70		<i>Acrocephalus stentoreus</i>	Clamorous Reed-warbler
71		<i>Sterna nilotica</i>	Gull-billed tern
72		<i>Sterna bergii</i>	Great Crested-Tern
73		<i>Acridotheres javanicus</i>	Javan Myna
74		<i>Zoothera interpres</i>	Chesnut-capped Thrush
75		<i>Zosterops chloris</i>	Lemon-bellied White-eye
76		<i>Zosterops palpebrosus</i>	Oriental White-eye
MAMMAL			
CARNIVORA			
1		<i>Vulpes bengalensis</i>	Bengal fox
2		<i>Canis aureus</i>	Jackal
3		<i>Lutra perspicillata</i>	Smooth otter
4		<i>Amblonyx cinerea</i>	Otter
5		<i>Herpestes edwardsi</i>	Mongoose
6		<i>H. javanica</i>	Java mongoose
7		<i>Paradoxurus hemaphroditus</i>	Palm civet
8		<i>Viverra zibetha</i>	Large Indian civet
9		<i>Panthera tigris</i>	Sumatra tiger
10		<i>Felis viverrina</i>	Fishing cat
11		<i>F. bengalensis</i>	Leopard cat
12		<i>F. haus</i>	Jungle cat
ARTIODACTYLA			
1		<i>Sus scropa</i>	Wild boar
2		<i>Muntiacus muncak</i>	Barking deer
3		<i>Axis axis</i>	Spotted deer
4		<i>Tragulus javanicus</i>	Mouse deer
AMFIBI			
1		<i>Bufo melanostictus</i>	Toad
2		<i>Rhacophorus maculatus</i>	Tree frog
3		<i>Rana cyanophlyctia</i>	Frog
4		<i>R. limnocharis</i>	
5		<i>R. tigrina</i>	
6		<i>Microhyla ornata</i>	
REPTILIA			
CROCODILIA			
1		<i>Crocodylus siamensis</i>	
2		<i>C. nova guinea</i>	Freshwater New Guinea crocodile
3		<i>C. porosus</i>	Estuarine crocodile
4		<i>Tomistoma schlegeli</i>	False gavia
SQUAMATA			
1		<i>Hemidactylus flaviviridis</i>	Wall gecko

NO.	ITEMS	SPECIES	COMMON NAME
2		<i>Eublepharis fasciolatus</i>	Leopard gecko
3		<i>Gecko gecko</i>	Tokay
4		<i>Mabuya multifasciata</i>	Common skink
5		<i>Calotes versicolor</i>	Lizard
6		<i>Chamaeleon zeylanicus</i>	Indian chameleon
7		<i>Varanus sp.</i>	Bengal monitor
8		<i>V. salvator</i>	Yellow monitor
9		<i>V. flavescens</i>	Ruddy sub-nosed monitor
10		<i>Naja naja</i>	Cobra
11		<i>Typhlops porractus</i>	Blind snake
12		<i>T. acutus</i>	Blind snake
13		<i>Ahaetula ahaetulla</i>	Whip snake
14		<i>A. cyanochloris</i>	
15		<i>Python reticulatus</i>	Python
16		<i>Natrix stolata</i>	Keel back
17		<i>Enhydris enhydris</i>	
18		<i>Fordonia leucobalia</i>	
19		<i>Bungards lividus</i>	Krait
20		<i>Acrochordus granulatus</i>	Wart snake
21		<i>Hydrophis obscurus</i>	
22		<i>H. nigrocinctus</i>	
23		<i>Microcephalophis cantoris</i>	Sea snake
24		<i>Enhydrina achistoss</i>	Beaked deep sea snake
25		<i>Cerberas thynchops</i>	
26		<i>Ptyas mucosus</i>	Rat snake
27		<i>Spalerosophis diadema</i>	
28		<i>Viverra russeli</i>	Russell's viper
29		<i>Pligodon arnensis</i>	Kukri snake
30		<i>Oligodon dorsalis</i>	
31		<i>Dryophis mycterigans</i>	Tree snake
32		<i>Lycondon aulicus</i>	Common wolf snake
33		<i>Eryx conicus</i>	Russel's wolf snake
34		<i>Psammophis condouarus</i>	
TESTUDINATE			
1		<i>Pelochelys bironi</i>	Coast shell-turtle
2		<i>Morenia petersi</i>	Bengal terrapin
3		<i>Batagur baska</i>	River terrapin
4		<i>Lepidochelys olivaca</i>	Ridley turtle
5		<i>Chelonia mydas</i>	Green turtle
6		<i>Tryonix hurun</i>	Peacock soft-shell turtle
7		<i>T. gageticus</i>	Ganges soft-shell turtle
8		<i>Lissemys punctata</i>	Indian flap-shell turtle
9		<i>Kachuga tecta</i>	India roofed turtle
10		<i>K. smiti</i>	
11		<i>K. kachuga</i>	

Source: LPP Mangrove (2000)

E. Mangrove Habitat

Based on tree dominant species, mangrove communities in Indonesia can be appeared as association (mix stand) and consociation (pure stand). There are five consociations commonly found in Indonesian mangrove, namely *Avicennia*, *Rhizophora*, *Sonneratia*, *Bruguiera*, and *Nypa* consociations. Regarding mix stand, association between *Bruguiera* spp. and *Rhizophora* spp. are frequently found mainly in landward. In general, because of large variety of local habitat, mangrove communities in Indonesia are frequently differs among islands.

Based on Sukardjo (1984), mangrove communities in Indonesia consist of:

(1) Shrub community

This mangrove community is formed by mangrove tree pioneer species growing at the coastal line or new delta. Tree species are dominated by *Avicennia marina*, *A. alba*, and *Sonneratia caseolaris*. The seedlings of *Ceriop tagal* grow in this community in the transition area between high and low tide. Sometimes some non-mangrove species i.e. *Phragmites karka*, *Pandanus* spp., and *Glochidion littorale* grow in this community.

(2) Young mangrove community

This community has one layer of forest canopy formed mainly by the species of *Rhizophora* spp. In unsuitable habitat for *Rhizophora*, *Avicennia* and *Sonneratia* take-over to be grown. At the further development, there will be mixed stand between *Rhizophora* and the other mangroves such as *Bruguiera* and *Xylocarpus* as well as *Excoecaria agallocha* in the far landward.

(3) Old mangrove community

This community is often called mangrove climax dominated by big trees of *Rhizophora* and *Bruguiera*. Commonly, some species such as *R. mucronata* and *R. apiculata* are dominated soft mud soils, *R. stylosa* dominated sandy soils, and *Bruguiera* spp. dominated firm mud habitat. At gaps or opening areas, some ground cover species are grown, such as *Acrostichum aureum*, *Derris* spp., and *Acanthus illicifolius*.

(4) *Nypa* community

In this community, *Nypa fruticans* grow extensively formed pure stand and sometimes grow mixed with sporadically other trees species (*Lumnitzera* spp., *Excoecaria agallocha*, *Heritiera littoralis*, *Instia bijuga*, *Kandelia candel*, and *Cerbera manghas*).

It was also reported that various mangrove community type found in several regions in Indonesia as shown on Table 6.

Table 6. Mangrove community type in Indonesia

No.	Location	Community type	Species richness	Source
A. Java Island				
1	Cilacap	<i>Aegiceras corniculatus</i> – <i>Ficus retusa</i> <i>Avicennia marina</i> – <i>Sonneratia alba</i> <i>Rhizophora mucronata</i> – <i>Bruguiera cylindrica</i>	14	Marsono (1986)
2	Ujung Karawang	<i>Avicennia marina</i> – <i>Avicennia corniculatus</i>	9	Djaja <i>et al.</i> (1984)
3	Indramayu	<i>Avicennia marina</i> – <i>Avicennia alba</i>	9	Sukardjo (1980)
4	Pulau Rambut	<i>Rhizophora mucronata</i> – <i>Rhizophora stylosa</i> <i>Rhizophora mucronata</i> <i>Schyphyphora hydrophyllacea</i> – <i>Lumnitzera racemosa</i>	13	Kartawinata and Waluyo (1977)
5	Pulau Dua	<i>Rhizophora stylosa</i> – <i>Rhizophora apiculata</i>	12	Buadi (1979)
6	Baluran	<i>Rhizophora stylosa</i> – <i>Rhizophora apiculata</i>	16	Indiarto <i>et al.</i> (1987)
7	Grajagan	<i>Rhizophora apiculata</i> – <i>Avicennia</i> spp.	14	Sukardjo, unpublished report
8	Muara Angke	<i>Avicennia alba</i> – <i>Avicennia marina</i> <i>AVicennia marina</i> – <i>Rhizophora mucronata</i>	11	Kusmana (1983)
B. Outside Java Island				
1	Kangean isles	<i>Rhizophora stylosa</i> <i>Rhizophora apiculata</i> <i>Ceriops tagal</i>	12	Soemodihardjo, unpublished report
2	Tanjung Apar (Kalimantan Timur)	<i>Rhizophora apiculata</i> – <i>Avocennia alba</i> <i>Avicennia officinalis</i> – <i>Avicennia alba</i> <i>Ceriops tagal</i> – <i>Rhizophora apiculata</i>	13	Sukardjo, unpublished report
3	Tanjung Kasam (Riau)	<i>Xylocarpus granatus</i> – <i>Lumnitzera racemosa</i> <i>Rhizophora apiculata</i> – <i>Xylocarpus granatus</i>	12	Sukardjo, unpublished report
4	Way Sekampung (Lampung)	<i>Avicennia</i> spp. <i>Hibiscus tiliaceus</i> – <i>Pongamin pinnata</i>	14	Sukardjo (1979)
5	Banyuasin (Sumatera Selatan)	<i>Rhizophora apiculata</i> <i>Bruguiera gymnorrhiza</i> – <i>Rhizophora apiculata</i>	9	Yamada and Sukardjo (1980)
6	Tanjung Bungin (Sumatera Selatan)	<i>Rhizophora apiculata</i> – <i>Nypa fruticans</i> <i>Nypa fruticans</i> – <i>Rhizophora apiculata</i>	9	Sukardjo <i>et al.</i> (1984)
7	Talidandang Besar (Riau)	<i>Bruguiera parvifolia</i> <i>Bruguiera sexangula</i> <i>Bruguiera sexangula</i> – <i>Nypa fruticans</i>	8	Kusmana and Watanabe (1992)
8	Sungai Gaung dan Mandah (Riau)	<i>Rhizophora apiculata</i> – <i>Rhizophora mucronata</i> <i>Bruguiera parviflora</i> – <i>Bruguiera sexangula</i> <i>Aegiceras comiculatus</i> – <i>Nypa fruticans</i>	7	Al Rasjid (1984)
9	Sulawesi Tengah - Ranu - Lapangga - Matube - Morowali	<i>Rhizophora apiculata</i> – <i>Ceriops tagal</i> <i>Rhizophora apiculata</i> – <i>Ceriops tagal</i> <i>Rhizophora mucronata</i> <i>Rhizophora apiculata</i>	3 8 3 5	Darnaedi and Budiman (1984)
10	Halmahera (Maluku)	<i>Sonneratia alba</i> <i>Bruguiera gymnorrhiza</i> – <i>Xylocarpus granatus</i> <i>Rhizophora apiculata</i> – <i>Bruguiera gymnorrhiza</i> <i>Nypa fruticans</i> – <i>Rhizophora stylosa</i>	14	Komiyama <i>et al.</i> (1988)

No.	Location	Community type	Species richness	Source
11	Bone-bone (Sulawesi Selatan)	<i>Sonneratia alba</i> – <i>Rhizophora apiculata</i> <i>Rhizophora mucronata</i> <i>Nypa fruticans</i> – <i>Rhizophora stylosa</i>	20	Ahmad (1989)
12	Simpang Ulim (Aceh)	<i>Rhizophora apiculata</i> – <i>Bruguiera gymnorhiza</i>	8	Al Rasjid (1983)

F. 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.

Since years ago, Indonesian government has initiated setting up the institution to strengthen the mangrove forest management, such as follow:

(1) Mangrove Forest Management Bureau (*Balai Pengelolaan Hutan Mangrove* or BPHM)

This bureau was established based on the Decree of Minister of Forestry No. P.04/Menhut-II/2007, 6 Februari 2007 consisting of:

- (a) BPHM Region I located at Denpasar Bali having the mandate for managing mangrove in Java, Bali, Madura, Nusa Tenggara, Sulawesi, Maluku and Papua.
- (b) BPHM Region II located at Medan, with the mandate for managing mangrove at Sumatra and Kalimantan

(2) National Mangrove Working Group (*Kelompok Kerja Mangrove Nasional* or KKMN) and Local Mangrove Working Group (*Kelompok Kerja Mangrove Daerah* or KKMD)

The member of KKMN is coming from inter-sector/institution/NGO. Nowadays, 23 KKMD at province level and 16 KKMD at regency/city level have been established to strengthen the capacity building for mangrove forest management. Fortunately, at the year of 2012 the President of Republic of Indonesia enacted the PerPres No. 73/2012 regarding National Strategy of Mangrove Ecosystem Management to realize the Sustainable Mangrove Ecosystem Management and to improve the welfare of local community based mangrove resources.

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 concessions.

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 well 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, Versteegh'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 whether 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 (\pm 85,000 ha), PT. BIOS (\pm 10,100 ha) and PT. Kandelia Alam (\pm 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 in Muara Angke, Pulau Rambut and Pulau Dua 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 7).

Table 7. Mangrove-beared wildlife protection areas in Indonesia

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

For many years ago, 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 $130 \times$ 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 $130 \times$ 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 Corporation) 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 tumpang sari* 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 54% fish pond and 46% forest (Zuna, 1998). The species raised in the *tambak* are usually bandeng (*Chanos chanos*), mujair (*Tilapia mosambica*), udang windu (*Panaeus monodon*) and udang putih (*Panaeus merguensis*). 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 month, through cultivating the species of the above-mentioned fish.

Since several years ago, the Government of Indonesia (c.q. Ministry of Forestry) has the high commitment to executed mangrove rehabilitation through the programs of National Action of Land and Forest Rehabilitation (*Gerakan Nasional Rehabilitasi Hutan dan Lahan* or *GN-RHL*) and routine planting project on activities. Besides, significant efforts to planted mangrove is also shown by Ministry of Marine and Fishery and many stakeholders, mainly Stated Owned Corporation (*Badan Usaha Milik Negara* or *BUMN*) and private companies through Corporate Social Responsibility (CSR) programs as well as various level of communities.

It was reported that Ministry of Forestry has rehabilitated mangrove areas amounted to 37,539 ha until the year of 2008. In the period of 2010 to 2014, Ministry of Forestry planned to do mangrove rehabilitation of about 10.000 ha per year through Mangrove People Nursery (*Kebun Bibit Rakyat* or *KBR*) program. At 2013, target of the mangrove rehabilitation project will be raised up to 15,000 ha through the programs of Land Forest Rehabilitation, People Nursery and Social Aid. Beside government, many international donor institutions set up joint work to execute mangrove rehabilitation in Indonesia, some of them were:

- (a) Asian Development Bank or ADB (mangrove management project at Sulawesi, 1997)
- (b) International Tropical Timber Organization or ITTO (mangrove forest management at North Sumatra)
- (c) UNDP-IUCN (program Mangrove Forest for the Future or MFF)
- (d) Yamamoto (mangrove rehabilitation at Riau 500 ha; Jambi 20,000 ha; South Sumatra 20,000 ha, Bangka-Belitung 10,000 ha)

In Jakarta, starting from 2005 Faculty of Forestry IPB and Marine and Agriculture Services of Jakarta DKI Province joined with the others (Jasa Marga, Bank Mandiri, Pertamina, Perusahaan Gas Negara, United Tractor, PT. Garuda Indonesia, AEON, etc.) rehabilitated destroyed mangrove area surrounding Sedyatmo Highway Jakarta using *Guludan* Technique introduced by Faculty of Forestry IPB (Figure 1). *Rhizophora* spp. seedlings were used for this mangrove rehabilitation project with totaled of more than 200,000 seedlings.



Figure 1. View of planted *Rhizophora* seedlings using *guludan* technique in the surroundings area of Sedyatmo Highway Jakarta.

REFERENCES

- Ahmad T. 1989. Potentialities of mangrove forest related to coastal aquaculture: A case study in Bone-bone, Luwu, South Sulawesi. *In: Soerianegara I, Zamora PM, Kartawinata K, UMaly RC, Tjitrosomo S, Sitompul DM, Rosalina U (Eds). Symposium on Mangrove Management: Its Ecological and Economic Considerations. Biotrop Special Publication 37: 287-299.*
- Al Rasjid H. 1983. Pengaruh pembinaan sistem silvikultur pohon induk terhadap perkembangan hutan payau di Simpang Ulim, Aceh. Laporan PUSLITHUT 416 : 8-30.
- Al Rasjid H. 1984. Penilaian permudaan alam hutan mangrove antara sungai Gaung dan Sungai Mandah, Riau. *In: Soemodihardjo S, Soerianegara I, Sutisna M, Kartawinata K, SUPardi, Naamin, Al Rasjid H (Eds). Prosiding Seminar II Ekosistem Mangrove: 314-320. Jakarta: MAB-LIPI.*
- [Bakosurtanal] Badan Koordinasi Survey dan Pemetaan Nasional. 2009. *Peta Mangroves Indonesia*. Cibinong: Pusat Survey Sumber Daya Alam Laut Badan Koordinasi Survey dan Pemetaan Nasional.

- Buadi. 1979. Hutan Bakau di Pulau Dua, Teluk Banten, Jawa Baratl. *In: Soemodihardjo S, Nontji A, DJamali A (Eds). Prosiding seminar ekosistem hutan mangrove: 69-71. Jakarta MAB-LIPI.*
- Darnedi D, Budiman A. 10984. Analisis vegetasi hutan mangrove Morowali, Sulawesi Tengah. *In: Soemodihardjo S, Soerianegara I, Sutisna M, Kartawinata K, Supardi, Naamin N, Al Rasjid (Eds.). Prosiding Seminar II Ekosistem Mangrove: 314-320. Jakarta: MAB-LIPI.*
- Department of Forestry of Republic of Indonesia. 1997. *National Strategy for Mangrove Management in Indonesia.* Jakarta: Department of Forestry of Republic of Indonesia.
- Djaja B, Sudargo G, Indrasuseno.1984. Hutan mangrove di Tanjung Karawang, Bekasi, Jawa Barat. *In: Soemadihardjo S, Nontji A, Djamali A (Eds). Prosiding seminar II ekosistem mangrove: 156–161. Jakarta: MAB – LIPI.*
- [DKP DKI Jakarta] Marine and Agricultural Services Jakarta DKI Province. Jumlah pulau kecil. http://www.ppk-kp3kdkp.go.id/index.php?option=com_content [7 Juli 2009]
- FAO. 1982. Management and utilization of mangroves in Asia and the Pacific. FAO Environmental Paper 3. Rome: FAO. 160 p.
- Indiarto Y, Prawiroatmodjo S, Mulyadi, Kabinawa IN. 1987. Analisis vegetasi hutan mangrove Baluran Jawa Timur. *In: Soerianegara I, Adisoemarto S, Soemodihardjo S, Hardjowigeno S, SUDomo M, Ongkosongo OSR (Eds). Prosiding seminar III ekosistem mangrove: 92-97. Jakarta: MAB – LIPI.*
- Kartawinata K, Waluyo EB. 1977. A preliminary study of the mangrove forest on Pulau Rambut. *Mar. Res. Indon.* 18: 119-129.
- Komiyama A, Moriya H, Prawiroatmodjo S, Toma T, Ogino K. 1988. Forest as ecosystem, its structure and function: 1. Floristic composition and stand structure. *In: Ogino K, Chinara M (Eds). Biological system of mangroves: A report of East Indonesian mangrove expedition 1986: 85 – 96. Ehime: Ehime University.*
- Kusmana C, Watanabe H. 1992. Production structure of main commercial tree species in a mangrove forest in East Sumatra Indonesia. *Biotropia* 5: 1-9.
- Kusmana C. 1983. Analisis vegetasi hutan mangrove Muara Angke Jakarta [Skripsi]. Bogor: Fakultas Kehutanan IPB.
- Kusmana C, Yunia C, Setyobudiandi I, Soendjoto MA. 1989. Training course on the management of mangrove forest: the fieldtrip report to a mangrove forest of Cikeong, Muara Angke-Kapuk, and Cilacap. Bogor: SEAMEO-BIOTROP.
- Kusmana C. 1991. Silvicultural practices of mangrove forests in Southeast Asian Countries. Technical Notes, Vol. III, No. 1, July 1991. Bogor: Faculty of Forestry Bogor Agricultural University.
- Kusmana C. 1993. The current status of mangrove forest management in Indonesia. Bogor: Faculty of Forestry, Bogor Agricultural University. Unpublished.
- Kusmana C. 1995. *Manajemen Hutan Mangrove di Indonesia.* Bogor: Laboratorium Ekologi Hutan Fakultas Kehutanan Institut Pertanian Bogor.

- LPP Mangrove. 2000. *Draft Strategi Nasional Pengelolaan Ekosistem Mangrove Indonesia*. Bogor: LPP Mangrove.
- Marsono Dj. 1989. Structure and composition of mangrove vegetation in Cilacap. *In: Soerianegara I, Zamora PM, Kartawinata K, Umaly RC, Tjtrosomo S, Sitompul DM, Rosalina U (Eds). Symposium on Mangrove Management: Its Ecological and Economic Considerations. Biotrop Special Publication 37: 73-114.*
- Mustafa M, Nurkim, Soegondo H, Sutika N, Sanusi H. 1979. Penelitian komunitas lingkungan dan regenerasi serta pengembangan hutan mangrove di Sulawesi Selatan, Universitas Hasanuddin, Ujung Pandang.
- Soegiarto A. 1984. The Mangrove Ecosystem in Indonesia: Its Problems and Management. *In: Teas HJ. (Ed.). Physiology and Management of Mangroves: 69-78. W. Junk Publishers, The Hague.*
- Soemodihardjo S, Soerianegara I. 1989. The status of mangrove forests in Indonesia. *In Soerianegara I, Zamora PM, Kartawinata K, Umaly RC, Tjtrosomo S, Sitompul DM, Rosalina U (Eds.). Proceedings symposium on mangrove management: its ecological and economics considerations: 73-114. Bogor: SEAMEO-BIOTROP.*
- Soemodihardjo S, Wiroatmodjo P, Abdullah A, Tantra IGM, Soegiarto A. 1993. *In: Clough BF (Ed.). The Economic and Environmental Values of Mangrove Forests and Their Present State of Conservation in The South-East Asia/Pacific Region, Hal. 17-40. ISME-ITTO-JIAM, Jepang.*
- Soerianegara I, Naamin N, Hardjowigeno S, Abdullah A, Soedomo M. 1986. Prosiding diskusi panel dayaguna dan batas lebar jalur hijau hutan mangrove. Jakarta: MAB-LIPI.
- Sukardjo S. 1979. Hutan payau di Kuala Sekampung, Lampung Selatan, Sumatera. *In: Soemodihardjo S, Nontji, Djamali (eds.). Prosiding Seminar Ekosistem Hutan Mangrove: 59-68. Jakarta: LIPI.*
- Sukardjo S. 1980. The mangrove on the New Cimanuk Delta. Presented at the LIPI-UNO join seminar on the Coastal Resources of the Cimanuk, West Java, Indonesia.
- Sukardjo S, Kartawinata K, Yamada I. 1984. The mangrove forest in Bungin river, Banyuasin, South Sumatra. *In: Soepadmo E, Rao N, MacIntosh DS (Eds). Proceedings Asian symposium on mangrove environment: research and management: 121-141. Paris: UNESCO.*
- Versteegh F. 1952. Problems of silviculture and management of mangrove forests. Asia and Pacific Forestry Commission, 1 – 13 December 1952, Singapore.
- Widiarti A, Effendi R. 1989. Socio-economic aspects of tambak forest in mangrove forest complex. *In: Soerianegara I, Zamora PM, Kartawinata K, Umaly RC, Tjtrosomo S, Sitompul DM, Rosalina U (Eds). Proceedings symposium on mangrove management: its ecological and economic considerations: 275-279. Bogor: SEAMEO-BIOTROP.*
- Wiroatmodjo P, Judi DM. 1979. Pengelolaan hutan payau di Indonesia. *In: Soemodihardjo, Nontji, & Djamali (Eds). Prosiding seminar ekosistem hutan mangrove: 191-198. Jakarta: MAB – LIPI.*

- Yamada I, Sukardjo S. 1980. Ecological study of mangrove and swamp forest in South Sumatra. *In*: Tsubouchi Y, Ilyas N, Takaya Y, Hanafiah AR (Eds). South Sumatra, Man and Agriculture: 1-34. The Center for Southeast Asian Studies, Kyoto University, Jepang.
- Zuna HY. 1998. Analisis Ekologi-Ekonomi Sistem Tambak Tumpangsari di RPH Poponcol, Desa Mayangan, Kabupaten Dati II Subang [Thesis]. Bogor: Graduate School of Bogor Agricultural University.