Peat swamp forests in Borneo and Sumatra —Original state, development and disasters during the past 50 years with a proposal for future eco-resource management—

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ABSTRACT The tropical peat swamp forests of Southeast Asia are unique and valuable forest types. Because of the difficulty of approaching the interior, these forests have remained untouched for many years. In the last two decades, however, development projects and forest fires have caused serious damage. Drawing from my experience in Sumatra and Borneo from the 1970s to the present, I describe here the original forest patterns, development typologies, and hazards. I also propose a new concept of “eco-resources” to promote better preservation and more healthy forms of development. Eco-resources are richest and most diverse in the tropics; and shifting to higher latitudes they become progressively more simplified. As peat swamp forests represent the last frontier of unspoiled nature, a total understanding of the relationship between human activities and nature is inevitably a central issue.

Key word: Sumatra, Borneo, peat swamp forest, Alan, development, eco-resources

Tropical rain forests in Southeast Asia contain the world's richest resources in terms of biomass and forest structure. Mixed dipterocarp forests and peat swamp forests, in particular, are unique to this part of the world. The peat swamp forests of Sumatra and Borneo are the forest type least touched by development because of the difficulty of access. But even in these remote areas, a wave of development has reached the interior and various ecological problems have occurred over the past two decades. In this paper, I describe the changing patterns of peat swamp forests in these areas according to my experience on the sites, and propose an alternative, possibly better, type of development based on the concept of eco-resource management.

1) Sumatra, 1978

My first experience in peat swamp forests was in Sumatra in 1978. During a mangrove survey in south Sumatra, I had a chance to see three types of development in the swampy area of the Musi River Basin (Yamada & Sukardjo, 1979).

One was the large-scale development of the transmigration project in the major swampy area between Palembang and Sunsang. The project used heavy machinery to dig wide canals for drainage and irrigation. The original landscapes were totally transformed into very flat and devastated areas. At the time, the canals were already experiencing problems, causing the suspension of water flow. The site managers told me they were well aware of the problems, but because it was a government project, no one could stop it. Large-scale development has since proceeded rapidly, changing all the peat swamp forests into cultivated areas.

The second type of development I saw was in the Bugis settlement in Pulau Rimau. The Bugis came from Sulawesi to this part of Sumatra after the large trees were extracted in the early 1970s. They cut the remaining trees themselves, dug small canals, and developed the area little by little. Paddy nurseries were established on the dikes or on the floors of houses to escape damage by inundation. Rice was transplanted twice to ensure a better harvest. Peppers, sugar cane, fruit trees, and coconut palms were planted on higher ground near tree stumps. Although the movement was very slow, the homegrown development and cooperation of the Bugis villagers have changed the situation gradually; several years later, coconut palms had grown big enough to bear fruit and coconut sales provided the major income in the area. Compared with the first type, this village-level development pattern seemed better adapted to the difficult environmental problems of peat swamp forests (Furukawa, 1994).

The third type of development consisted of individual

Table 1. Three types of development in the peat swamp forests in Sumatra in 1978.

<u>Level</u>	<u>Individual Household</u>	<u>Village</u>	<u>Company/Government</u>
Scale	Small	Medium	Large
People	Individual	Villager	Company
Labour	Single fighter	Community work	Mechanics
Budget	None	Small	Big
Destruction	Small	Small	Large
Local knowledge	Enough	Enough	Poor
Sustainability	Weak	Fair	Poor
Future Perspectives	No	Yes	No
Ecological balance	Bad	Good	Bad
Integration	No	Good	No

Fig. 1. Difference in canopy height of Alan bunga (2) and Alan batu (1).

efforts to open up forest in order to cultivate land. This kind of effort was usually in vain, as cultivators were unable to surmount the environmental challenges of the area. The evidence found in south Sumatra in 1978 is summarized in Table 1.

2) Brunei Forests, 1982-86

Brunei is a small country located on the northwestern coast of Borneo island. Although the area is small, the forests of this country were in fairly good condition because oil and gas production produced enough wealth to spare the forest.

To commemorate the independence of Brunei from the United Kingdom, international cooperation between Brunei and Japan was inaugurated in 1984. The project was called the Forest Research Center Project and included basic forest ecological research, afforestation, and the conservation of genetic resources.

At that time, I was working at the Kanto Forest Tree Breeding Institute, a research institution working for genetic conservation and the promotion of tree breeding in Japan. I was dispatched to Brunei from 1984 to 1986 to help establish the cooperative project. During this time, I spent many days in the forests and made extensive surveys of various forest types, of which the peat swamp forests were the most important.

Fig. 2. Crown projection of the Alan bunga forest type in Brunei.

Fig. 3. Large root system of Alan batu

Table 2. Summarized forest biomass in major forest types in Brunei.

FOREST TYPE	PLOT SIZE (m ²)	No./ha	BA./ha (m ³)	SPECIES No./plot	HMAX (m)	DMAX (cm)
Agathis	100 × 50	610	38.4	33	47.0	92.7
Alan batu	100 × 50	522	42.6	24	57.5	140.0
Alan bunga	100 × 50	310	43.4	22	51.5	96.6
Alan	50 × 50	400	50.7	14	51.0	80.5
Padang alan	50 × 50	872	39.7	17	43.5	63.5
Alan padang	50 × 50	744	34.5	10	33.0	46.0
Ulat bulu	50 × 50	1172	32.6	26	30.5	46.5
Mixed peat swamp (1)	50 × 50	828	36.5	41	36.0	73.3
Mixed peat swamp (2)	100 × 100	645	33.9	58	47.0	140.0
Mixed dipterocarp	100 × 100	736	49.4	174	50.0	114.0
Kapor paya	50 × 50	884	36.7	28	33.5	47.5

Table 3. Candidate species for the reforestation of peat swamp forest by Anderson (1961)

Preferred species:

Ramin	(<i>Gonystylus bancanus</i>)
Jongkong	(<i>Dactylocladus stenostachys</i>)
Meranti lop	(<i>Shorea scabrida</i>)
Meranti lilin	(<i>Shorea teysmanniana</i>)
Meranti buaya	(<i>Shorea rugosa</i> var. <i>uliginosa</i>)
Meranti paya	(<i>Shorea platycarpa</i>)
Kapur paya	(<i>Dryobalanops rappa</i>)
Sepetir paya	(<i>Copaifera palustris</i>)
Semayor	(<i>Shorea inaequilateralis</i>)

Acceptable species:

Jelutong	(<i>Dyera lowii</i>)
Perupok	(<i>Lophopetalum multinervium</i>)
Durian burong	(<i>Durio carinatus</i>)
Geronggang paya	(<i>Cratoxylon arborescens</i>)
Geronggang padang	(<i>Cratoxylon glaucum</i>)
Bintangor	(<i>Calophyllum spp.</i>)
Terentang	(<i>Camponosperma coriacea</i>)

As already reported by Anderson (1961), Brunei and Sarawak have splendid tropical peat swamp forests. The most important tree species is Alan (*Shorea albida*), of which there are two important types. One is Alan bunga, a matured pure forest type with a 70–90cm diameter and 50m height; the other is Alan batu, an over-matured forest type with a diameter of at least 100–150cm and a height of 70m. As shown in Fig. 1, the canopy class of each is quite different. Alan bunga has a uniform canopy projection, as shown in Fig. 2. The root system is very large, as shown in Fig. 3, and a pseudo-forest floor is established on the

upper surface of the root mat. Leaves and fruits fall onto this pseudo-forest floor and decomposition occurs here. As shown in Table 2, the biomass of peat swamp forest types was as large as that of mixed dipterocarp forests. (Yamada, 1997)

Because the Alan bunga grow as pure stands, most of these areas became targets for harvesting. The method of harvest, performed by a contractor from Sarawak, was typical, using a small railway and the sliding sledge system. After cutting one site, the rail was removed and set up again in a neighboring logging site.

Natural regeneration of *Alan* in the forest is very rare. The species is weakened by wind and attacked by insects called *Ulat bulu* and its flowering intervals are very long. In 1986, there was gregarious flowering in the Badas peat swamp area of southern Brunei, but regeneration was not successful. A plantation trial for this species was conducted in Sarawak, where good diameter growth rate of 10cm was observed over 10 years. Vegetative propagation in a mist box has proven quite successful. Effective reforestation of *Alan* is one of the most important goals for this area.

Besides *Alan*, many other species have good reforestation potential in peat swamp forests. Anderson (1961) mentioned several candidates, as shown in Table 3. He also proposed preserving a series of peat swamp forest types and a strict nature reserve. But there are not many locations where we can find a series of each peat swamp forest type. In the Badas peat swamp area, the series was in good condition in the 1980s; it is doubtful whether it is still intact today. Even in Brunei, the pressure from private sector logging interests is very high.

In the 1960s and 1970s, peat area studies advanced greatly in Sarawak, leading many scientists to agree that it is better not to develop the deeper peat areas, but to

conserve them as forests (Tropical Agriculture Research Center, 1980).

3) Disasters in the late 1990s in Kalimantan

In 1998, I joined the ITTO Forest Fire Prevention Mission to survey conditions in Kalimantan and Sarawak. This mission, organized by ITTO Head Quarters in Yokohama, included specialists from India, Nepal, Germany, and Japan. We conducted intensive interviews and observations in the areas studied and found the damaged forest to have many critical problems in the wake of fires. The forest fires first occurred on a huge scale in east Kalimantan in 1983 where 3 million ha of forest burned. Subsequently, several large fires occurred every 3 to 4 years; the fire in 1997 was especially severe on the peat swamp forest.

Simultaneously, a large-scale development project in central Kalimantan, called the "Mega Rice Project," started to open up large areas for cultivation. For this purpose, large canals were dug and new migrants were sent to the area. As is widely known, this project failed mainly due to poorly conceived canal design.

But other factors kept up the pressure. Large-scale fires spread into the peat areas and burned the remaining forests (Guhardja *et al.*, 1993). Local autonomy became

Fig. 4. Concept of eco-resources

the dominant trend following the fall of President Suharto, allowing people more free access to logging than ever before. As we conducted surveys in the years from 1999 to 2001, we found the effects of these combined factors to be causing the forests to become more and more degraded.

4) The concept of eco-resources: towards a harmonious life in the future

Bio-science has become an advanced discipline in recent years, and the term "bio-resources" has become very common. Currently however, the concept does not include the entire ecosystem in which bio-resources live. A lack of ecosystem understanding and the wide-scale, speedy extraction of these resources have left devastated primary forests in many parts of the world. Obviously, bio-resources will not survive in the absence of suitable environmental conditions in particular ecosystems, but this simple argument has been ignored over the last two decades. If this trend continues, our bio-resources will be seriously threatened with extinction in the near future.

In contrast to this model of extraction and degradation, there are still many minority groups in the deep forests of Southeast Asia who live in a sustainable manner with a deep understanding of the natural environment (Sellato, 1994; Rousseau, 2000). The concept of "eco-resources" emerged from their examples and from my research experience in many parts of the world. The general concept is shown in Fig. 4. I divide eco-resources into three broad categories. First are the fundamental resources of atmosphere, soil, and water,

which form our earth. Second are the so-called bio-resources. Third are eco-human resources, the most important part of eco-resources.

In this category, I include the life resources of agriculture, forestry, fisheries, and stock farming. More important are anthropogenic factors such as culture, religion, healing, and so forth. Such cultural elements have been excluded from the nature preservation concept for many years, but recent trends have been changing.

For instance, religion has emerged as an important factor in protecting the forest in many Buddhist countries (Siam Society, 1989). Minority group traditions of preserving certain forests near their village as sacred places are also being recognized. And eco-tourism has become more and more attractive as people seek to spend time in natural sites to heal themselves from their exhausting urban lives (Fennell, 1999; Yamada, 2002).

This trend is completely different from the bio-resources concept we know so far. Production is not important here because what we are seeking is unspoiled nature, not the extraction of bio-resources. The role of the forest has been changed from a source of resources to a preserver of harmonious pure nature. And this trend should be accelerated quickly because the pressure to destroy nature is ever more intense. What remains of pure nature will have elevated importance and value in the future. As shown in Fig. 4, it is important to include the whole ecosystem as well as the cultural and mental elements of human activities.

To see the concept of eco-resources in a particular area, Fig. 5 shows the concrete example of Brunei. This

Fig. 5. Eco resources chart in Brunei. Only forest-related matters are shown.

Fig. 6. Eco-resources chart for the peat swamp forests in Borneo and Sumatra. Forest types, depth of peat and possible land use.

is one example of a small area. By accumulating these data from many parts of the world, we can arrive at a broad view of the world's eco-resources and identify the fundamental principles of eco-resources as follows:

(1) Eco-resources are basically sustainable resources if no severe disturbance(s) occurs. Once disturbed, however, the cost of recovery is very high.

(2) The most highly diversified and rich eco-resources are found in the tropics. As we move toward the polar regions, eco-resources become uniform and show centralized distribution.

(3) The most fundamental types of eco-resources are found in primary nature, the opposite of which is the city.

(4) Anthropogenic factors are essential to the eco-resources concept in order to understand the relationship between humans and nature.

Looking back on the history of the earth, we see that human beings have been destroying nature for thousands of years. And some of the most severe destruction is ongoing in the peat swamp areas of Southeast Asia. Activities to date in Sumatra and Borneo have mostly destroyed the original natural systems and threaten the lives of people living in and around these areas. These are extremely wasteful activities because the original peat swamp forests were unique and are among the most valuable eco-resources on the planet.

This should not be disregarded: rehabilitation and protection of what remains is possible. Fig. 6 shows a tentative idea for land use according to peat depth. The

integration of many disciplines will be necessary, but I believe that seeking a harmonious relationship between humans and nature in peat swamp areas is a most urgent task.

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