Utilization and Management of Mangrove Ecosystem

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I. Introduction

The environmental problem nowadays, from global level to domestic level and from synthetic judgment of necessity to solitary treatment, is various. Because many types of human activities such as forest cutting, shifting cultivation utilizing "slash and burn" methods for temporary agriculture, coastline filling, urbanization etc., effect directly or indirectly the tendency of desert spread, salinization of arable land, abnormal weather and the nature changing worse in global level. These combined a big decrease of Biomass on the earth, namely biological resources. On the other hand, even in the domestic level, for example, it happened breakdown of natural ecosystem because of population increasing and the development of industry from the late 1960's in tropical Asia. Many kinds of environmental problems have arisen from that.

The reproduction of biological resources and management of agriculture, marine product industry are begun owing to the natural ecosystems that biological resources have been reproducted as much as necessary. Recently, how to manage coordination of using and keeping the nature or biological resources for human environment is required. On the basic, to study and elucidate the natural ecosystem is necessary.

The theme raised by the author this time, concerns mangrove ecosystem which is one of the important natural ecosystem to maintain tropical environment. And nowadays, economical and ecological problems of the mangrove area occurr. Because influence of human activity is remarkably increasing.

For the sake of that, the international organizations, such as UNESCO, FAO, have been proceeding research of mangroves. The author also had chances many times to perform field survey of mangrove in tropical Asia. Especially, this paper conducted a part of results of eco-managerial research in mangrove which was held in Thailand by JSPS in 1984 and 1985.

II. Outline of Mangrove Ecosystem

One of the primary features of coastal ecosystem throughout the tropical and subtropical zones of the world is mangrove forest, being described as "coastal woodland", "mangal" (MacNae 1968), "tidal forest" (Schimper 1903), and "tidal swamp forest" (Chapman 1975).

As based on the data in table 1, it can be estimated that the total mangrove

Table 1 Area distribution of the mangroves (After Aksornkoae 1985)

Country	Areas (Thousand ha)	Country	Areas (Thousand ha)
Bangladesh	450	Malaysia	674
India	96	Peninsular Malaysia	(149)
Pkaistan	345	Sabah	(350)
Sri Lanka	4	Sarawak	(175)
Burma	812	Philippines	240
Thailand	287	Kambodia	10
Brunei	7	Viet Nam	320
Indonesia	2,500	Papua New Guinea	553
Australia	m	Fiji	m
		New Zealand	m
Total area of mangrove in Tropical Asia 6,246,000 ha			
Mexico	660	Bolivia	m
Costa Rica	39	Brazil	2,500
El Salvador	45	Colombia	440
Euatemala	50	Ecuador	235
Honduras	145	Uruguay	m
Nicaragua	60	Peru	28
Panama	486	Venezuela	260
Central America & Mexico	1,485	Tropical Latin America	3,463
Belize	75	Guyana Francais	55
Guyana	150	Haiti	18
Jamaica	7	Republic Dominicana	9
Trinidad & Tabago	4	Surinum	115
Cuba	400	Others of the Caribean	597
Total area of mangrove in tropical America 5,781,000 ha			
Senegal	169	Equatorial Guinea	20
Gambia	60	Gabon	140
Guinea-Bissau	230	Zaire	50
Guinea	260	Mozambique	455
Sierra Leone	170	Madogascar	300
Liberia	20	Tanzania	96
Ivory Coast	m	Kenya	45
Ghana	m	Somalia	20
Togo	m	Ethiopia	m
Benin	m	Sudan	m
Cameroon	272	Nigeria	970
Angola	125		
Total area of mangrove in tropical Africa 3,402,000 ha			
Grand total area of mangroves 15,429,000 ha			

areas of the world is approximately 15,429,000 ha and it is composed of 6,246,000 ha in tropical Asia, 5,781,000 ha in tropical America and 3,402,000 ha in tropical Africa. The mangrove area in Thailand which was checked by satellite imagery in 1979 was about 2,873 square kilometers (Aksornkoae 1985).

Mangrove ecosystem is, a space and time system concerned in inorganic environment and community of life inhabiting the place flooded by the sea water and the brakish water around tropical and subtropical seacoast or estuary. Then mangrove ecosystem is the borderline between land condition and marine condition. Mangrove ecosystem is composed of many species of tree plants as land factor. Total number of tree plant species of mangrove ecosystem are 53, which are summarized into 9 families (Nakasuga 1979). These tree species are 16 species of family Rhizophoraceae, 11 species of family Vebenaceae, five species of family Sonneratiaceae and those three families have a majority. In Japan, there are only 5 genus and 7 species, as *Kandelia candel* (L.) Druce, *Bruguiera gymnorrhiza* Lamk. (=*B. conjugata* (L.) Merr.), *Rhizophora mucronata* Lamk., *Avicennia marina* Vierh., *Lumnitzera racemosa* Willd., *Sonneratia alba* Smith, *Nypa fruticans* Wurmb. On the other hand there are many types of marine factors and marine products such as crabs (family Grasidae, Ocypodidae, Portunidae etc.), shrimps (genus *Metapenaeus, Penaeus*).

The mangrove areas have finetextures, tidal sediment and alluvial sediment. Soils distributed in the areas are mainly water-saturated clay (muddy) soils, but sandy or peaty soils are also seen.

III. Ecological and Managerial Analysis on the Mangrove Area

During the long human history, mangrove ecosystem is combined complexly with people who live in coastal area of tropics (regarding tropical Asia, we focus it on Thailand to discuss this time). From the relation of human activities, mangrove ecosystem is divided into the economical point and socio-ecological point. Economical point can be said to perform biological resources that can convert into money, such as firewood, charcoal products, housing construction and marine products etc. The total of marine shrimp landed in Thailand in 1980 was 118,341 metric tons and 3,669 metric tons was fresh water shrimp. The fresh frozen shrimp was exported 17,915 metric tons in 1980 (Fisheries record of Thailand, 1980). And also, mangrove land is cultivated for shrimp farming and rice farming. Socio-ecological point can be said to perform a fortunate place for human daily life. It can be supplied as tree and grass to be the building materials of dwelling, contribution to health and hygiene, places for working, etc.

But, due to the excessive utilization exceeds the reproduction ability of mangrove ecosystem, recently, and secondly the mangrove area is being destroyed indirectly by the mining, shrimp farm etc.. Therefore in Thailand, there are many groves with the financial and scientific helps from Japan, not to allow the disordered utilization of mangrove ecosystem but to announce a poli-

cy of management on the basis of the scientific data and knowledges.

About management of mangrove ecosystem, there are two sides as utilization and conservation to coordinate, its important functions can be separated (1) the whole mangrove area, (2) the main biological components named mangrove forest of mangrove ecosystem.

1. Economical and ecological value of mangrove area

Here, economical value can show the result by a quantity or an amount of money concretely, copeing with ecological value. Economical value in mangrove area can be concluded as following:

— marine products (fish, crab, shrimp, shell fish, etc.)
— shrimp farm, fish culture
— tin mining
— residence of fisherman, factory of marine products
— tourism

One of the above, utilization of marine products are reformed up to the present, have no problem therefore it is less than the quantity of reproduction of mangrove ecosystem. The problem is that shrimp farm and fish culture only have under 10 years life, and they are as long as shifting cultivation (Suzuki & Sasaki 1982), deterioration of potential power on the habitat. So that a new culture place is necessary one after another, therefore mangrove area is destroyed on a large scale. Because of tin mining, the soil and sand are flooding to mangrove area to break down the living mangrove ecosystem step by step, reducing the marine products.

Thailand is one of the few tin producting countries and it has started to harvest the tin on land since 1907. The harvesting from the sea, was begun recently. Tin mining in the mangrove areas of Ranong, Phang Nga and Phuket (Thailand), occupying the area of 37,790 ha (Chua-Intra 1976), will cause severe destruction to marine organizations.

The managerial policies of maintaining today's economical value can be formed by (1) resource integrity, and (2) adjustment of new developmental project (hotel, road, recreation area, fishery station).

Ecological value is searching the function of maintaining the wholesome regional ecosystem from now to future. And most of the ecological factors on

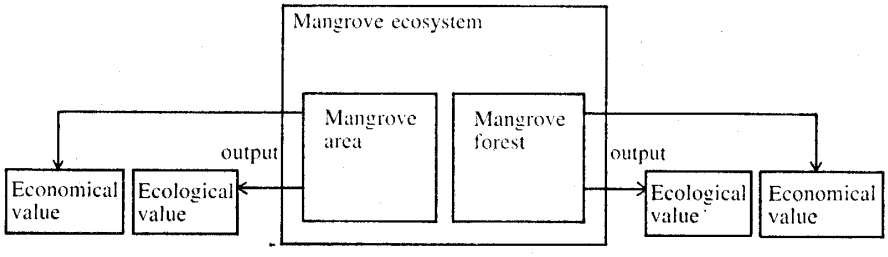

Fig. 1 Relation between mangrove ecosystem and its producing value.

the mangrove area are difficult to measure quantitically. Ecological value on the mangrove area is shown as following:

— living space of mangrove animals and plants
— water purification
— diversity of nature
— climate control

For maintaining of the ecological value, a concrete managerial policy is to designate the mangrove research area and to study and elucidate the mangrove ecosystem from the quantitical and qualitical view points. The second policy is ordered as natural mangrove area or national area for the restriction of excessive utilization.

2. Economical and ecological value of mangrove forest

The main biological supporter of the ecosystem in mangrove area is mangrove forest, namely plant community. The vanish of mangrove forest not only means the extermination of biological components but also to loss the non-biological construction factor beginning from soil. And it suspended the reproduction activity of biological resources of mangrove too.

Economical value on the mangrove forest is shown as following:

— timber, pulp, polyphenol
— firewood, charcoal products
— chemical products (ethanol, menthane fermentation)
— food (fruits)
— building material, furniture

The first half of the 1960's is a boundary as fuel revolution occurred

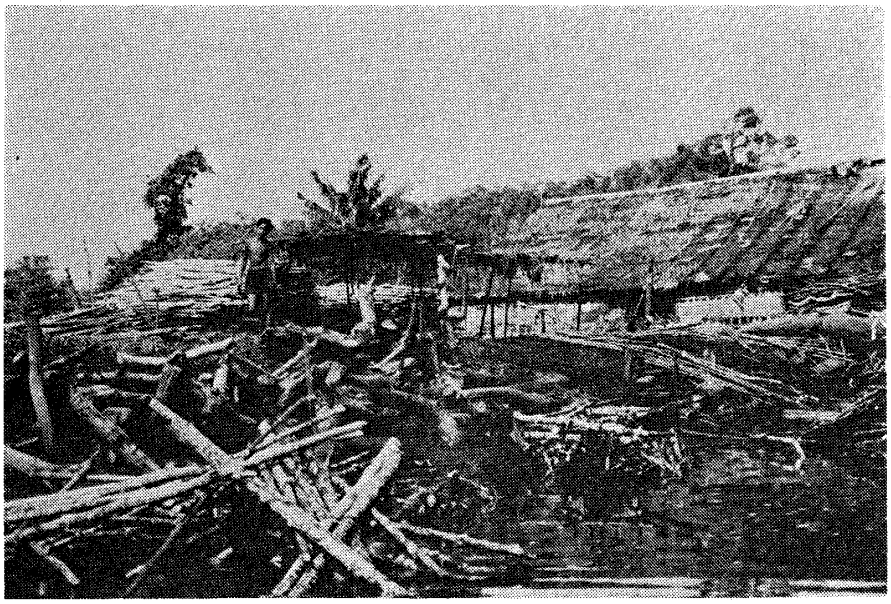

Photo 1 Charcoal factory using mangrove products (Kapur in Thailand).

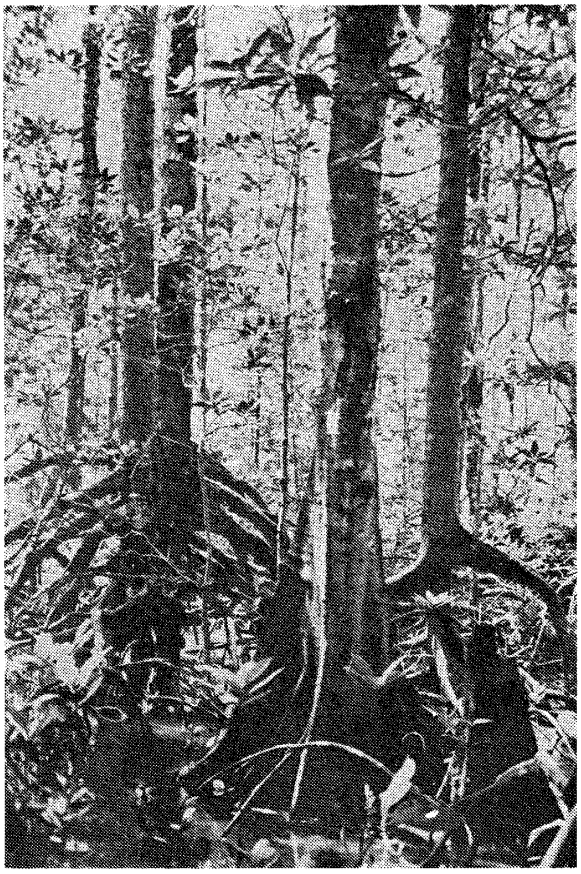

Photo 2 Natural mangrove forest (Rhizophoro apiculatae-Bruguieretum gymnorrhizae, Ranong in Thailand).

in Japan. Firewoods and charcoals are replaced by petroleum and the economical value of a former coppice was remarkably falling down. If this kind of alteration is not made in Thailand, Malaysia, Singapore, and other far east countries, the necessity of charcoal products from mangrove forest in Thailand do not decrease. Therefore the more products it need the more cutting were done, so that the tendency of mangrove forest to poverty is remarkable because of the decrease of reproduction power.

Tree plants used as charcoal products are limited to two species, one is *Rhizophora apiculata*. The other is *Rhizophora mucronata*. Those tall trees cover more than 80% in the canopy layer of some types of natural forest (Plant association: Rhizophoretum mucronatae, Rhizophoro apiculatae-Bruguieretum gymnorrhizae). But on other types of natural forest, such as the plant association: Sonneration albae-Avicennietum albae, Aegicerato-Kandelietum candel, Ceriopo-Xylocarpetum granati, Acrosticho-Xylocarpetum moluccensis, Sonneratietum ovatae, those species cover 10%–20% in canopy layer.

The secondary or substitutional forest revived on the mangrove area, where it has been cut once. The rate of *Rhizophora* spp. of secondary forest is lowering except some types of young plant community such as *Rhizophora apiculata-Rh. mucronata*-community. On the other hand, more than 80% of tall trees in

the plant associations of the mangrove area as *Sonneratia alba, Avicennia alba, Xylocarpus granatum, X. moluccensis, Ceriops tagal,* can be used if it extended to the utilization as firewood and timber, for secondary forest too.

The managerial policy of maintaining the economical value of mangrove forest is concerned in ecological value deeply. First, it revise the feeling series, secondly, plantation, control on logging within the presoription of the working plan et al. can be raised.

Ecological value in mangrove forest can be concluded as following:

— oxygen provision
— living space of animals, plants, fungus
— preservation of coastline
— biological system
— landscape

Biological system means the whole flora and fauna that has been depending directly or indirectly on mangrove forest to live. And landscape means inter-dependence relationship between creatures (including human being) and environment and the forest is an important and main component on that system. For maintaining this ecological value, the establishment and practice of silviculture system are demanded to do, it is a kernel of managerial policy.

IV. Discussion

Ecosystem of tropical rain forest and mangrove ecosystem, has been maintained the high potentiality of natural resources and natural informations. The destruction is already proceeding. There is almost nothing to be left in ecosystem of tropical rain forest. Recently, the alteration is remarkable and management policy is requested for mangrove ecosystem. But, the comparison between economical characteristics and ecological characteristics of mangrove ecosystem, as a premise of management is not researched yet, therefore including the issue is investigated also this time.

As performing the summary this time, it come into much collision for lack of concrete data. From now on, the author eagerly clarifies a more definite form of mangrove ecosystem and improves analysis centering on blank area.

Summary

Mangrove ecosystem, one of the highest potentiality of natural resources and natural informations in the world, has been changing worse in tropical Asia. In this paper, the economical and ecological adjustment and evaluation on mangrove ecosystem in Thailand are performed. Mangrove ecosystem is divided into two analyzing points, mangrove areas level and mangrove forest level. And each level can be analyzed to economical value, ecological value and tomorrow's managerial policy.

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