Southeast Asian Studies, Vol. 31, No. 2, September 1993

The Present Status of the Mangrove Forests in the Northern Coast of West Java with Special Reference to the Recent Utilization

Sukristijono SUKARDJO*

Abstract

The mangrove forests in the northern coast of West Java are estimated to be about 32,353.66 ha (1987). They are mostly the young stands (62.83%). The mangrove ecosystem in the northern coast of West Java has been heavily disturbed partly due to population explosion and rapid development, and partly because of various demands, e.g. fire wood for subsistence and for sale. Reliable information on deforestation rate due to over-exploitation of fire wood etc., is highly needed to work out a rational afforestation plans to control deforestation. This paper aims at brief discussion on the present status of utilization and management of mangrove forests in the northern coast of West Java.

Introduction

The mangrove ecosystem in the northern coast of West Java played an important role in local economy for the people living in the area [Sukardjo 1980a ; 1982a ; 1987a].

There are seven rivers running from upland to the northern coast of West Java. Due to wide environmental variability of the estuaries and coastal surface topography, the mangrove ecosystem of the northern coast of West Java provides an interesting natural laboratory for ecologists [Sukardjo and Akhmad 1982].

In terms of national awareness, it has been widely appreciated that mangroves provide valuable and essential natural resources. Nevertheless, it is almost certainly true that the incidence of destructive activities in the northern coast of West Java could and would reduce the extent of mangrove forests. Therefore, research and more effective guidelines for their conservation and management are urgently needed [Sukardjo 1980a ; Sukardjo and Toro 1988].

The objectives of the present paper is to assess the utilization of the mangrove forest and their management implication with special reference to the recent activities of the people in the coastal zone.

* The Centre for Oceanological Research and Development, Indonesian Institute of Sciences, Jl. Pasir Putih 1 Ancol Timur, P. O. Box 4801, Jakarta 11048, Indonesia

The Study Area

The total areas of mangrove forests in the northern coast of West Java are estimated at about 32,353.66 ha (1987) ; and are found mainly in Jakarta Bay and from Ujung Karawang to Indramayu (Fig. 1, Table 1). Very little quantitative ground data are available for that sector to be used for evaluation and record of the total loss of mangrove areas in the region. I believe that the total mangrove forest areas are still as conservative estimated [cf. Darsidi 1987]. Wirjodarmodjo and Hamzah [1984] reported that the Perum Perhutani Unit III (The State Forestry Corporation) managed a mangrove forest with an area of about 32,530 ha. The present extent and distribution of mangrove forests are discontinuous from Mauk to Cirebon (Fig. 1). They are managed partly by Perum Perhutani and partly by PHPA (Direktorat Perlindungan Hutan dan Pengawetan Alam=Directorate of Forest Protection and Nature Conservation of the Department of Forestry).

The mangrove communities in the region comprise small to medium sized trees, shrubs, vines, palms, and oddly thrive in a habitat which is hostile to most faunal and floral

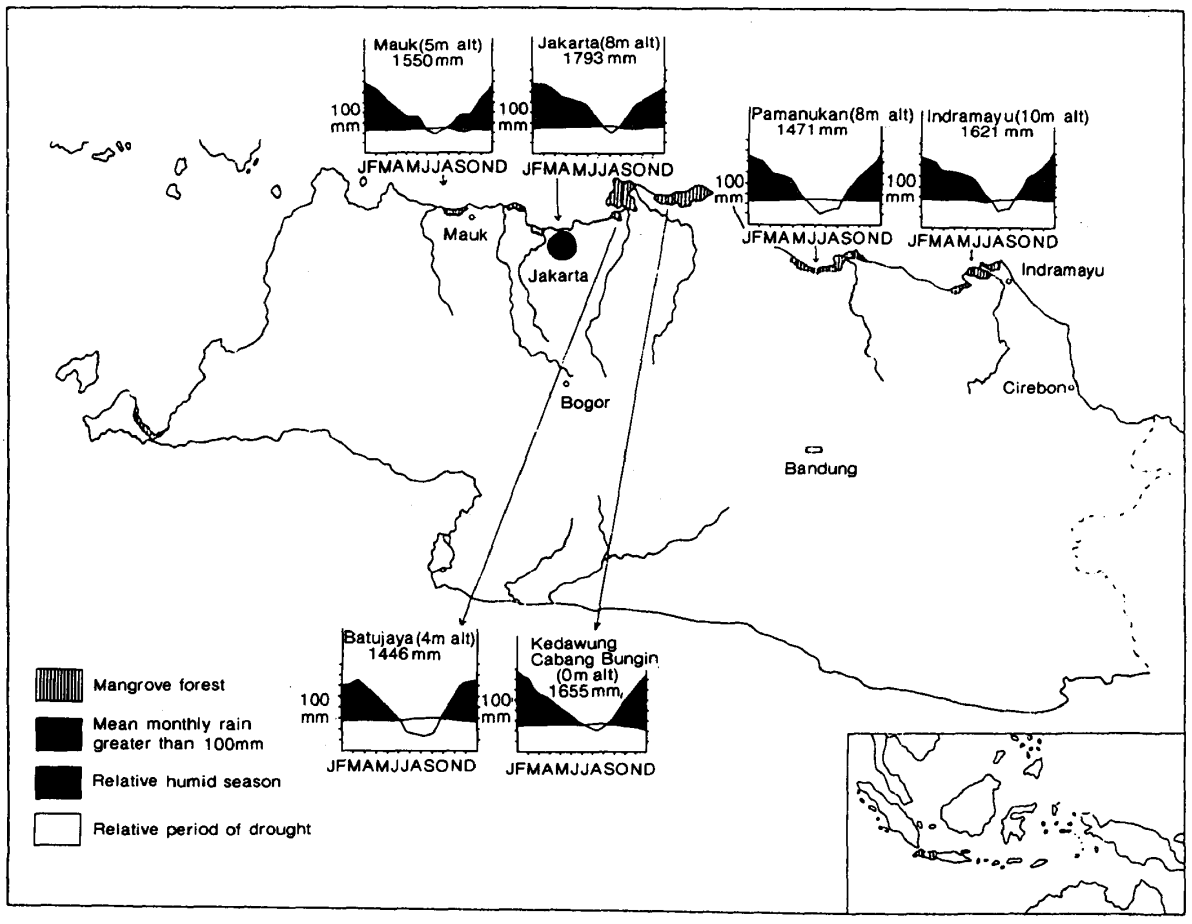

Fig. 1 A map Showing the Locations and the Climate Diagrams of the Mangrove Forest Areas on the Northern Coast of West Java

Table 1 The Mangrove Forest in the Northern Coast of West Java

Administrative level			Size	Total
KPH= Forest District	BKPH= Sub Forest District	RPH= Forest Ranger	(ha)	size (ha)
KPH Bogor	Ujung Karawang	—	10,481.15	
	Tangerang	—	1,647.10	12,128.25
KPH Indramayu	—	Cemara	1,748.30	
		Cangkring	2,080.73	
		Purwa	1,903.18	
		Pabean Ilir	1,395.35	7,127.56
KPH Purwakarta	Cikiong	Pakis	1,114.70	
		Cikeruh	1,401.30	
		Pangakaran	1,518.10	
		Ciwaru	2,080.50	
		Cibuaya	1,707.35	
	Ciasem	Tegal Tangkil	707	
	Pamanukan	Muara Ciasem	785.20	
		Poponcol	1,461.80	
		Bobos	2,257.40	13,097.85
Kapuk-Muara Angke*	—	—	95	95
				32,353.66

Source : Perum Perhutani [1987]
Note : * Nature reserve managed by PHPA

lives. Floristically, 32 species of the true mangrove species are found (Table 2). KPH (Kesatuan Pemangkuan Hutan=Forest District) Bogor area, KPH Indramayu area, and Seribu Islands have 27 species of mangrove whilest KPH Purwakarta area and Muara Angke area only 24 and 22 species, respectively. Only 10 species occur as dominant and co-dominant in each community. *Avicennia alba* and *A. marina* are found to be dominant in most forest district areas, viz in Muara Angke [Sukardjo 1988a ; 1989a], in Cimanuk delta complex of the KPH Indramayu [Sukardjo 1980b], and in Tanjung Karawang of the KPH Bogor [Djaja *et al.* 1984]. *Rhizophora apiculata* stands are found abundantly in KPH Bogor, KPH Indramayu and KPH Purwakarta as young forests, e. g. in Tiris of the KPH Indramayu [Sukardjo 1988b]. Significant communities are found due to natural stressors and human interferences (e. g. illegal cutting, haphazard felling and conversion). An ecological study of a natural rejuvenation in those areas had been recently reported by Sukardjo [1984a ; Sukardjo *et al.* 1985] and floristic inventory by Sukardjo [1980a] and Sukardjo and Akhmad [1982]. Knowledge of the management and its problems caused by traditional uses are summarized and reviewed by Wirjodarmodjo and Hamzah [1984], Perum Perhutani Unit III Jawa Barat Bandung [1984], Perum Perhutani Unit III Jawa Barat [1984], Perum Perhutani Unit III Jawa Barat Kesatuan Pemangkuan Hutan Indramayu [1984], Perum Perhutani KPH Bogor [1984], and Tim Ekosistem Mangrove

Table 2 List of Mangrove Species and Their Relative Dominant in the Northern Coast of West Java

Species	KPH Bogor area	KPH Indramayu area	KPH Purwakarta area	Seribu islands	Mauk to Muara Angke
1	2	3	4	5	6
I. TREES:					
APOCYNACEAE					
1. Cerbera manghas L.	† (10)	† (5)			† (5)
COMBRETACEAE					
2. Lumnitzera littorea (Jack) Voilt.	† (8)			†† (40)	
3. L. racemosa L.	†† (8)	† (5)	† (6)	† (25)	† (5)
EUPHORBIACEAE					
4. Excoecaria agallocha L.	††† (25)	† (4)	† (8)	†† (10)	†† (10)
LYTHRACEAE					
5. Pemphis acidula J. R. & G. Forst.				†††† (70)	† (5)
MELIACEAE					
6. Xylocarpus granatum Koen.	†† (13)	† (2)	† (5)	†† (25)	
7. X. moluccensis (Lamk.) Roem	† (6)	† (4)	† (6)	† (14)	
MYRSINACEAE					
8. Aegiceras corniculatum (L.) Blanco	†† (255)	†† (45)	† (10)	†† (12)	† (4)
PALMAE					
9. Nypa fruticans Wurmb.	† (5)	† (7)	† (10)	† (2)	† (4)
RUBIACEAE					
10. Syphyphora hydrophyllacea Gaertn.		† (6)	† (4)	† (50)	
RHYZOPHORACEAE					
11. Bruguiera cylindrica (L.) Lmk.	†† (13)	† (3)	†† (35)	†† (8)	
12. B. gymnorrhiza (L.) Lmk.	†† (22)	† (18)	†† (22)	† (2)	† (4)
13. B. parviflora (Roxb.) White & Arn. ex Griff.	† (5)	† (9)			
14. B. sexangula (Lour). Poir.	† (10)	† (4)	† (2)		
15. Ceriops decandra (Griff). DingHou	† (4)	† (6)		† (13)	† (2)
16. C. tagal (Perr). C. B. Robins	† (8)	† (3)	† (4)	††† (10)	† (2)
17. Rhizophora apiculata Bl.	††††† (120)	†††† (114)	††† (90)	†††† (40)	†† (22)

Table 2 Continued

1	2	3	4	5	6
18. R. mucronata Lmk.	††† (80)	†††† (85)	†† (40)	††† (430)	†† (40)
19. R. stylosa Griff.	†††† (25)	† (2)		††††† (100)	† (2)
20. Kandelia candel (L.) Druce			† (4)		
SONNERATIACEAE					
21. Sonneratia alba J. E. Smith	†† (8)	†† (10)	††† (50)	†† (40)	†† (12)
22. S. caseolaris (L.) Engl.		† (4)	† (8)	† (10)	† (4)
23. S. ovata Back				† (4)	
VERBENACEAE					
24. Avicennia alba Bl.	††††† (185)	††††† (220)	††††† (320)	††† (40)	†††† (224)
25. A. marina (Forsh.) Vierh.	††††† (125)	††††† (215)	††††† (230)	†† (50)	†† (45)
26. A. officinalis L.	††† (102)	†††† (320)	††††† (275)	† (5)	††† (15)
STERCULIACEAE					
27. Heritiera littoralis Dryand ex. W. Ait	† (4)	†† (14)	†† (18)	† (4)	
II. HERBS :					
28. Acanthus ebracteatus Vahl.	††	††	†††	†	†
29. A. illicifolius L.	†††	††††	††††	††	††††
30. A. volubilis Wall.	†				†
POLYPODIACEAE					
31. Acrostichum aureum L.	†††	†††	††	††	†††††
III. CLIMBERS :					
LEGUMINOSAE					
32. Derris heterophylla Backer.	†††	††††	††††	††	†††††

Key to Table : ††††† : Dominant = more than 50%
†††† : Very Common = 5-50%
††† : Common = 0.5-5%
†† : Less Common = 0.1-0.5%
† : Rare = 0.1%
Value in parentheses means average density per hectare.

MAB LIPI-Perum Perhutani [1984]. Information on mangrove litter fall production is limited only to the area in Muara Angke-Kapuk, Tiris of the KPH Indramayu and Rambut Island [Sukardjo 1989a ; 1989b ; Brotonagoro and Abdulkadir 1979]. The results of the one year studies indicated that the litter production varied from 4.95 t/ha/year to 17.5 t/ha/year. The net primary production in Muara Angke-Kapuk in the period of June 1983 to September 1984 ranged from 16.62 kg C/ha/day to 31.95 kg C/ha/day [Sukardjo 1988a].

The zonation of mangrove species parallels to the shore. This has led to application of successional models of mangrove swamp development. The mangrove forest in the region lacked the clear zonation due to heavy depletion. The coastal area receives a huge volume of sediments from seven big rivers. The mangrove contributes to trapping sediments and stabilizing the coast. The sediments are mostly clay. From comparison of map surveyed and photographs taken at different period, it was found a new land is coming up. It was reported 2,440.52 ha (1987) had been deposited during 1979 and 1987. There is little data available on mangrove soils. Soerianagara [1971] has classified mangrove soils in Ujung Karawang, as clay, but there always a great local variation, from organic peat to clay or sand [Sukardjo 1982a ; 1987b ; 1988a ; 1988b]. The particulate percentage of the soil sample taken from all stations showed the dominance of clay with a range from 51.10% to 74.10%, with a decreasing trend from the coast landward [Sukardjo 1982b ; 1987b ; 1988c]. Compaction of soil is not apparent.

The climate is over-wet to (mid-year) dry [Kartawinata 1977]. The annual rainfall ranges from 1,446 to 1,793 mm [The Institute of Meteorology and Geophysics-Department of Communication Indonesia, 1980]. The rainy season occurs from November to March or April. During the rainy season the rainfall is plentiful and regular, with less variability. The maximum rainfall occurs in January. The duration of the dry season is less than 7 months. The seasonal temperature varies less i. e., 0.9 °C. The mean monthly temperature during the dry season rarely exceeds 29.50 °C, and during the rainy season rarely drop below 25.50 °C, mostly remaining at 26.80 °C. The average relative humidity also remains fairly constant at about 65% and rarely drops below 50%. According to Schmidt and Ferguson [1951] the area belongs to D (Mauk, Indramayu and Ujung Karawang) and C (Jakarta and Pamanukan) types, with the mean number of dry months (less than 60 mm per month) from 4.0 to 4.7 and the mean number of wet months (more than 100 mm per month) from 4.8 to 6.7 ; the ratio between dry and wet months is 0-79.90%.

Material and Method

Intensive collection of vegetational and floristic data, and literature reviews were made to study the mangrove forest in the northern coast of West Java. Informations on traditional uses and exploitation of mangroves, and conversion of mangrove area into *tambak* (fish pond) and *tambak tumpang sari* (taungnya fish pond) were collected from villagers. Interviews were always carried out on an informal basis without using any sheets of questionnare.

The topography of the mangrove habitats and their interaction with adjacent ecosystems were noted based on the survey data. The management policies were also reviewed.

Table 3 Value of the Man-made Mangrove Stands in the Northern Coast of West Java

KPH= Forest District	Size (ha)	Economic value of the stand (Rp)
KPH Bogor	4,365.95	1,690,722,782.08
KPH Indramayu	4,730.45	1,831,856,766.19
KPH Purwakarta	11,897.15	4,607,194,893.83
Total	20,993.55	8,129,774,492.13

Source : Perum Perhutani [1985]

Result

Uses of the Mangrove Forest

The mangroves in the region were long exploited for firewood e. g. in Ujung Karawang-KPH Bogor [Encycl. Ned. Indie 1918 : 20], for construction materials, for fishing gears and for other marine uses products (e. g. fish pond, salt pond). There are 20,993.55 ha of man-made mangrove stands in the region with their economic value estimated at about Rp 8,129,774,492.13 (1984) ($ US equal to Rp 1,700.00) (Table 3). So far, the economic contribution of the mangroves as a resource has not been well documented [Muluk *et al.* 1980 ; Missen 1980 ; Anwar *et al.* 1986].

The traditional uses of the mangroves have mostly been for the villagers' own consumption [Sukardjo 1980a]. But the mangrove managements are partly in the hand of Perum Perhutani and partly PHPA, Department of Forestry. The two managements are differently done. Often they are conflicting to each other.

From the utilization point of view, vegetation management could be done to increase the stock of commercial mangrove species for the benefit of both Perum Perhutani and inhabitants. Dealing with the prosperity program of the Perum Perhutani, two kind of utilization of the mangrove forest can be classified as (1) sustainable uses and (2) exploitative uses.

1. Sustainable Uses

Sustainable uses is a concept involves either a sustainable harvest or sustainable economic returns, though the latter are governed by many factors beyond the control of the producer besides the site productivity and yield. The product should be renewable in perpetuity by following conservation policies and proper management practices.

1.1. Traditional Uses : There are a hundred villages in the surrounding of mangrove areas in the region. The villagers have traditionally depended on the mangrove products for their subsistence. Almost all the villagers not only consume the mangrove products for their livelihood but get cash income from the sale of marine products (e. g. Rp 3,000.00/day/fisherman in 1985). Only little published information on the utilization of mangrove by inhabitant is available [Sukardjo and Akhmad 1982 ; Sukardjo 1986 ; Heyne 1952].

Five years (1983-1988) observation by the author in the Ciasem-KPH Purwakarta, Pamanukan and Cimanuk delta complex-KPH Indramayu disclosed that fish traps on the tidal flats and fishing plat forms within the mangroves were common. Many plants are used for food, e. g. soft stems of *A. marina*, young roots of *R. stylosa* and *N. fruticans*, and hypocotyls of *B. gymnorrhiza*. Interviews with the elders revealed that mangroves were utilized predominantly for fuelwood, wood carving, tanbark and thatching materials (*N. fruticans*). The nipa palms were usually harvested on a rotation of four to five months. A fisherman usually collected up to three bundles of leaflets a day, equivalent to Rp 4,500.00 (December 1988). The inhabitants exploited the mangroves for both home consumption and market demand. When mangroves are utilized for subsistence purposes, the mangrove ecosystem maintains its equilibrium state.

1. 2. Grazing: Mangroves are grazed upon by domestic animals, such as goat, sheep, cattles and buffaloes. Mangroves are particularly nutritious. Due to lack of strict vigilance, the mangrove forest reserves were also subject to intense grazing. Those mangrove species as *Rhizophora* spp., *Avicennia* spp. and *Sonneratia* spp. are suitable for food. *Acanthus* spp., *Derris trifoliata* are frequently used to feed goats and sheeps. Their high salt and iodine contents are highly acknowledged.

In the Cimanuk delta complex-KPH Indramayu, buffaloes graze the mangroves, particularly *Avicennia* spp. as prefered species. Over-grazing by domestic animals has not occurred yet. No reports disclosed the impact of domestic animals to the destruction of seedlings, rejuvenigation of the forest, or growth of the trees. The mangrove forests are not regarded as a target of range management. No official care are taken for maintaining the forest condition. But traditionally, the villagers take responsibility for artificial plantation of prefered species, such as *Avicennia* spp. Those activities were observed in the Cimanuk delta complex-KPH Indramayu.

1. 3. Firewood: Firewoods were long exploited from mangrove forest traditionally and culturally. It is evident that the demand for firewood and charcoal is increasing for cooling, heating and ironing especially in the rural areas. Table 1 shows the areas of the mangrove forest. In KPH Indramayu (7,127.56 ha), only 6,937.33 ha (97.33% of the total area) of mangrove forests was declared as production forest. The potential production of firewood was estimated at 30 sm ha 20 years cycle, or in total 129,722.40 sm. Firewood and charcoal wood are harvested essentially in the same manner. But firewood does not need debarkation. The harvestable tree sizes are not yet regulated. And the people cut trees down indiscriminately. The commonly used species are *Avicennia, Sonneratia* and *Rhizophora*. Villagers can usually collect two pikuls a day (about 40 kg fresh weight), thus earning Rp 7,500.00 (1985). Firewood consumption in the village was influenced by family size and season. During the aggravative difficulties of food in the dry season, the demand for firewood as cash crop increased considerably. The mean firewood consumption per individual per year estimated at 3.93 sm. Volume figures are calculated on the assumption that 1 sm of wood weighs 600 kg.

2. Exploitative Uses

Exploitative uses of mangrove forest involve conversion of mangrove areas to other uses resulting in irreversible changes in land use pattern.

2. 1. Salt Ponds : The 496 ha of mangrove forest has been totally converted into salt ponds. Most of them are located in the Sukamandi to Indramayu areas. Muara Eretan is the main area of salt production and is a representative of the traditional salt grounds of the region. The salt is produced by permanent resident villagers. The production under moderate operation is nearly 150 t salt/ha/year. The salt is for domestic consumption and local market demand.

The construction of salt pond results in total eradication of vegetation, levelling and diking of the area, building of drainage channels and canals and mechanical compaction of the soil surface. The process also threatens the adjoining area as a result of infrastructure and population growth.

2. 2. Tambak (Fish Pond) : *Tambak,* shrimp and fish farming, is widely practiced in the region. Shrimp and fish ponds are built on the clear-cut site, levelling, and building embankments. The area of tambak increased from 35,550 ha in 1980 to 41,420 ha in 1982, not including areas converted into *tambak tumpang sari* and abundoned without replanting.

2. 3. Human settlements : More than 480.723 ha of mangrove forest have been reclaimed for settlement. It is defined as a self-sustaining community that depends upon the mangrove and estuarine areas for livelihood without destructing the ecosystem. These human settlements create heavy pressure on coastal ecosystem.

Issues and Problems on Mangrove Resources

The human population of the region is still increasing and is expected to continue increasing until at least the turn of century.

Recently, the magnitude of industrial and agricultural activities, and the affluence and life style of most inhabitants have had a considerable impact on mangroves. The human activities which constitute threats to the survival of mangroves are numerous and in many cases overlapping and destructively synergistic in their effects.

The illegal over cutting without replanting has sometimes converted forests into wasteland. This has increased erosion and loss of soil fertility. The land-hungry people are eager to pursue a lot for paddy and often ignore the management of a forest. Over exploitation of single product of any kind leading to the direct destruction is the most serious problem in the region.

Increasing people living in the surrounding mangrove forest areas pose conflicting demands on the mangrove resources. *Avicennia* spp. is the most abundant species and is subjected to illicit felling for firewood. In five years observation (1975-1980), destruction of the mangrove forest by illicit felling estimated at about 1,720.15 ha. As a result, the general growth of mangroves has become very poor in the region and their average height of the stands is about 2.5 m (e. g. in Cimanuk delta complex-KPH Indramayu and in KPH

Purwakarta) with diameter less than 5 cm. The average diameter of stands before illicit felling was 11.75 cm with a mean annual increment in DBH of individual trees of 0.85 cm. Due to the opening of the canopy, many areas are invaded by the grasses and sedges at a fast rate which makes it difficult for the development of propagules. Regeneration is always poor in such areas, with the seedling mortalities for *Avicennia, Sonneratia, Ceriops, Bruguiera* and *Rhizophora* being 75.20%, 70.15%, 80.50%, 85.75% and 90.10%, respectively.

Mangrove Rehabilitation

In the region the loss of mangrove area due to human interference estimated to be about 4,870 ha (1975-1985), and the greatest extent found in the Ciasem-Pamanukan, KPH Purwakarta (113.81 ha).

The rehabilitation and regeneration of denuded mangroves is intensified and realized through reforestation activities, with the Perum Perhutani as the leading agency (Table 4). Replenishment of denuded mangrove in the KPH Indramayu was undertaken by the Perum Perhutani Unit III through the various projects within its supervision e. g. project MALU. This project had both social and economic objectives. The social objective was to encourage the inhabitants to participate in the artificial regeneration of the mangrove forest and thereby to solve the conflicts of interest that often divide forestry specialists and inhabitants when the latter feel they are being deprived of arable land and are not benefiting from reforestation activities. The economic objective was to increase the quality and value of the plantation. Since 1968 the Perum Perhutani took initiative in rehabilitation of the degraded mangrove areas especially located at KPH Purwakarta for both forestry and fishery purposes. The basic idea was the healthy mangrove forest contributed significantly to inhabitants.

Reforestation species adopted were *Rhizophora* (KPH Bogor, KPH Indramayu), *Avicennia* (KPH Indramayu), *Ceriops* (KPH Bogor), *Bruguiera* (KPH Purwakarta), *Sonneratia* (KPH Purwakarta) and non-mangrove species viz, *Hibiscus tiliaceus* (451.21 ha in KPH

Table 4 Size and Cost of the Mangrove Forest Rehabilitation/Afforestation by the Perum Perhutani Unit III up to 1983

KPH= Forest District	Period	Size (ha)	Cost (Rp)
KPH Bogor	1967-1975	166.95	6,845,775.00
		4,199.00	130,954,900.00
KPH Indramayu	1964-1974	349.05	18,010,980.00
		6,080.32	247,801,969.00
KPH Purwakarta	1968-1974	376.00	19,401,600.00
	1975-1983	13,801.65	653,971,019.72
Total		24,972.97	1,075,986,243.72

Source: Perum Perhutani [1985]

Table 5 The Man-made Mangrove Stands in the Northern Coast of West Java in 1983

KPH	Age class (years)	Year of planting period	Species and Size (ha)				Total Size (ha)
			Rhizophora	Rhizhopora+ Avicennia	Avicennia	Other	
Bogor	III 10-16	1967-1967	—	123.00	—	—	123.00
	II 5-9	1974-1978	—	1,605.95	—	1,413.00	3,018.95
	I 0-4	1979-1983	—	2,469.00	—	5,286.05	7,755.05
		Sub total	—	4,197.95	—	6,699.05	10,897.00
Indramayu	IV 16-19	1964-1967	71.05	—	—	—	71.05
	III 10-14	1969-1973	168.00	—	—	—	168.00
	II 5-9	1974-1978	2,375.38	—	—	100.00	2,475.38
	I 0-4	1979-1983	1,832.18	—	—	302.67	2,134.85
		Sub total	4,446.61	—	—	402.67	4,842.30
Purwakarta	III 11-15	1968-1972	106.50	71.50	66.10	—	244.45
	II 6-10	1973-1977	565.90	900.80	253.40	—	1,720.10
	I 0-5	1978-1985	7,158.45	2,042.41	608.89	123.20	9,932.95
		Sub total	7,830.85	3,014.71	928.39	123.20	11,897.15
		total	12,277.46	7,212.66	928.39	7,224.92	27,636.45

Source : Perum Perhutani [1985]

Indramayu) and *Acasia auriculiformis* (123.83 ha in KPH Purwakarta). The initial implementation took place in the BKPH (=Balai Kesatuan Pemangkuan Hutan) Ciasem Pamanukan in 1968, reforesting about 930 ha with *Avicennia* during 1968-1971, 1,191 ha with *Rhizophora*, 1969 and 1983, and 3,015 ha with mixed of *Avicennia* and *Rhizophora* during 1969-1982. Natural regeneration of *Avicennia* accounted for about 230 ha. On silty clay or clayey sites of the BKPH Ciasem Pamanukan where salinity is moderate, *Sonneratia caseolaris* is planted. By 1983 the total area of mangrove reforestation covered 27,636.45 ha (Table 5). The Perum Perhutani hopes to expand the reforestation project into populated area (e. g. in BKPH Ujung Karawang), as an integrated social forestry concept, i. e. *tambak tumpang sari* [Sukardjo 1989c]. The area under *tambak tumpang sari* project reached to 5,010.254 ha in BKPH Ujung Karawang (KPH Bogor), 50 ha in RPH (=Resort Polisi Hutan) Ciasem (KPH Indramayu) and 1,290 ha in KPH Purwakarta. Afforestation offers a chance of employment of a large number of people. Perum Perhutani reported that raising and tending man-made forests in mangrove areas during 1964-1983 generated employment of a thousand local people. It was calculated that a fisherman had a total income of Rp 3,730.00 per day in 1984. For the success of *tambak tumpang sari*, the population living surrounding the mangrove forest should be participating in the project and other program, e. g. conservation [Sukardjo 1987a].

Very few research on the problems of species establishment and survival in the mangrove rehabilitation areas. On the other hand, invasion of brackish and or fresh water

grasses and sedges such as *Panicum repens, Paspalum commersonii, P. vaginatum* and *Cyperus malaccensis* into the mangrove forest (e. g. in the Cimanuk delta complex) will be serious plant competitors to the mangrove seedlings and hinder the establishment of mangrove seedlings [Sukardjo 1984a ; Sukardjo *et al.* 1985]. Moreover, those species are observed spreading rapidly, and pose the main problem in the mangrove rehabilitation.

The Goal and Scope of Management

The management of the mangrove forests has always been the responsibility of the Perum Perhutani and Department of Forestry. The objective of management for mangroves in the region was to controll exploitation for firewood, and utilize their modified habitat for settlement, salt bed, *tambak* or agriculture. In Ujung Krawang mangrove forest (KPH Bogor) these goals already have been employed to develop mangrove management strategy [Tim Ekosistem Mangrove MAB LIPI and Perum Perhutani 1984]. With respect to the poor people and with the imposition of the Perum Perhutani working plans, the objective of management for the mangrove forests in the northern coast of West Java was to satisfy the domestic demands for fuelwood. However, recently the objectives were broadened to cover aspects of regeneration (natural and artificial) and conservation, and to ensure a fuller utilization of the mangrove resources.

As a result of the limited success and difficulties experienced with natural regeneration and spectacular achievements of certain plantations such as *Ceriops* and *Bruguiera*, and non mangroves species (*H. tiliaceus* and *A. auriculiformis*) many foresters unanimously recommended the artificial regeneration. The poorness of natural regeneration of the mangrove forest complicates the problem of forest degradation, reaches to the conservation issue in Java.

The establishment of one or more reserves looked a key feature in any mangrove management plan ; and administrative control over adjoining land and water of the reserve is essential. The flora and fauna of mangrove forest strongly depend on the adjoining tidal wetland habitat (e. g. in the Cimanuk delta complex [Sukardjo 1987a]). A management plan needs to provide a comparably high larger area. Sound management should be based on the knowledge on silviculture and ecology of the mangrove forest. Also, zonal structure of mangrove forests differs from place to place. A wider range conservation is highly wanted.

Discussion and Conclusions

Mangroves in the region at present are either natural or man-made. Descriptions of natural mangrove forests have been outlined [Sukardjo 1980a ; 1980b ; Sukardjo and Akhmad 1982]. The structural community analyses of each different physiography will be valuable for large scale resource assessment mapping of the mangrove vegetation in the northern coast of West Java.

Recently, there are many mangrove forest areas in the northern coast of West Java which have been developed through salt bed (96 ha in KPH Indramayu), *tambak* (5,010.254 ha in BKPH Ujung Karawang-KPH Bogor, 50 ha in KPH Indramayu), homesteads (103 ha in KPH Purwakarta, 35.92 ha in KPH Indramayu, 31.403 ha in BKPH Ujung Karawang-KPH Bogor), rice field (304.90 ha in KPH Purwakarta, 1,467.32 ha in BKPH Ujung Karawang-KPH Bogor), cultivable land (1,251.87 ha in BKPH Ujung Karawang-KPH Bogor, 1,391.75 ha in KPH Indramayu) and rental land (306.40 ha in KPH Indramayu). Accordingly, resource survey of mangrove forests in the northern coast of West Java through remote sensing is quite an important task [Sukardjo 1980a].

Growing awareness of the important economic aspects of marine production in the coastal belt of the northern coast of West Java calls for a better understanding of mangrove forests as an ecosystem. Recently, mangrove ecosystem in the northern coast of West Java is delicate and complex, and their principal parameters are the physical and chemical environment, the flora, the fauna and human interference. Each component of the environment, namely, climate, salinity, fresh water supply, siltation, erosion, substrate and nutrient acts on the flora and fauna of the mangrove ecosystem, and, in turn, these influence the environment.

There is a new land formation in the northern coast of West Java which estimated to be about 4,870 ha and these materials will serve as a guide for the expansion of future mangrove plantation programmes. To assist the process of siltation and promote species succession, afforestation of newly formed lands is being done by the Perum Perhutani. Preliminary afforestation is a good technique to assists in the stabilization of new formations. Detailed studies of local hydrology are important for locate favourable planes for new formation and predict their permanence, if stabilized by mangroves afforestation techniques. Afforestation in the coastal belt of the northern coast of West Java and conservation of mangrove forests (7,195 ha) will help in consolidating the newly accreted land. A part from the accretion studies, a land reclamation process (1,740 ha in BKPH Ciasem-Pamanukan-KPH Purwakarta) should be introduced to make the land more productive. Conservation of mangrove ecosystem requires that resources exploitation by Perum Perhutani is kept within sustainable limits. The scientific problem is to define these sustainable limits.

Dealing with the muddy habitats, information is scanty on the processes which permit the establishment of pioneer mangroves on tidal mudflat in the northern coast of West Java. It is necessary to know about the factors that favour or inhibit seedling establishment and growth to maturity, and more about the life span of mangroves. In broader terms, data on the biological production of mangrove forests, and changes in standing crop or total biomass that proceed with time are needed badly. On the basis of such information, it would be possible to determine the degree of stability of a mangrove system, and to decide the extent to which changes in progress are natural, or a response to man's activities. No detailed research has been done on the importance of natural stressors for

mangrove ecosystem in the northern coast of West Java. Studies when conducted will probably indicate that these natural stressors have long term effects on the floristics, structure and stability of these ecosystems. Research in this field is urgently needed.

Mangrove forests have played an important role in the socio-economic life of the people in the northern coast of West Java at subsistence level and lately at commercial scale. These forests are now being rehabilitated. Single use options for *tambak* are not to be permitted anymore, and the mangrove dependent people (631 people per km^2) are not ignorant of the importance and value of the mangrove forest. They are aware of the many benefits they derive from it. They have changed their own uses with the conversion of *tambak* into *tambak tumpang sari* (40,257 ha) with *Avicennia* and *Rhizophora* as main crop. Aside from this they also have their own concept of law and their attitude toward law enforcement. Mangrove destruction is by and large attributable to people who live outside the mangrove, more often that not, big city dwellers. Many *tambak* in the northern coast of West Java are owned by the well-to-do people from Jakarta. Thus, in this case, the inhabitant are only labourers who work for the owner somewhere in Jakarta. From information sources [e. g. Heyne 1952; Sukardjo 1980a; Sukardjo and Akhmad 1982; Sukardjo and Toro 1988] it is clear that mangrove forests in the northern coast of West Java have had a long history of use for many purposes. Elsewhere in the northern coast of West Java, the harvest by Perum Perhutani appears to be minor extent, and specifically managed and carried out in satisfaction of inhabitants and Perum Perhutani needs. As far as I am aware, mangrove forests are utilized commercially in the northern coast of West Java, but the integrated benefits in terms of forestry and fisheries are primarily their goal (e. g. *tambak tumpang sari*). Optimalization of management, whether for firewood, fisheries production, or for ecological purposes, depends on a broad understanding of the primary productivity of mangrove ecosystems. In elucidating these interactions it is important to recognize that many environmental factors that influence primary productivity individually may also have synergistic effects that must be taken into account.

Acknowledgments

The author is very grateful to anonymous referees who read critically the manuscript.

References

Anwar, E.: Wibowo, R.; and Rachman, A. M. A. 1986. Konsepsi pembangunan wilayah pantai dalam hubungan dengan penentuan jalur hijau [The Concept of Coastal Zone Development in Relation to the Establishment of Green Belt]. In *Prosiding Diskusi Panel Daya Guna dan Batas Lebar Jalur Hijau Hutan Mangrove, 27 February - 1 March 1986, Ciloto,* edited by I. Soerianagara; S. Hardjowigeno; N. Naamin; M. Sudomo; and A. Abdullah, pp. 85-98. Jakarta:

LIPI Panitia Program MAB Indonesia.

Brotonagoro, S. ; and Abdulkadir, S. 1979. Penelitian pendahuluan tentang kecepatan gugur daun dan penguraiannya dalam hutan bakau P. Rambut [Litter Fall and Its Decomposition in Mangrove Forest of Isle Rambut]. In *Prosiding Seminar Ekosistem Hutan Mangrove, 27 February - 1 March 1978, Jakarta,* edited by S. Soemodihardjo ; A. Nontji ; and A. Djamali, pp. 81-85. Jakarta : LIPI Panitia Program MAB Indonesia.

Darsidi, A. 1987. Perkembangan pemanfaatan hutan mangrove di Indonesia [Mangrove Forest Utilization in Indonesia]. In *Prosiding Seminar III Ekosistem Mangrove, 5-8 August 1986, Denpasar-Bali,* edited by I. Soerianagara ; S. Adisoemarto ; S. Soemodihardjo ; S. Hardjowigeno ; M. Sudomo ; and O. S. R. Ongkosongo, pp. 27-37. Jakarta : LIPI Panitia Program MAB Indonesia.

Djaja, B. ; Sudargo, G. ; and Indrasuseno, B. 1984. Hutan Mangrove di Tanjung Karawang, Bekasi Jawa Barat [The Mangrove Forest of Tanjung Karawang Bekasi West Java]. In *Prosiding Seminar II Ekosistem Mangrove, 3-5 August 1982, Baturraden,* edited by S. Soemodihardjo ; I. Soerianagara ; M. Sutisna ; K. Kartawinata ; Supardi. ; N. Naamin ; and H. Al. Rasyid, pp. 156-162. Jakarta : LIPI Panitia Program MAB Indonesia.

Encyclopaedie van Nederlandsch-Indie 2^e drunk, 2^e decl. 1918. Leiden : Brill.

Heyne, K. 1952. *De Nuttige Planten van Nederlandsch Indie.* Buitenzorg.

Kartawinata, K. 1977. The Ecological Zones of Indonesia. Paper presented at the 13th Pacific Science Congress, 18-20 August 1977, Vancouver, Canada. 6 p.

Missen, G. 1980. Socio Economic Studies in Java in the Content of a Coastal Resource Evaluation. In *Proc. of the Jakarta Workshop on Coastal Resources Management,* edited by E. C. F ; Bird and A. Soegiarto, pp. 47-53. Tokyo : The United Nation University.

Muluk, C. ; Ngadiono, Koesoebiono ; and Partoatmodjo, S. 1980. Model Development for Integrated Utilization of Land-Water Interactive Resource Systems in the Coastal Part of the Citarum Watershed. In *Proc. of the Jakarta Workshop on Coastal Resources Management,* edited by E. C. F. Bird and A. Soegiarto, pp. 8-17. Tokyo : The United Nations University.

Perum Perhutani. 1985. Laporan tahunan pengelolaan hutan mangrove di wilayah utara Jawa Barat [Annual Report on the Management of the Mangrove Forest in the Northern Coat of West Java]. Unpublished Report, Jakarta. 145 p.

_____. 1987. Program rehabilitasi hutan mangrove di wilayah Perum Perhutani Jawa Barat [Reforestation Programmes in the Perum Perhutani Areas in West Java]. Unpublished Report, Jakarta. 45 p.

Perum Perhutani Unit III Jawa Barat Bandung. 1984. Pengalaman dalam pengelolaan hutan payau di Jawa Barat [On the Management of the Mangrove Forest in West Java]. In *Prosiding Seminar II Ekosistem Mangrove, 3-5 August 1982, Baturraden,* edited by S. Soemodihardjo ; I. Soerianagara ; M. Sutisna ; K. Kartawinata ; Supardi. ; N. Naamin ; and H. Al. Rasyid, pp. 50-52. Jakarta : LIPI Panitia Program MAB Indonesia.

Perum Perhutani Unit III Jawa Barat. 1984. Pengelolaan hutan mangrove KPH Purwakarta [The Management of Mangrove Forest at Purwakarta Forest District]. In *Prosiding Seminar II Ekosistem Mangrove, 3-5 August 1982, Baturraden,* edited by S. Soemodihardjo ; I. Soerianagara ; M. Sutisna ; K. Kartawinata ; Supardi ; N. Naamin ; and H. Al. Rasyid, pp. 53-56. Jakarta : LIPI Panitia Program MAB Indonesia.

Perum Perhutani Unit III Jawa Barat Kesatuan Pemangkuan Hutan Indramayu. 1984. Pengelolaan hutan mangrove di KPH Indramayu [The Management of Mangrove Forest at Indramayu Forest District]. In *Prosiding Seminar II Ekosistem Mangrove, 3-5 August 1982, Baturraden,* edited by S. Soemodihardjo ; I. Soerianagara ; M. Sutisna ; K. Kartawinata ; Supardi. ; N. Naamin ; and H. Al. Rasyid, pp. 57-61. Jakarta : LIPI Panitia Program MAB Indonesia.

Perum Perhutani KPH Bogor. 1984. Pengelolaan hutan mangrove di KPH Bogor [The Management of Mangrove Forest at Bogor Forest District]. In *Prosiding Seminar II Ekosistem Mangrove, 3-5 August 1982, Baturraden,* edited by S. Soemodihardjo ; I. Soerinagara ; M. Sutisna ; K. Kartawinata ; Supardi ; N. Naamin ; and H. Al. Rasyid, pp. 62-64. Jakarta : LIPI Panitia Program MAB Indonesia.

Schmidt, F. H. ; and Ferguson, F. A. H. 1951. *Rainfall Types Based on Wet and Dry Period Ration for Indonesia with Wastern New Guinea.* Verhandelingen no. 24. Jakarta : Djawatan Meteorologi Geofisik.

Soerianagara, I. 1971. Characteristics of Mangrove Soils of Java. *Rimba Indonesia* 16 : 141-150.
Sukardjo, S. 1980a. The Mangrove Ecosystem in the Northern Coast of West Java. In *Proc. of the Jakarta Workshop on Coastal Resources Management,* edited by E. C. F. Bird ; and A. Soegiarto, pp. 54-63. Tokyo : The United Nations University.
_____. 1980b. The Mangrove in the New Cimanuk Delta. Paper presented at the Joint Seminar LIPI-UNU on the Cimanuk Coastal Resources, Jakarta, 18 August 1980. 35 p.
_____. 1982a. Mangroves of Jakarta Bay Need Conservation. *Duta Rimba* 3 (51) : 3-5.
_____. 1982b. Soil in the Mangrove Forest of the Cimanuk Delta, West Java (Indonesia). *Biotrop Spec, Publ.* No. 17 : 191-201.
_____. 1984a. Ekologi permudaan alami hutan mangrove di delta Cimanuk [The Ecology of Natural Rejuvenation of the Mangrove Forest at Cimanuk Delta]. In *Prosiding Seminar II Ekosistem Mangrove, 3-5 August 1982, Baturraden,* edited by S. Soemodihardjo ; I. Soerianagara ; M. Sutisna ; K. Kartawinata ; Supardi. ; N. Naamin ; and H. Al Rasyid, pp. 329-339. Jakarta : LIPI Panitia Program MAB Indonesia.
_____. 1984b. The Present Status of the Mangrove Forest Ecosystem of Segara Anakan Cilacap, Java. In *Tropical Rainforest : The Leeds Symposium,* edited by A. C. Chadwick ; and S. L. Sutton, pp. 53-70. Spec. Publ. of the Leeds Philosophical and Literary Soc.
_____. 1986. Memahami beberapa aspek sosial ekonomi hutan mangrove di delta Cimanuk [Toward the Understanding of the Some Socio-Economical Aspects of the Mangrove Forest in Cimanuk Delta]. *Oseana* 11 (1) : 17-27.
_____. 1987a. Conservation of the Marine Life of Mangrove Forest, Estuarine and Wetland Vegetation in the Cimanuk Nature Reserve. *Biotrop Spec. Publ.* No. 30 : 35-52.
_____. 1987b. Tanah dan status hara di hutan mangrove Tiris Indramayu Jawa Barat [Soils and Nutrient Status in the Mangrove Forest in Tiris Indramayu West Java]. *Rimba Indonesia* 21 (2-4) : 12-23.
_____. 1988a. Produksi primer neto hutan mangrove di Kapuk Muara Angke, Jakarta [The Net Primary Productivity of the Mangrove Forest in Kapuk Muara Angke]. In *Prosiding Seminar Laut Nasional II, 27-30 July 1987, Jakarta,* edited by Panitia Penyunting pp. 331-345. Jakarta : Kantor Menteri Negara KLH, Laboratorium Ilmu-Ilmu Kelautan UI-IPB dan ISOI.
_____. 1988b. The Mangrove Forest of Tiris, Indramayu West Java. Manuscript to be published.
_____. 1988c. Penelitian produktivitas hutan mangrove di cagara alam Cimanuk, Indramayu : 1. Tanah-tanah mangrove di komplek delta Cimanuk, Multivariate approach [The Studies of Mangrove Forest Productivity in the Cimanuk Nature Reserve : 1. Soils of the mangrove Forest in Cimanuk Delta Complex, Multivariate Approach]. In *Prosiding Seminar Ekologi Tanah dan Ekotoksikologi, 20-22 November 1987, Salatiga,* edited by S. Anantawirya ; and S. Notosudarmo, pp. 15-41. The Satya Wacana University Press.
_____. 1989a. Litter Fall Production and Turnover in the Mangrove Forest in Muara Angke-Kapuk, Jakarta. *Biotrop Spec. Publ.* No. 37 : 129-144.
_____. 1989b. Litter Fall Production in the Mangrove Forest of Tiris, Indramayu. Manuscript to be published.
_____. 1989c. Tumpang Sari Pond as Multiple Use Concept to Save the Mangrove Forest in Java. *Biotrop Spec. Publ.* No. 37 : 115-128.
Sukardjo, S. ; and Akhmad, S. 1982. The Mangrove Forest of Java and Bali. *Biotrop Spec. Publ.* No. 17 : 113-126.
Sukardjo, S. ; and Toro, A. V. 1988. Guidelines for the Protection and Management of Mangroves and Estuarine Wetland In Indonesia. In *Proc. of the Symposium on New Perspectives in Research and Management of Mangrove Ecosystem, 11-14 November 1986, Colombo, Sri Lanka,* edited by C. D Field ; and M. Vannucci, pp. 203-226. New Dehli, India : UNDP-UNESCO.
Sukardjo, S. ; Azkab, H. M. ; and Toro, A. V. 1985. Weeds in Natural Regeneration Area of Mangrove Forest in Cimanuk Delta Complex. Paper presented at the Workshop on the Ecology and Management of Aquatic Vegetation in the Tropic, Jakarta, March 26-29, 1985.
The Institute of Meteorology and Geophysics, Department of Communication Indonesia. 1980. Climatological Data for Jakarta Observatory. Unpublished Report. 45 p.
Tim Ekosistem Mangrove MAB LIPI and Perum Perhutani. 1984. Telaah tata guna ekosistem mangrove pantai utara Jawa Barat [Studies on the Land Use of the Mangrove Ecosystem in the

Northern Coast of West Java]. Unpublished Report. 69 p. + 4 appendixes.
Wirjodarmodjo, H. ; and Hamzah, Z. 1984. Beberapa pengalaman Perum Perhutani dalam pengelolaan hutan mangrove [Mangrove Forests Mannagement : Perum Perhutani Experiences]. In *Prosiding Seminar II Ekosistem Mangrove, 3-5 August 1982, Baturraden,* edited by S. Soemodihardjo ; I. Soerianagara ; M. Sutisna, ; P. Kartawinata, ; Supardi. ; N. Naamin, ; and H. Al. Rasyid, pp. 29-40. Jakarta : LIPI Panitia Program MAB Indonesia.