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Mangrove Plant Condition in the Greenbelt Area of Banyuasin Peninsula, Sembilang National Park, South Sumatra, Indonesia and Its Restoration Plan

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ABSTRACT

Mangrove ecosystem is the largest habitat in the Sembilang National Park, Banyuasin district, South Sumatra, Indonesia where the pond activity has been the main cause of mangrove degradation. Mangrove restoration program is planned to be held in the Sembilang National Park to restore the mangrove areas that are currently managed as fish pond, and some of these activities will be funded through funding assistance from JICA Jakarta. In order to implement the restoration program, we have conducted studies on the location of the prospective restoration. The review includes assessment of meteorological conditions, tides, vegetation, mangrove composition, soil, water, and socio-economic community around it. This study was carried out from October 2010 to February 2011. Sample of mangrove vegetation was collected by using method of plot line transect. Mangrove vegetation density, relative density, frequency, relative frequency, basal area, dominance, relative dominance and importance value index were analysed. Mangrove in greenbelt area of Banyuasin Peninsula consisted of 9 species of true mangrove (Avicennia marina (Forssk.) Vierh., Avicennia alba Blume, Avicennia officinalis L., Rhizophora apiculata Blume, Rhizophora mucronata Lam., Bruguiera gymnorrhiza (L.) Lam., Bruguiera sexangula (Lour.) Poir., Sonneratia alba J. Sm., and Excoecaria agallocha L. A. marina was the dominant species that had importance value index was 72.88-300.00 for tree level and 0.00-300.00 for sapling level. R. apiculata and R. mucronata that was planted on ex-ponds grew well. Mangrove restoration plan of about 200 hectares has been arranged based on the current mangrove condition and other related data.

Key words: Mangrove, Greenbelt, Ponds, Restoration, Sembilang National Park

INTRODUTION

Mangroves extend into temperate regions but are largely confined to the regions between 30o north and 30° south of the equator. Mangrove ecosystems are estimated to cover 181,000 km^2 worldwide. Out of 102 countries recorded with mangroves, Indonesia has the largest areas with cover 23.5% of the world's mangroves area (Spalding et al., 1997). Mangrove forests are among the world's most productive ecosystems that protect coastal populations and support coastal fisheries and livelihood (Kathiresan and Bingham, 2001). Mangrove vegetation has been known to play an important role in the ecological protection of the coastline. Mangrove species exhibit unusual reproductive adaptation to vivipary that enables them to grow in the intertidal habitat. It has been

reported that mangroves did sedimentation, and trap and accumulate soils, especially clay, silt and organic matter in their specific root systems (Alongi et al., 2005; Furukawa and Wolanski 1996; Lovelock et al., 2007), immobilize very significant amounts of nitrogen and phosphorus; and planting of mangroves improves the coast for various organisms (Mumby et al., 2004).

Mangrove biodiversity and conservation have received considerable attention in recent years since research has increased the understanding of the values, functions and attributes of mangrove ecosystems (Macintosh and Ashton, 2002). This increase in awareness of the importance of mangroves has led to rehabilitation of some areas. In a few regions, mangrove area is actually increasing as a result of forestry plantations and natural regeneration (Field, 1996). However, mangrove reforestation is often done as monospecies plantations and evaluation of the success of replanting is not often done and reported in the literature (Macintosh and Ashton, 2002).

Mangrove ecosystem is the largest habitat in the Sembilang National Park and also the largest mangrove area in the western part of Indonesia. Sembilang National Park area plays an important role as a temporary habitat of some migrant birds from Siberia. This area is also the protected habitat for several rare species of mammals and reptiles. Moreover, the presence of mangrove forests in this area acts as damper for wind waves, coastal protection from abrasion, and mudguard sediment catcher transported by surface water flow as well as the area of nursery, feeding, and spawning of many aquatic biota. However, the condition of mangroves in the region has been under pressure and degradation from year to year (Ulqodry et al., 2010). The main cause of damage to mangroves in this region is cultivation of fish ponds, especially in Banyuasin Peninsular. The existence of fish pond activity resulted in the degradation of mangroves, especially in the greenbelt area (Suwignyo et al., 2011).

JICA Jakarta Office and Ministry of Forest Republic of Indonesia have been implementing the "Project on Capacity Building for Restoration of Ecosystems in Conservation Areas" since April 2010 to March 2015 at Sembilang National Park. This project is focused to strengthen the capacity of relevant stakeholders for restoration of degraded land in conservation areas in order to restore the degraded land contributing to ecosystem health in promoted conservation areas. In order to implement the restoration activities, studies on the location of the prospective restoration have been conducted on meteorological conditions, tides, vegetation, mangrove composition, soil, water, and the social economy of the surrounding community. This paper presents the results of mangrove plant condition and data analyses on the prospective location, and its restoration plan in the Greenbelt Area of Banyuasin Peninsula, Sembilang National Park South Sumatra, Indonesia.

MATERIALS AND METHODS

The research was conducted from October 2010 to January 2011 in the mangrove area of Sembilang National Park, Banyuasin Peninsula, South Sumatra, Indonesia (Figure 1). Sembilang National Park is located on the east coast of South Sumatra Province, Indonesia with geographical position on the 104° 11' - 104° 94' East Longitude and 1° 63' - 2° 48' South Latitude.

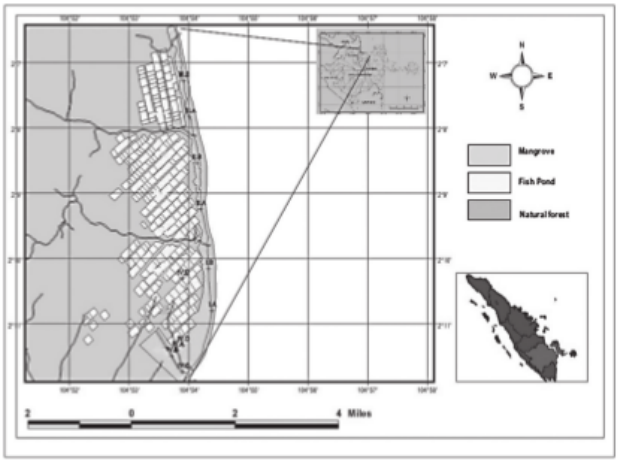

Figure 1. Map showing the location of the study area at Banyuasin Peninsula region of Sembilang National Park, Banyuasin regency in South Sumatra.

Studies of mangrove vegetation structure and composition is done by using the transect line is equipped with a square plot (Mueller-Dombois and Ellenberg, 1974). This method gives an overview of mangrove vegetation structure contained in the plot vegetation (Holmgren et al., 1997). Mangrove vegetation structure and composition are the basic data that can give an idea of a community physiognomy of mangroves (Tomlinson, 1994) which include basal area, density, dominance, diversity, diameter, height and zoning of vegetation (Smith, 1992).

At each observation station, fixed line transects from the sea landward direction (perpendicular to the shoreline along the mangrove forest zoning) in the intertidal area and each zone mangrove forest located along the transect lines, randomly placed sample plots square with a size 10 x10 m. The distance between the square plots were systematically established primarily based on differences in vegetation structure. At each sample plot, it was measured the number of individuals of each species and tree trunk circumference. Trunk circumference measurements performed breast height (DBH =Diameter Breast High) or about 1.3 m from ground level. DBH measurements performed on a true mangrove vegetation in the tree level (DBH > 4 cm) and saplings (DBH 1-4 cm) (Bengen, 2004). Analysis of vegetation data used the method of Mueller-Dombois and Ellenberg (1974).

Along with observations on mangrove vegetation structure and composition, soil and water quality were also observed at each observation point. Meteorological and tidal data were taken from the Meteorological Station of SMB II Airport of Palembang and PT. Pelindo II Palembang. Socio-economic community condition was obtained through direct interview to the farmers at around mangrove areas. All of these data was then used as a basic data for mangrove restoration plan.

RESULTS AND DISCUSSION

Rainfall data obtained from the climatological station near the location of the observation of mangroves can be seen in Table 1. Total rainfall annual average over a period of 10 years is more than 2,500 mm per year. Very high rainfall reached more than 3,000 mm occurred in 2001, 2005, and 2010. The cycle of monthly rainfall shows the dry months from May to September, and the wet months of the next period (Figure 2). The data obtained in this study will be used as a basic data in determining the mangrove plant growing season. In the process of restoration and planting, mangrove planting will be started in the rainy season which begins in October. Furthermore, the air temperature data can be seen in Table 2. Overall, the air temperature did not show extreme fluctuations. During the period 2001-2010, the average monthly minimum air temperature was 25.9°C, and its maximum temperature was 28.4°C. Average monthly air temperature does not show an

extreme increase during the dry season. To find out more details of the air temperature, the daily temperature will be slightly higher in the dry season (October) compared with the rainy season (January) (Figure 3).

Table 1. Distribution of monthly and yearly rainfall for the period of 2001-2010.

Year	Monthly rainfall (mm)												Total yearly rainfall
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2001	353	214	350	389	84	197	36	71	140	594	467	557	3,452
2002	318	112	407	277	117	41	291	3	29	67	285	252	2,199
2003	166	272	217	199	130	46	51	106	114	413	406	341	2,460
2004	224	236	357	136	165	71	243	1	53	303	202	282	2,273
2005	324	257	485	319	297	197	161	88	137	292	310	303	3,170
2006	325	337	473	383	187	124	122	59	4	27	185	168	2,394
2007	479	198	139	540	150	129	80	3	47	167	197	285	2,412
2008	252	148	328	300	27	11	102	138	116	200	653	269	2,543
2009	191	154	565	258	52	192	28	40	22	161	196	328	2,186
2010	225	284	501	335	335	213	185	123	22	333	599	233	3,386
Monthly average	286	221	382	314	154	122	130	63	68	256	350	302	2,648
Std.	93.1	69.7	133	111	98.7	75.8	89.1	51	52.6	169	174	102	493

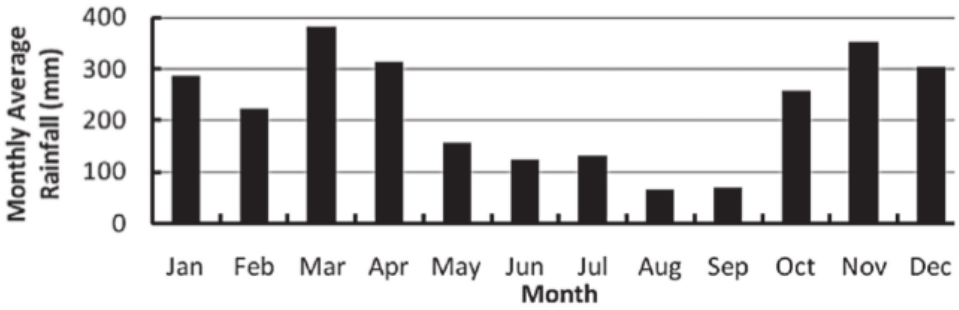

Figure 2. Average of monthly rainfall during the period of ten years (2001-2010).

Table 2. Distribution of monthly temperature for the period of 2001–2010.

Year	Monthly temperature (°C)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	26.1	26.3	26.4	27.2	27.1	26.9	27.0	27.2	26.6	26.8	26.6	26.2
2002	25.9	26.5	26.7	27.0	27.6	27.2	27.1	27.5	27.5	27.3	26.6	26.8
2003	26.7	26.1	26.9	26.9	27.8	27.2	26.6	27.3	27.1	26.9	26.7	26.3
2004	26.3	26.3	26.9	27.3	27.7	27.6	26.4	27.2	27.4	27.1	27.0	26.4
2005	26.3	27.0	26.7	27.1	27.7	27.3	27.0	27.2	27.5	26.9	26.7	26.7
2006	26.2	26.9	26.8	26.7	27.1	26.6	27.2	27.2	27.4	28.4	27.2	27.3
2007	26.5	26.4	27.1	27.3	27.4	27.3	26.8	27.0	27.3	27.2	27.1	26.4
2008	26.6	26.6	26.3	27.0	27.5	27.1	26.5	26.3	26.8	26.7	26.9	26.5
2009	26.0	26.3	26.8	27.7	28.0	27.4	27.2	27.6	28.3	27.2	27.0	26.5
2010	26.6	26.8	27.2	27.9	28.1	27.0	26.8	26.9	26.5	27.3	26.9	26.5
Avg	26.3	26.5	26.8	27.2	27.6	27.2	26.9	27.1	27.2	27.2	26.9	26.6
Max	26.7	27.0	27.2	27.9	28.1	27.6	27.2	27.6	28.3	28.4	27.2	27.3
Min	25.9	26.1	26.3	26.7	27.1	26.6	26.4	26.3	26.5	26.7	26.6	26.2

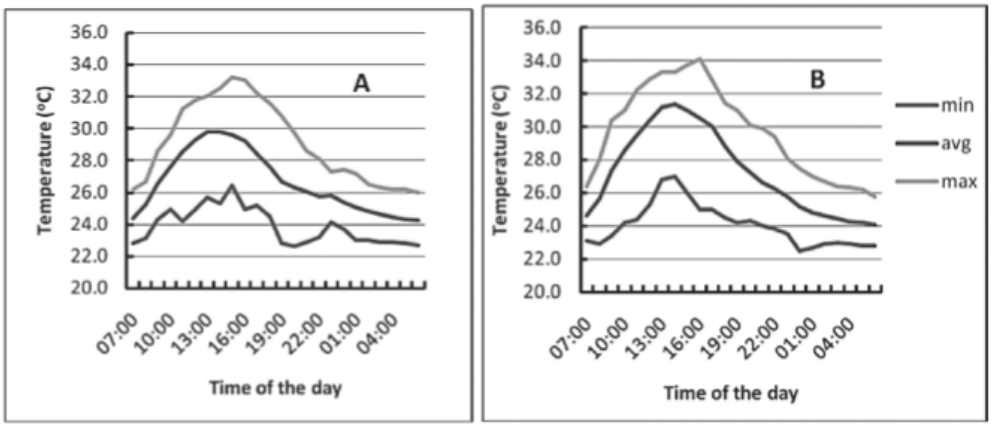

Figure 3. Average daily air temperature during January 2010 (A) and October 2010 (B).

The tidal cycle during the year can be seen in Figure 4. Tidal cycle in coastal waters east of South Sumatra only happens once a day. In the month of January to March, the high tide occurred in the morning, while in the month of June to August occurred at night. Changes in the daily tidal cycle is the result of climate change that occurred in Indonesia. Changes in high tide and low tide for a year can be seen in Table 3.

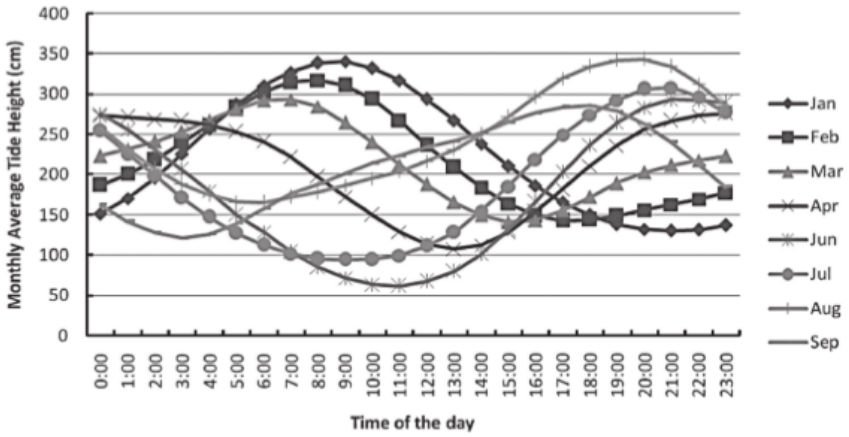

Figure 4. Daily cycle of tides for each month in 2010.

Table 3. Average sea water level at the highest and lowest tide period in the year of 2010.

Month	Average sea water level (cm)	
	Highest tide	Lowest tide
January	418	44
February	400	68
March	394	66
April	384	58
May	388	26
June	378	6
July	392	28
August	448	70
September	404	60
October	410	50
November	416	46
December	420	53

Observation of soil and water quality at each location can be seen in Table4. In general it can be said that the conditions of soil and water quality is quite good and can support the needs of mangrove plants. Soil and water pH is at neutral conditions, thus supporting the chemical processes that occur in the soil. C and N content of soil is at a low level, although in some locations of sampling is still quite moderate. Meanwhile, soil P content is at a sufficient level. K and Ca content of the soil are at moderate to high levels.

Table 4. Conditions of soil nutrient and water quality in some locations near pond area.

Sampling location	Soil quality										Water quality		
	pH (1:1)		C	N	P-Bray I	K	Na	Ca	Mg	CEC			
	H_2O	KCl	(%)		(ppm)	(me/100 g)					Salinity	pH	Temp. (°C)
1	7.18	6.92	1.75	0.15	9.15	0.64	1.09	11.88	1.77	18.05	21	6.5	30
2	7.51	7.35	1.6	0.14	11.4	0.58	0.98	11.5	0.85	19.23	22	6.5	30
3	7.63	7.44	1.31	0.12	8.55	0.64	0.87	11.58	2.3	23.05	21	6.5	30
4	7.57	7.36	1.6	0.14	12.6	0.58	1.09	5.7	1.33	16.23	21	6	29
5	7.71	7.62	1.68	0.15	38.1	0.51	1.09	6.68	1.5	17.4	21	6	29
6	7.66	7.4	2.62	0.2	8.7	0.45	0.76	6.3	1.08	16.05	18	6	29
7	7.32	7.03	3.57	0.28	16.8	0.64	0.87	7.13	1.62	17.4	19	6.5	28
8	7.63	7.45	1.9	0.17	13.35	0.58	1.09	8.13	2.42	15.23	18	6	28
9	7.62	7.13	0.95	0.1	28.5	0.51	0.87	4.65	0.98	17.4	18	6.5	28
10	7.59	7.31	2.11	0.16	12.9	0.51	0.76	5.8	1.09	15.23	18	6.5	29
11	7.87	7.37	2.55	0.18	10.95	0.45	0.98	7.2	1.05	17.4	18	6	30
12	7.59	7.07	0.73	0.07	21.6	0.51	1.09	4.23	1.27	18.23	18	6.5	29
13	7.77	7.44	0.87	0.09	34.65	0.38	1.87	4.35	1.78	19.05	15	6	29
14	7.88	7.51	0.8	0.08	21.45	0.45	0.76	7.18	1.32	22.23	15	6	28
15	7.75	7.39	0.95	0.1	19.65	0.45	0.98	6.15	2.25	21.4	16	6.5	28
16	7.85	7.34	1.31	0.12	14.65	0.51	1.09	6.48	1.55	19.05	16	6.5	28
Avg.	7.63	7.32	1.64	0.14	17.68	0.52	1.45	7.18	1.51	18.28	18	6.3	28
Max.	7.88	7.62	3.57	0.28	38.1	0.64	1.87	11.88	2.42	23.05	22	6.5	30
Min.	7.18	6.92	0.73	0.07	8.55	0.38	0.76	4.23	0.85	15.23	15	6	28

Socio economic data of farmers were collected through direct interviews with farmers. The farmers who are now in the Sembilang National Park came from several places, namely Serang, Jambi, East Lampung, Central Lampung, Metro, Belitang, Bugis, East Java, Central Java, and Jakarta. Most of them came to this location because they want to earn more money for their lives. Fish pond is the main income for most of the farmers in this region. The farmers came to the pond site started in 1994. They made the pond together by clearing mangrove plants. After cleaning the location, they started to cultivate shrimp in 1996. Since then, many new farmers began to come to the site. At first they only cultivated shrimp, but later they switched to cultivate fish since 2003. This transition occurs because shrimp cultivation requires higher capital costs and also needs more difficult cultivation method.

The Farmers, in principle, realize that they are engaging in a prohibited location. Nevertheless, their presence that existed before Sembilang National Park was inaugurated. Sembilang cause the relocation of people requires a careful process. In connection with the restoration of mangrove replanting in the greenbelt area, they will be involved in the process of planting and maintenance. The management of Sembilang National Park makes the policy to restrict land area that can be cultivated by each farmer. Each farmer is only allowed to cultivate four hectares of ponds. Farmers are also not allowed to do an intensive cultivation process by adding chemicals into the pond. Because of the low productivity, there are still farmers who cultivate more than the allocation pond area.

The composition of mangrove vegetation at tree level vegetation (Table 5), saplings level vegetation (Table 6), and seedling level vegetation (Table 7) in the area of greenbelt of Sembilang National Park, Banyuasin Peninsula consist of 9 species, namely: *Avicennia marina* (Forssk.) Vierh., *Avicennia alba* Blume, *Avicennia officinalis* L., *Rhizophora apiculata* Blume, *Rhizophora mucronata* Lam., *Bruguiera gymnorrhiza* (L.) Lam., *Bruguiera sexangula* (Lour.) Poir., *Sonneratia alba* J. Sm., and *Excoecaria agallocha* L. In addition to the above types of mangroves, we also found mangrove species of *Acanthus ilicifolius* L., *Acrostichum aureum* L., *Aegiceras floridum* Roem. & Schult., *Ceriops tagal* C. B. Rob., and *Nypa fruticans* Wurmb at the zones outside the greenbelt area.

Table 5. Distribution of mangrove tree level vegetation in the greenbelt area.

Mangrove species	Distribution of mangrove tree level in each transect										
	IA	IB	IIA	IIB	IIIA	IIIB	IVA	IVB	IVC	IVD	IVE
Avicennia marina	+	+	+	+	+	+	+	+	+	+	+
Avicennia alba		+	+	+		+	+			+	
Avicennia officinalis										+	
Rhizophora apiculata									+	+	
Rhizophora mucronata										+	
Bruguiera gymnorrhiza									+		
Excoecaria agallocha											+
Total	1	2	2	2	1	2	2	1	3	5	2

Description: + = Found; - = Not found

Table 6. Distribution of mangrove sapling level vegetation in the greenbelt area.

Mangrove species	Distribution of mangrove sapling level in each transect										
	IA	IB	IIA	IIB	IIIA	IIIB	IVA	IVB	IVC	IVD	IVE
Avicennia marina	+		+	+	+	+	+	+	+	+	+
Avicennia alba		+	+			+	+			+	
Avicennia officinalis					+						
Rhizophora apiculata									+		
Rhizophora mucronata								+			
Bruguiera gymnorrhiza	+				+		+		+		
Bruguiera sexangula						+					
Sonneratia alba							+				
Excoecaria agallocha											+
Total	2	1	2	1	3	3	4	2	3	2	2

Description: + = Found; - = Not found

Table 7. Distribution of mangrove seedling level vegetation in the greenbelt area.

Mangrove species	Distribution of mangrove seedling level in each transect										
	IA	IB	IIA	IIB	IIIA	IIIB	IVA	IVB	IVC	IVD	IVE
Avicennia marina	+		+	+	+	+	+	+		+	+
Avicennia alba		+	+								
Avicennia officinalis					+						
Rhizophora apiculata			+		+	+			+		
Rhizophora mucronata								+			
Bruguiera gymnorrhiza	+				+						
Bruguiera sexangula						+					
Excoecaria agallocha											+
Sonneratia alba					+						
Total	2	1	3	1	5	3	1	2	1	1	2

Description: + = Found; - = Not found

Mangrove genus *Avicennia*, in particular *A. marina* is found in almost all locations of transects. This is due to the greenbelt area directly opposite the sea and often submerged during the tide. According to Arief (2003), *Avicennia* grow in the outer layers of the mangrove vegetation, soft

muddy ground, in the seafront and is also a pioneer mangrove that has the ability to live on longer flooding tide condition.

Plant density and important value index of mangrove vegetation at the tree and saplings levels on each transect are presented in Figure 5 and 6. The existence of the genus *Avicennia* are evenly across all locations of observation. This condition is particularly dominated with *A. marina* and *A. alba* species. Important value index of *A. marina* in 11 observation transects ranged from 72.88 to 300 for the tree level. Important value index is a parameter that indicates the role of a species in a community with a maximum value of 300.

Avicennia dominance is very high, but we also found mangrove of species *B. sexangula* in transect III.B (the area between Barong River and Siput River). *B. sexangula* was found generally at the level of saplings, and at the time of survey we did not find the parent tree. The existence of this type *Bruguiera* allegedly due to the formation of mudflat in front of the beach side of the transect III.B, so that the area covered by *B. sexangula* condition of the land is more protected from the influence of tides so that it becomes more dry. *Bruguiera* generally grow well in the inundation areas of the highest high tide (spring tide). In addition, the presence of *Avicennia* species of trees and saplings at the level of the sub-zone is also quite rare, allowing the type *B. sexangula* can compete. The existence of other mangrove species were also seen on the transects in non-farm areas such as type *R. apiculata* and *R. mucronata* in non-farm transect IV.D and the type of *E. agallocha* in non-farm transect IV.E.

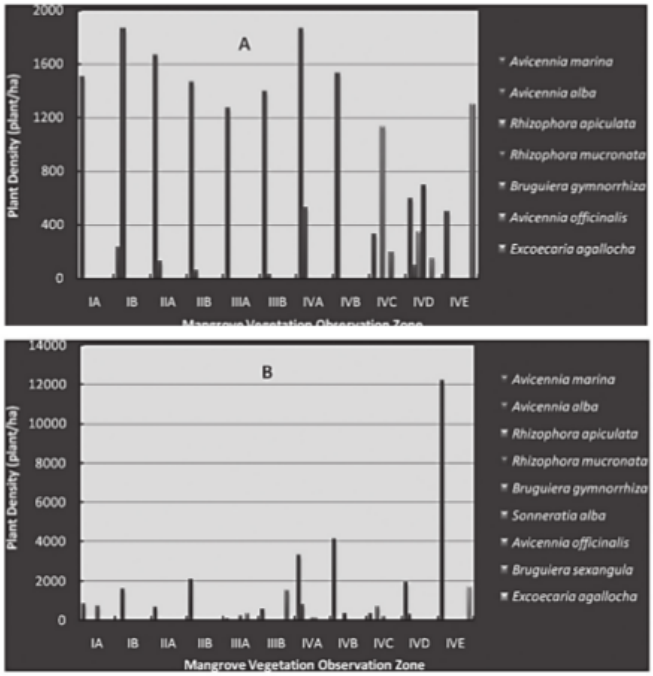

Figure 5. Histogram of plant density of mangrove at tree (A) and saplings (B) levels.

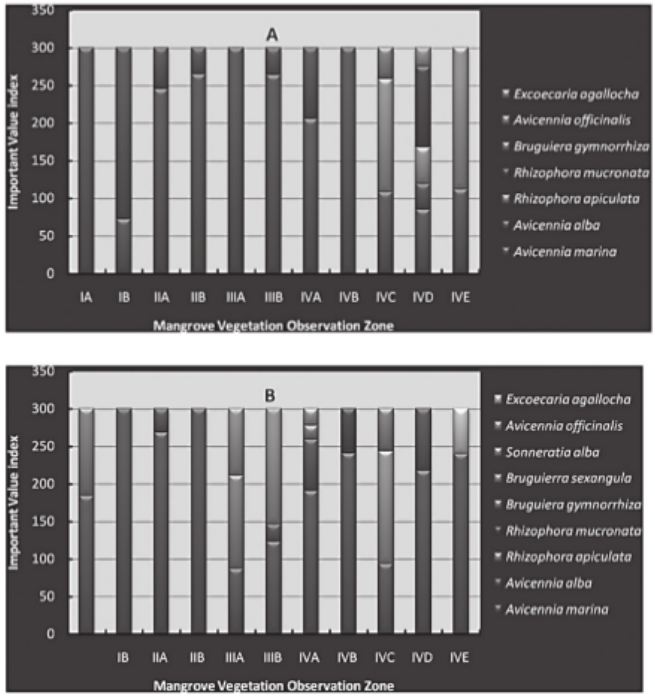

Figure 6. Histogram of importance value index of mangrove at tree (A) and saplings (B) levels.

Moreover, the existence of mangrove *Rhizophora* species in transect IV.D which was once a former pond area, can not be separated from the "intervention" of the former owner of the pond in the period 2005-2007. The former ponds planted *R. apiculata* and *R. mucronata*. Both types can grow well up to a height of more than 6 meters. This indirectly indicates that the former pond soil conditions allow for planting mangrove species other that *Avicennia* species. It can also reduce the fears of the influence of antibiotic and fertilizer residues which was formerly used in the ponds on mangrove growth.

Rhizophora planted also began to develop into some saplings and seedlings. Nevertheless, the growth of saplings and seedlings are not optimal, due to competition with saplings and seedlings of *Avicennia* species. *Avicennia* massive growth can also be seen in other zones of non-pond areas, i.e. transect IV.A (pond abandoned in 2007), transect IV.B (pond abandoned in 2005) and transect IV.E (pond abandoned in 2007).

Based on the above land condition and existing mangrove plants in these locations, then mangrove restoration plan in the Sembilang National Park is arranged. To accommodate greenbelt area that is separated by three rivers (Figure 1), mangrove restoration site is divided into three main locations, namely Block I located in the southern part, Block II, which are in the middle, and block III located in the northern part. The restoration of mangrove will be done on the target area of 200 ha during the implementation of 4 years (2011-2014) activities. In the year of 2011, the restoration will cover 50 ha consisting of 12 ha in block I, 24 ha in block II, and 14 ha in block III.

In designing of mangrove planting method, we have decided to apply three kinds of mangrove growth method, i.e. Natural regeneration and assisted natural regeneration, enrichment planting, and new planting (Table 8). This three methods will be used in an attempt to determine the growth of mangroves with different planting methods. This three methods are used to seeing the growth of mangroves in the long run. In natural regeneration method, mangrove plant will be allowed to grow naturally, while on the enrichment planting method, there will be new addition of mangrove species after one year grow naturally. In the new method of planting, land pond will be planted

with mangrove species in accordance with the planned planting patterns (Table 9). With reference to the mangrove species at the transect site and its surroundings, three main species of mangroves to be planted are *Rhizophora mucronata, Rhizophora apiculata,* and *Bruguiera gymnorrhiza*. The composition of each type can be seen in Table 9.

Table 8. Restoration method and its area at each block location for 4 year restoration project.

Restoration method	Block I	Block II	Block III	Total
1. Natural regeneration and assisted natural regeneration	10	20	20	40
2. Enrichment planting	10	20	10	40
3. New planting	30	50	40	120
Total	50	90	60	200

Table 9. Mangrove species and its area at each block of restoration area.

Mangrove species	Area (ha) and its percentage (%)			Total
	Block I	Block II	Block III	
1. *Rhizophora mucronata*	14 ha (46.7%)	10 ha (20%)	8 ha (20%)	32
2. *Rhizophora apiculata*	6 ha (20%)	26 ha (52%)	8 ha (20%)	40
3. *Bruguiera gymnorrhiza*	6 ha (20%)	10 ha (20%)	20 ha (50%)	36
4. Others	4 ha (13,3%)	4 ha (8%)	4 ha (10%)	12
Total	30 ha	50 ha	40 ha	120

CONCLUSION

Annual rainfall in the area is relatively high with annual average over a period of 10 years of more than 2,500 mm per year. Very high rain fall of more than 3,000 mm occurred in 2001, 2005, and 2010. The cycle of monthly rainfall shows the wet months start from October. During the period 2001-2010, air temperature did not show extreme fluctuations with average monthly minimum air temperature was 25.9°C, and its maximum temperature was 28.4°C. Tidal cycle in coastal waters east of South Sumatra only happens once a day. In the month of January to March, the high tide occurred in the morning, while in the month of June to August occurred at night. The conditions of soil and water quality is quite good and can support the needs of mangrove plants.

The farmers in Sembilang National Park came from several places of Indonesia and have been cultivating shrimp and fish since 1996. The farmers realize that they are engaging in a prohibited location, but the relocation of people requires a careful process. They will be involved in the process of planting and maintenance during the restoration of mangrove.

The composition of mangrove in the area of greenbelt of Sembilang National Park, Banyuasin Peninsula consists of 9 species, namely: *Avicennia marina* (Forssk.) Vierh., *Avicennia alba* Blume, *Avicennia officinalis* L., *Rhizophora apiculata* Blume, *Rhizophora mucronata* Lam., *Bruguiera gymnorrhiza* (L.) Lam., *Bruguiera sexangula* (Lour.) Poir., *Sonneratia alba* J. Sm., and *Excoecaria agallocha* L. *Avicennia marina* is the most dominant species. Other mangroves that grow well in the area outside the greenbelt area are *Acanthus ilicifolius* L., *Acrostichum aureum* L., *Aegiceras floridum* Roem. & Schult., Ceriops tagal C. B. Rob., and *Nypa fruticans* Wurmb.

Mangrove restoration site is divided into three main locations, namely Block I located in the southern part, Block II, the which are in the middle, and block III located in the northern part. Three types of mangrove growth method will be applied are natural regeneration and assisted natural regeneration, enrichment planting, and new planting. Three main species of mangroves to be planted are *Rhizophora mucronata, Rhizophora apiculata,* and *Bruguiera gymnorrhiza* with different composition of each type at each site of restoration.

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REFERENCES

Alongi, D.M., J. Pfitzner, L.A. Trott, F. Tirendi, P. Dixon, and D.W. Klumpp. 2005. Rapid sediment accumulation and microbial mineralizationin forests of the mangrove *Kandelia candel* in the Jiulongjiang Estuary, China. Estuarine, Coastal and Shelf Science 63: 605-618.

Bengen, D.G. 2004. Technical guidelines of identification and management of mangrove ecosystem. Center for Coastal and Marine Resources. Bogor Agricultural University, Bogor, Indonesia.

Field, C. D. 1996. Restoration of mangrove ecosystems. International Society for Mangrove Ecosystems. Okinawa, Japan.

Furukawa, K., and E. Wolanski. 1996. Sedimentation in mangrove forests. Mangroves and Salt Marshes 1: 3-10.

Holmgren, P., T. Thuresson, and S. Holm. 1997. Estimating forest characteristics in scanned aerial photographs with respect to requirements for economic forest management planning. Scandinavian Journal of Forest Research 12: 189-199.

Kathiresan, K., and B.L. Bingham. 2001. Biology of mangrove and mangrove ecosystems. Advances in Marine Biology 40: 81-251.

Lovelock, C. E., I. C. Feller, J. Ellis, A. M. Schwarz, N. Hancock, P. Nichols, and B. Sorrell. 2007. Mangrove growth in New Zealand estuaries: the role of nutrient enrichment at sites with contrasting rates of sedimentation. Oecologia 153(3): 633-641.

Macintosh, D. J., and E.C. Ashton. 2002. A review of mangrove biodiversity conservation and management. Centre for Tropical Ecosystems Research, University of Aarhus, Denmark.

Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley & Sons, London.

Mumby, P.J., A.J. Edwards, J.E. Arias-Gonzalez, K.C. Lindeman, P.G. Blackwell, A. Gall, M.I. Gorzynska, A.R. Harborne, C.L. Pescod, H. Renken, C.C.C. Wabnits, and G. Lewellyn. 2004. Mangroves enhance the biomass of coral reef fish communities in the Caribbean. Nature 427: 533-536.

Smith III, T.J. 1992. Forest structure. p. 101-136. In A.I. Robertson and D.M. Alongi (eds) Tropical mangrove ecosystem. American Geophysical Union, Washington, D.C.

Spalding, M. D., F. Blasco, and C. Field. 1997. World mangrove atlas. The International Society for Mangrove Ecosystems, Okinawa, Japan.

Suwignyo, R.A., Munandar, Sarno, T. Z. Ulqodry, and E.S. Halimi. 2011. Some experiences in the assistance of community in mangrove forest management. Paper presented at the Workshop of the Establishment of South Sumatera Province Regional Mangrove Working Group. 26 May 2011. Palembang, Indonesia.

Tomlinson, P.B. 1994. The botany of mangrove. Cambridge University Press, New York.

Ulqodry, T.Z., Fauziyah, and F. Agustriani. 2010. Mangrove of Sembilang National Park, South Sumatra, Indonesia. Paper presented at International Symposium on the Biodiversity Associated with Mangrove Ecosystem in Southeast Asia. 17-19 May 2010. Hanoi, Vietnam.

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