THE STUDY OF SILVOFISHERY IN THE BAY OF JAKARTA AND SERIBU ISLAND FOR SUPPORTING MARICULTURE

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Abstract

The economic development has created a negative impact to the quality of the environment. One of the indicator's of the decrease of environmental quality in the coastal area is areal decline of the mangrove forest. In 1982 the Department of Forestry stated that the mangrove forest acreage was 4.25 million hectares, but in 1987 PHPA-AWB (Forestry Agency and Asia Wetiand Bureau) reported an acreage of only 3.24 million hectares.

The Jakarta Bay area is less conducive for sustainable mangrove growth and fisheries. The economic development had caused pollution in the Jakarta Bay and its surroundings. The contents of heavy metals (Hg, Pb, Cd, Cu, and Cr) in sediments of the Jakarta Bay was monitored in June and December 1990. The Steam Energy Generating Plant (PLTU) of Muara Karang, Jakarta Bay, has an impact on mangrove growth on a long term bases. The hot water discharge from PLTU has also a negative impact on the composition and distribution of zooplankton and fish community.

The mangrove community in some of the islands in Seribu Island is severely damaged by oilspill from ships sailing in the Jakarta Bay. During the last 5 years, PHPA, Forest Agency, and other participants have tried to rehabilitate the vegetation in Rambut Island by replanting mangrove. However, these efforts failed due to the high oil content in the soil, i.e. 11.276 ppm. Therefore, it is least appropriate to apply a silvofishery program in the Jakarta Bay or Seribu Islands.

To solve the mangrove problem, the Department of Forestry introduced a mangrove rehabilitation program. In 1988, in order to support the program, the Department of Forestry has launched the Social Forestry Program. Silvofishery is a part of the Social Forestry Program to stimulate people's participation in the mangrove rehabilitation program, as well as to increase their income by fish cultivation.

In Pemalang, Central Java, the Local Government is executing a mangrove rehabilitation program in the northern coast of Java. The Pemalang's environmental quality is more conducive than the Jakarta Bay. To accelerate this program, the Local Government invited other institutions to participate or join this program.

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I. INTRODUCTION

The mangrove forest, also known as coastal forest, tidal forest, or brackish water forest, is a unique ecosystem and consists of four different biological entities: land, water, the flora and the fauna. Mangrove communities are developed in coastal areas and estuaries, where the influence of tidal streams is very prominent. Therefore, the mangrove forest ecosystem is a delicate and complicated interaction of the land ecosystem and shore ecosystem.

The economic development has positioned the coastal community as a strategic resource for fishery, pond-culture industry, resettlement, and recreation resorts. These activities have, of course, positive impacts by increasing the living standards of people and the opening of work and business opportunities. However, the development of coastal areas should also be based on the sustainable capacity of the community. Otherwise, the over-exploitation of the coastal ecosystem could result in the deterioration of the mangrove forest community.

Rehabilitation of mangrove forest has been conducted by the right of forest management (HPH) owners in the eastern coast of Riau, South Sumatera, northern coast of Java, and Cilacap. However, these attempts were limited to replanting of mangrove stands, especially bakau-bakau (Rhizophora sp.). Two approaches have been adopted by Perum Perhutani (1993), Forestry Agency, i.e. technical and non-technical approaches. In the first approach, Perum Perhutani promoted a system of silvofishery. In the second approach, Kelompok Tani Hutan (KTH, Agroforestry Group) are set up by farmers. These groups of farmers propose a working plan and are involved in the development of mangrove forest. The KPH is also equipped with a cooperative program which help the farmers in the supply of the production inputs and post-harvest handling facilities.

a. The Habitat

Mangroves can be found in coastal areas close to an estuary or delta, where mud sediment is apparent. As a coastal ecosystem, mangrove forest is under constant influence of ocean and land factors. The main factors are the distance from the sea, frequency and duration of inundation by sea water, tidal dynamics, soil aeration, and salinity (Hamzah, 1988). The supply of fresh water is another limiting factor in the growth of mangrove. Therefore, mangrove forest is found only in the intertidal and supra-tidal zones in the tropics and sub-tropics, where the supply of fresh water is available. Because mud sedimentation is a prerequisite for the development of mangrove, the mangrove forest usually develops very well in coastal areas which is protected from high waves and strong tidal streams (Snedaker et aL, 1985; Nontji, 1987; Hamzah, 1988).

b. Main Environmental Parameters Influencing The Sustainability Of Mangrove Forest

According to Dahud et aL (1996), the growth of mangrove is determined by three major environmental parameters, i.e. supply of fresh water and salinity, supply of nutrients, and substrate stability.

1. Supply of fresh water and salini . The efficiency of mangrove forest is determined by the availability of fresh water and salt concentration. The availability of fresh water in turn depends on: (a) the frequency and volume of the incoming water from the river or irrigation system; (b) the frequency and volume of the circulated water during high and low tides, and (e) the evaporation rate.

2. Supply of nutrients. The supply of nutrients to a mangrove ecosystem is a complicated process and involves the flow of mineral ions and organics through an intertidal nutrient recycling system, based on the food chain. Detritus is the main factor in this mechanism. According to Odum (1992) low constellation and the optimal ratio of nutrients are necessary for maintaining the productivity of mangrove ecosystem. These are determined by (a) the frequency, amount, and duration of inundation by the fresh and salt water, and (b) the dynamics of the internal circulation of a complex detritus.

3. Substrate stabilization. Substrate stabilization - the ratio of erosion to the movement of sediment position - is determined by the velocity of the fresh water flow, sediment loading, water stream during low tide, and wind. The importance of sediment movement to the growth of mangrove species in the forest could be illustrated from the ability of a mangrove forest to withstand damage.

II. THE CHRONOLOGY OF SILVOFISHERY

Traditional farmers managed fish ponds in mangrove forest. The assumption that mangrove forest is the best place for ponds is based on some practical reasons, i.e. the simple water management of the ponds, as the area is under the influence of tidal streams. The negative impacts of the over-exploitation of mangrove forest was realized by the Department of Forestry. In order to rehabilitate the forest function, the Government has launched a reforestation program in the 1980's through silvofishery system (empang parit).

In the fishery discourse, silvofishery is a relatively new terminology. The terminology was proposed in accordance with the program on Social Forestry of Mangrove Forest, initiated by Perum Perhutani through a decree of the Board of Directors No.60.2/Kpts/DIR/1988. The decree is also used as a technical guide for the social forestry program. The main objectives of the program are to increase the welfare of the people living nearby the forest and to maintain the mangrove ecosystem (Sumarhani, 1995). According to some experts, silvofishery is a culture management of fish by empang parit system. According to the author, silvofishery in essence is any fish culture system in the mangrove forest by abiding sustainable management of the ecosystem.

The Directorate General of Reforestation and Land Rehabilitation, Department of Forestry defines silvofishery as a management of fish culture in a mangrove forest in the form of mixed culture. The system is designed as an alternative in the management of mangrove forest with the objective to manage the forest optimally without damaging the forest resources and reducing the forest function, and in the same time increasing the welfare of the people surrounding the forest. This management system is in accordance with the program of Forest for People.

a. Empang Parit And Komplangan Patterns

In Indonesia, silvofishery is practiced through two patterns, i.e. "komplangan" and "empang parit" (Figures I and 2). These patterns are being adopted as a model in the economic development of people in the mangrove forest. Each pattern, however, has its own merit and weakness and the choice of a suitable pattern depends on specific situations.

Most of the ponds in the reforestation or in the rehabilitation forests are dominated by the empang parit design. In this design, mangrove is planted in the middle of the pond (occupying 80% of the area). This area is strongly influenced by tidal stream, that is inundated during high tide and dry during low tide. The ponds are surrounded by parallel channels close to the ridge of the pond. The width of the channel is in general 3-5 m and is situated 40-80 cm below the pond's floor (Quarto, 1998).

The mangrove density in empang parit design is in the range of 0.17-2.5 trees per square meter. The tree density determines the accumulation of the debris and organic matters in the pond, and also influence the richness of algae, plankton and other plants, which are the main food sources for fish. The tree density will affect the fish productivity and therefore the farmers prefer to manage a rather less dense (more or less 0.2 trees per square meter) for milk fish ponds (Fitzgerald, 1977).
According to Fitzgerald (1977), empang parit design has some drawbacks compared to the open ponds (tambak), i.e.:

1. Difficult to manage;
2. Potential toxicity from tannin;
3. Construction cost per unit pond is high;
4. The shading of the mangrove trees reduces the sunlight.

b. Social Forestry

Social Forestry was launched by Perum Perhutani and aimed to develop, maintain, and conserve forest with the involvement of people surrounding the forest. With this program, the function of the forest could be increased while the prosperity of people inhabiting the forest is increasing as well. It is hoped that the program could reduce the deterioration of land and forest resources and the socioeconomic problems caused by the presence of people in the forest area.

Social forestry is an integral part of agroforestry, which is an effective compromise between forestry and people's interest. According to Satjapradja (1981), there are five schemes of agroforestry, i.e. agrisylviculture, sylvopasture, silvofishery, farm forestry, and multi-purpose forest. The choice of the most appropriate scheme to be adopted depends on the local physical and ecological characteristics as well as the socio- economy of the local people.

The agroforestry system could be based on either food plants, animal husbandry, or forestry (Setiawan, 1991). When the forest is combined with fish or shrimp ponds, the scheme is called coupled ecosystem silvofishery (CES) (Nugroho et aL, 1990). The application of CES is considering the following principles: (1) the functional continuity of the mangrove forest, (2) conservation of the life web in the forest ecosystem, (3) conservation of the biodiversity of the forest, (4) the forest

should be regarded as a collective property, and (5) the negative impacts of development should be controlled (Salim, 1986).

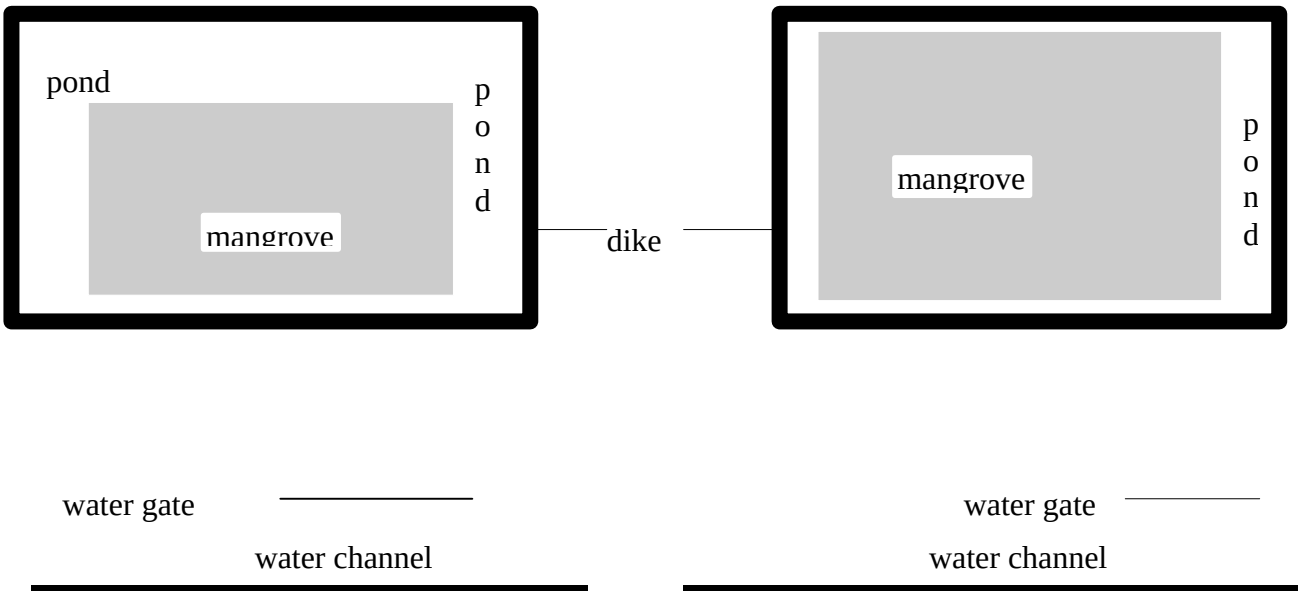
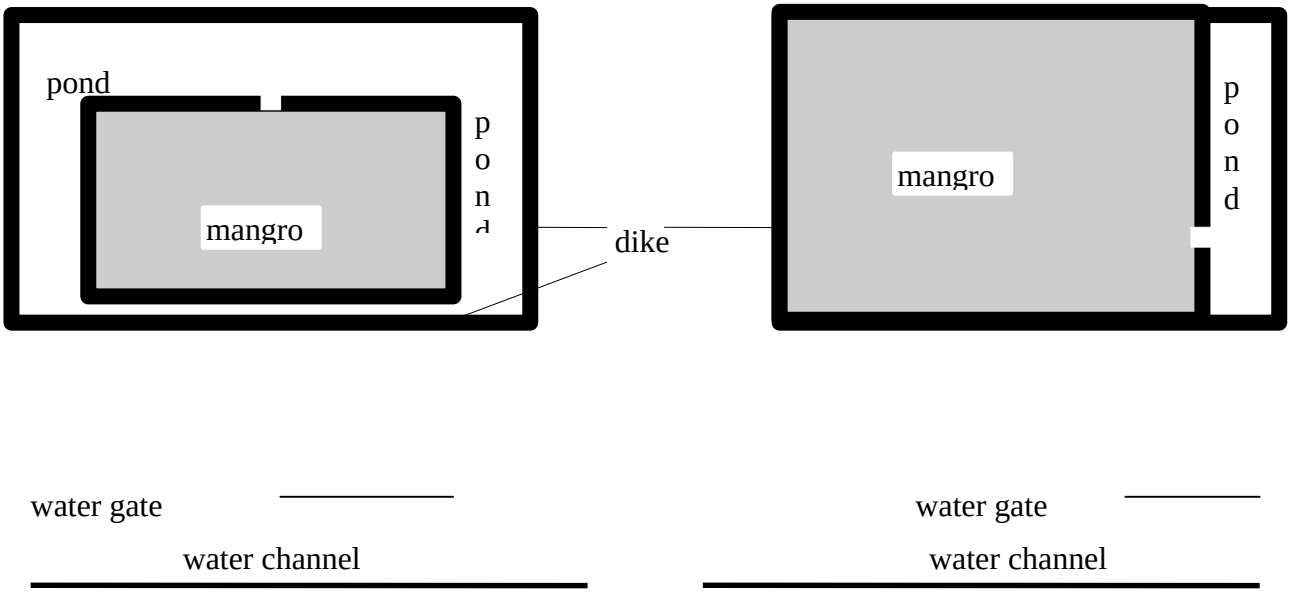


Figure 1.a. Empang parit

Figure 1.b. Komplangan



III. CHARACTERISTICS OF THE SERIBU ISLANDS

The Seribu Islands is a group of 113 islands scattered in the Jakarta Bay. Administratively these islands belong to a Keeamatan of the city of North Jakarta and is divided into four Kelurahans, i.e. Pulau Untung Jawa, Pulau Tidung, Pulau Panggang, and Pulau Kelapa.

According to a list produced by the Governor of Jakarta, Mr. Wiyogo Atmodarminto, in 1989, the islands are permitted to be exploited as human settlements, tourist resorts, natural parks, reforestation, fishery, scientific resorts, archaeology parks, camping grounds, sports, and nautical navigational purposes. Most of the tourism resorts are located in Kelurahan Pulau Kelapa.

Pulau Pad is allocated for scientific exploration. Replanting of mangrove and some research on mangrove and fish community are conducted on this island. As mangrove and sea water are among the main prerequisite for silvofishery, a field survey was conducted to collect data on the status of mangrove community on the coast of Jakarta, Pari Island, and Rambut Island.

According to Naryanto (1998), the islands are always under threat of natural disasters, such as:

1. Earthquake. The islands are close to some epicenters in the Sunda Strait, Sumatera Island, and Indian Ocean.
2. The islands are very prone to tsunami disaster. 3. Coast abrasion by waves.
4. Sea water intrusion. An uncontrolled ground water exploitation could deteriorate equilibrium of fresh ground water, resulting in the intrusion of sea water.
5. Windstorm is frequent in the islands and have left considerable damages.

a. The Status Of Mangrove Community In Muara Angke

Exact data on mangrove in Jakarta is not available. Data from the Department of Forestry (1982) indicated that the mangrove area in Jakarta (including West Java) was 28,608 ha. However, PHPA-AWB (1987) reported that the mangrove area was 5,700 ha. Darsisi (1982) reported even a lower figure of merely 95 ha. This data is recently supported by a team of experts from the Netherlands and Australia who reported that the mangrove area in Jakarta is only 50 ha and the condition was not sustainable. Quoting data from other sources, Setiadi (I 983) said that the area is only 5,827 square meters. Suryani (1995) stressed out that this condition should be made clear.

b. The Status Of Mangrove Community In Rambut Island

The Mangrove Foundation (1994) reported that circa 50% of the mangrove community in Rambut Island is severely damaged by oil sludge dumped by ships sailing in the Jakarta Bay. It is of common practice to dump sludge in bags into the sea. Due to the action force of the waves, the bags are often ruptured and oil spill flowed to nearby shores and are stacked to mangrove stands. Oil sludge is very damaging for the mangrove plant. During hot days, the sludge on the surface of mangroves will melt, just like tar or asphalt. The melted sludge clogs the aerial roots

of the mangrove and eventually this condition will kill the plant. In some parts of the island people mined sand from the shore. This activity disrupted the 'api-api' community and other mangrove species growing on the shore.

c. The Content Of Heavy Metals In Sediments Of The Jakarta Bay

Some heavy metals, like Cd, Hg, and Pb, are toxic for organisms. The content of heavy metals (hg, Pb, Cd, Cu, and Cr) in sediments of the Jakarta Bay has been monitored during June and November 1990. For mercury analisis, the wet sample was destructed by a mixture of H2SO4, K2Cr2O7 and H202 and the amount of Hg was determined by AAS without flame method, For other metals, the dry samples were destructed by a mixture of HN03, HC104, and HF. The amount of Pb, Cd, Cu, and Cr were determined by AAS with air-acetylene flame (Hutagalung, 1994).

d. The Impact Of Hot Water Discharged From The Steam Energy Generating Plant (Pltu) Muara Karang, Jakarta Bay

Previous research indicated that mangrove plants are not very sensitive to high water temperature. From his observation in Segara Anakan water, Cilacap, However, Hardjosoewarno (1989) believed that exposure of mangrove plants to temperatures of 35-40" C in the long run could show negative impacts.

Recently the Local Government of Jakarta decided to start a reclamation project in the Jakarta Say. The change of shore line will reduce the mixing zone of the hot water discharge from PLTU Muara Karang. Furthermore, the hot water could flow back into the cold water intake. The negative impacts of hot water to the composition and distribution of zooplankton and fish community was studied by Adnardi (1994) and Burhanuddin eta/. (I 994).

IV. CHEMICAL QUALITY OF THE JAKARTA BAY

The Bureau of the Assessment of City and Environment of the Local Goverment of Jakarta has monitored the water quality of the Jakarta Bay in 1996 and 1997. Important parameters, such as COD, BOD, ammonia and metal contents, have been measured from samples taken from zone A (5 km from the shore), zone B (5-10 km from the shore), zone C (10-15 km from the shore), and zone D (15-20 km from the shore). The results are shown on Tables 1, 2, 3, 4, and 5.

Table 1. Average COD (mg/l) value in the Bay of Jakarta water in 1996

Zone	1	2	3	4	5	6	7
A	27,36	32,49	37,5	34,32	32,62	35,49	34,63
B	33,35	35,3	32,08	37,36	34,95	37,36	41,38
C	-	45,71	41,85	46,85	41,1	49,12	-
D	-	-	54,98	59,3	55,91	54,83	-

Notes: COD thresholds for marine organisms or fish are <40.0 mg/l (preferred) and <80.0 mg/l (permitted)

Table 2. Average BOD (mg/l) value in the Bay of Jakarta water in 1996

Zone	1	2	3	4	5	6	7
A	10,08	12,65	12,5	10,99	12,28	13,28	13,42
B	13,42	13,03	32,08	13,95	12,59	13,15	14,95
C	-	13,28	12,90	16,43	15,78	16,43	-
D	-	-	22,73	19,95	23,53	23,68	-

Notes: BOD thresholds for marine organisms or fish are <25 mg/l (preferred) and <45 mg/l (permitted)

Table 3. Average Ammonia (mg/l) value in the Bay of Jakarta water in 1996

Zone	1	2	3	4	5	6	7
A	0,37	0,32	0,72	0,23	0,30	0,29	0,36
B	0,36	0,80	0,30	0,23	0,18	0,27	0,21
C	-	0,37	0,30	0,17	0,24	0,69	-
D	-	-	0,69	0,34	0,36	0,50	-

Notes: Ammonia thresholds for marine organisms or fish are =0,3 mg/l (preferred) and =1,0 mg/l (permitted)

Table 4. Procentation of metal value in the Bay of Jakarta and the estuary water that exceeded the standard value in 1996.

Parameters	Permitted the Bay	Permitted the Estuary	Preferred the Bay	Preferred the Estuary	Permitted (mg/L)	Preferred (mg/L)
Cu	13,04	37,5	91,30	100,0	<0,06	0,001
Pb	34,78	25,0	34,78	25,0	<0,01	0,0002
Zn	21,74	43,75	100,00	100,00	<0,10	0,002
Ni	0,0	68,75	0,0	68,75	<0,002	0,007
Cd	0,0	0,0	0,0	0,0	<0,005	<0,00045

Table 5. The range of metal in the sediment in the Bay of Jakarta (mg/kg) in 1996

Zone	Cu	Pb	Cd	Cr	Ni	Zn
A	9,17-17,13	12,34-14,12	*	8,75-14,54	8,50-20,70	52,70-71,58
B	10,83-25,27	12,23-19,77	*	10,68-14,72	7,62-11,81	60,02-89,14
C	18,42-29,66	16,89-29,70	*	10,80-13,78	6,79-9,47	78,54-107,71
D	28,05-65,66	24,36-43,08	*-0,15	10,18-18,96	4,97-26,84	111,11-219,8

Notes: * undetecable

NB. All datas are quoted from the report of The Bureau of the Assessment of City and Environment of the govermnent of Jakarta

V. CONCLUSION

1. The feasibility study indicated that the Jakarta Bay and Seribu Islands are not suitable for sylvofishery activities. The water is heavily polluted by heavy metals, oil spill, and other wastes. This condition could damage the growth of mangrove forest.
2. Seribu Islands is not suitable for optimal growth of mangrove as the shore is not muddy and fresh water supply is limited.
3. The construction of ridges for the construction silvofishery ponds will make the soil unstable which will endanger the existence of the island.
4. Silvofishery could provide a better solution for maintaining the existence of mangrove forests and increase the prosperity of local people.

RECOMMENDATIONS

1. Seribu Island is not recommended for silvofishery.
2. The application of silvofishery system will be more successful if conducted in suitable areas for mangrove growth. The awareness of local people to the importance of maintaining mangroves should be increased as well.
3. Silvofishery activities should invite the involvement of various institutions, either governmental or private.
4. Silvofishery activities could be integrated into the mangrove rehabilitation program.

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