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Degradation and loss of forest land and land-use changes in Sarawak, East Malaysia: a study of native land use by the Iban

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Abstract Swidden agriculture, commercial logging and plantation development have been considered to be the primary common causes of degradation and loss of tropical rain forests in Southeast Asia. In this paper, I chose a part of northeastern Sarawak, East Malaysia as my case study area to analyze the changes in its land-use characteristics. In the study area, as well as primeval forests, we see that land use began about 100 years ago by a native group called the Iban; commercial logging began in the 1960s, and the development of oil palm plantations began recently. I describe the changes in land use as well as their social and economic causes by referring to aerial photographs, literature surveys, interviews with government officers and the Iban, and observation of land use. My analysis of land use demonstrates that on “state land”, where commercial logging and oil palm plantation development are occurring, large areas of forest have been disturbed in a short period of time. The objective is to benefit economically in response to the social and economic conditions surrounding the study area. On the other hand, in the “Iban territory,” where the Iban practice their land use, land conversion has not occurred on a large scale and in a short period of time, even though the forest has been cut and agricultural fields have been created in response to social and economic conditions as well. They disperse small agricultural fields throughout their forest land. Therefore, the landscape of the “Iban territory” is based on secondary forest, composed of patches of forest in various stages and with several types of agricultural land. Today in Sarawak, monocrop plantations are rapidly expanding and little primeval forest remains. Given these conditions, the land-use practices of natives such as the Iban will be evaluated from the viewpoint of ecosystem and biodiversity conservation. It could play

an important role in providing habitats for natural wildlife.

Keywords Tropical rain forest · Iban · Secondary forest · Swidden agriculture · Commercial logging · Oil palm plantation · Sarawak

Introduction

One of the primary causes of the degradation and loss of tropical rain forests, composed of complex ecosystems and the most diverse natures, is continuous and rapid conversion of primeval forest to other land uses (Walker and Steffen 1999). For the purpose of ecosystem and biodiversity conservation, it is necessary to examine the characteristics of these changes in land use. These could be, for example, the social conditions under which land-use changes occur and how the changes will evolve in the future. We should also consider the role of land use in areas other than primeval forests, because the amount of remaining primeval forest is already limited.

Tropical rain forests in Southeast Asia are mainly distributed in isolated areas of Malaysia, Indonesia and the Philippines. Although they are in different countries and there is distance between the areas, there are several commonalities with respect to forest degradation and loss. These include swidden agriculture, commercial logging (Lanly 1982), and plantation development (Primack and Corlett 2005), through which oil palm has become lucrative, particularly in the last two decades. Therefore, results of an analysis of land-use changes in a case study area can be applied to a wider area encompassing tropical rain forests distributed throughout Southeast Asia. This paper focuses upon Sarawak of East Malaysia on Borneo Island, which lies in the center of the distribution of tropical rain forests in Southeast Asia.

I give particular consideration to land use that includes swidden agriculture practiced by natives. Several researchers have considered native land use, especially

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swidden agriculture, as a cause of the degradation and loss of tropical forests (Lanly 1982; Freeman 1955). Based on those research results, after the 1960s, governments with jurisdiction over tropical rain forests have insisted that the main cause of the degradation and loss of tropical forests was swidden agriculture. On the other hand, they have stated that commercial logging, which they promoted, was a sustainable type of forest use because it has been conducted using selective logging.

Another researcher insists that if swidden agriculture is practiced in the traditional way with long enough fallow periods, it is a sustainable method of land use because the forest can recover (Chin 1987). Research results have found native land use including swidden agriculture to be positive (Aumeeruddy and Sansonnens 1994; Coomes et al. 2000; Salafsky 1993), because its mosaic pattern of fallow forests and various agricultural fields provides habitats for natural wildlife.

In Sarawak, oil palm plantation development began in the mid 1960s. From the 1990s in particular, the area used for plantations rapidly increased, while the production volume of timber decreased. There are many cases where oil palm plantations were developed after clear cutting forests where commercial logging had already been practiced. In recent years, plantation development using fast-growing trees, such as *Acacia mangium*, is planned or started in hilly or mountainous areas of the middle and upper reaches of river systems, which are inappropriate places for oil-palm growing. The rapid expansion of monocrop plantations in recent years has also been seen in Indonesia and the Philippines.

This paper addresses the issue of evaluating native land use from the perspective of its role in ecosystem and biodiversity conservation, at a time of change in the factors contributing to the degradation and loss of forests.

As already mentioned above, previous studies assessed native land use from the standpoint of the agricultural system, such as the use of fallow periods and periods of continuous cultivation, as well as from an ecological standpoint. In this paper, I focus on the scale and speed of the disturbance to forests, which have not been adequately considered, by analyzing periodical changes in land use. In conclusion, I highlight the important role of native land use for ecosystem and biodiversity conservation in the tropical rain forests of Southeast Asia, where the area used for monocrop plantations is rapidly increasing.

Overview of Sarawak, the selection of the study area, and methodology

Overview of Sarawak

Sarawak has a tropical rainforest climate, with an annual rainfall that ranges from 3,000 to 5,000 mm. The area of Sarawak State is about 120,000 km², of which

forest areas cover about 65% and fallow forests with patches of swidden cover about 30% (Department of Statistics, Malaysia 2004). The number of oil-palm plantations has been recently been on the rise, covering an area that occupies 4% of the state (Fig. 1). Untouched primeval forest is dispersed in small patches.

Before the Brooke (British Governor) regime began in Sarawak in the 19th century, primeval forest was mainly exploited by natives through swidden agriculture. Development in forests requiring larger amounts of capital proceeded gradually during the Brooke regime and during the British occupation after World War II. However, in the last few decades, development including commercial logging, oil-palm plantation development, road construction and urbanization, has proceeded rapidly.

Sarawak is home to about 2.7 million inhabitants (Department of Statistics, Malaysia 2004), and they are comprised of various ethnic groups, such as the Iban, Chinese, Malay and Bidayuh. The population is divided into two categories, natives and non-natives, such as Chinese and Indian. In Sarawak, almost everyone except the Chinese, who account for slightly less than 30% of Sarawak's population, are native peoples (Department of Statistics, Malaysia 2004). The largest ethnic group is the Iban who make up more than 30% of the population (Department of Statistics, Malaysia 2004).

Through Freeman's research, the Iban became well known as hill shifting cultivators (Freeman 1955). However, they usually practice wet rice cultivation in the flatlands (Ichikawa 2003a). More recently they have diversified their livelihoods to include the cultivation of cash crops and wage work (Ichikawa 2003b). In major parts of rural areas where other natives live, the residents have also practiced swidden agriculture, as the Iban have done, as one of their main sources of livelihood,

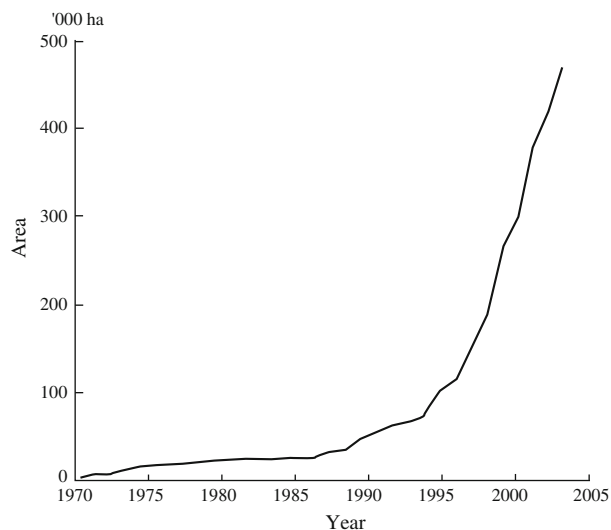


Fig. 1 Increase in the area of oil-palm plantations in Sarawak [source, Department of Agriculture Sarawak (1981, 1991); Department of Statistics, Malaysia, Sarawak (2004)]

although recently this is also changing. Therefore, it is generally true that with the exception of some groups, such as hunter-gatherers, land use by the natives in rural areas is similar.

Selection of the study area

The primary causes of the degradation and loss of tropical rain forests in Sarawak were noted earlier to be swidden agriculture, commercial logging and plantation development. Today, in rural areas in the middle and lower reaches of the rivers, we can see a mosaic landscape pattern consisting of undisturbed or less-disturbed forest and land use from the above-mentioned activities, i.e., fallow forests with swiddens, logged forests and oil-palm plantations. In this study, I chose an area of about 27,500 ha that encompasses the above-mentioned land uses (Fig. 2). It is located to the southwest, 25 km from Miri, an urban center northeast of Sarawak. The center of the study area is hilly or mountainous, and primeval forests still remain. The Bakong River, a tributary of the

Baram River, passes through the southeastern part of the study area. Iban land use extends along the left side of the river. On the right side, there are logged swamp forests, and some parts are beginning to be developed as oil-palm plantations. Oil-palm plantations are also seen in the southwest part of the study area and are beginning to be developed in the northwest as well. Logged forests extend through the northern part of the study area.

Methods

To analyze land use changes in my study area, I drew land use maps using several aerial photographs taken in 1963, 1977 and 1997, and measured the changes in land use. Classification of land use was conducted based on visual characteristics (Table 1).

Information on land use changes and their causes was collected by means of interviews and collection of documents. I conducted interviews with people familiar with the land use conditions both in the past and the present, such as the Iban and staff from the Forestry and

Fig. 2 The study area

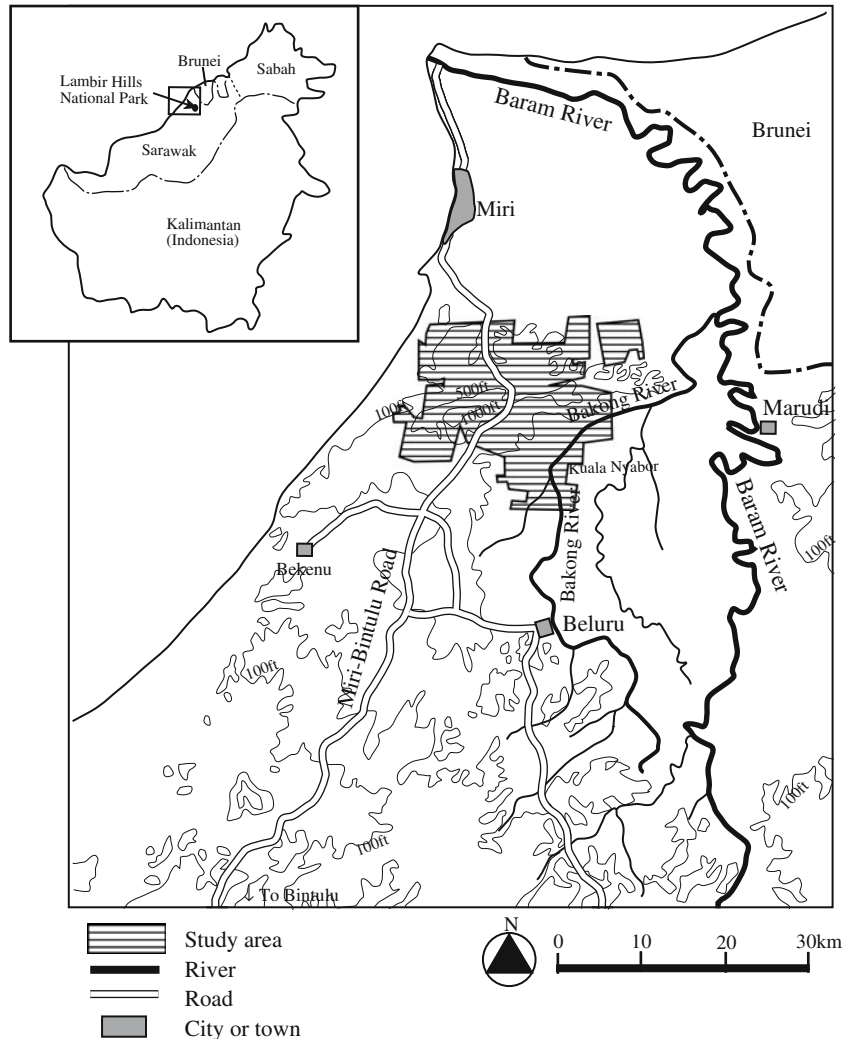


Table 1 Characteristics of each type of land use visible on aerial photographs

Type of land use	Characteristics visible on aerial photographs
Primeval or mature forest in hills	Forest height is more than 30 m, and forest cover is almost 100%. No human disturbance has been made, or if there was some disturbance, the forest has recovered sufficiently
Peat swamp forest	Distributed in the lowlands along the Bakong River. Forest consists of <i>Shorea albida</i>
Swamp forest (primeval or mature)	Forest except for "peat swamp forest" extends through the lowlands along the Bakong River and in valleys among hills
Logged forest in hills	Selectively logged "primeval or mature forest on hills". Many logging roads visible. Tree density lower than in original forest
Logged forest in swamps	Selectively logged "peat swamp forest" and "swamp forests (primeval or mature)". Several railways for extracting logs can be seen. Tree density is lower than in original forest
Secondary forest in hills	Mainly fallow forest for swidden agriculture. Forest patches of variable height from 5 m to 30 m extend in a mosaic pattern. Swiddens, rubber gardens, fruit groves and pepper gardens 0.1–2 ha in size are dotted throughout this secondary forest
Secondary forest in swamps	Mainly fallow forest for swidden agriculture. Forest patches of variable height from 5 m to 30 m extend in a mosaic pattern. Swamp swiddens, and in relatively elevated places, rubber gardens and fruit groves 0.1–2 ha in size, are dotted throughout this secondary forest
Hill swidden	About 1 ha area with paddies, other crops, grasses and shrubs. Crops may be grown there, or were already harvested 1 or 2 years ago
Swamp swidden	About 1 ha area with rice, other crops, grasses and shrubs. Rice may be grown there, or was already harvested 1 or 2 years ago
Plantation	Area largely planted with para rubber and oil palm

Agriculture Departments, as well as Chinese living in towns near the study area. I visited the Iban five or six times each in ten longhouses located in the study area, and interviewed chiefs and seniors there. I collected documents, such as the Sarawak Gazette, earlier official gazettes, and statistics from government offices related to land use. The study was conducted intermittently from 1996 to 2005, and I lived in a longhouse for more than a year in total (cf. Ichikawa 2003c).

Results

Land use changes

The study area could be roughly divided into two types of area according to the landscape and the characteristics of the land-use changes (Fig. 3). In this paper, one is called "Iban territory" (around 7,600 ha), and the other is called "state land" (around 19,900 ha) (Fig. 3a).

The "Iban territory" consists of the areas where the Iban make their livelihood. These are almost all in "secondary forest in hills", "secondary forest in swamps", "hill swidden" and "swamp swidden.". The land code in Sarawak prescribes categories of land that the natives have the right to occupy and use. The category with the largest area is native customary right land, to which the natives have usufruct rights according to the adat of the natives, by cutting the primeval forest. The land code, however, limits the right to areas first cut before 1958. Only a few parts of the native customary right lands have been registered. Today, the natives sometimes use land without usufruct rights for their agriculture. The "Iban territory" in this paper consists of areas where the Iban consider themselves to have

usufruct rights and are actually still using the land. I confirmed those areas through interviews with the Iban. The Iban community lives together in a longhouse. The longhouse community territory primarily extends around the longhouse.

The "state land" consists of areas that have been used by the Sarawak state and private companies with permission from the government. In practice, some Iban have made swiddens on the "state land". Therefore, we actually see "secondary forest in hills" that contains fallow forest resulting from swiddens being fallowed, on the "state land" (Fig. 3c).

Land use changes in the "Iban territory"

There are two ways in which primeval forests were changed to secondary forests (Fig. 4). In one, the primeval forest was opened to make hill or swamp swiddens. The swiddens were fallowed after the harvest, and then secondary forest grew there. In the other, the primeval forest was selectively cut for commercial log production, and then swiddens were made there. After the swiddens were fallowed, they were replaced by secondary forest. From 1963 through to 1977, the area of primeval forest in both hills and swamps decreased, changing to secondary forest (Fig. 4a). In Iban territory, secondary forest eventually accounted for the largest part of the area (Fig. 4b).

Hill swiddens are made after cutting and burning a patch of forest on relatively dry land. The main crop is hill rice, and some vegetables, root crops and other crops are also produced (Ichikawa 2005a). In 1995, the cut forests for swiddens were from 7 to 10 years after the fallowing of the previous swiddens, and the forests were

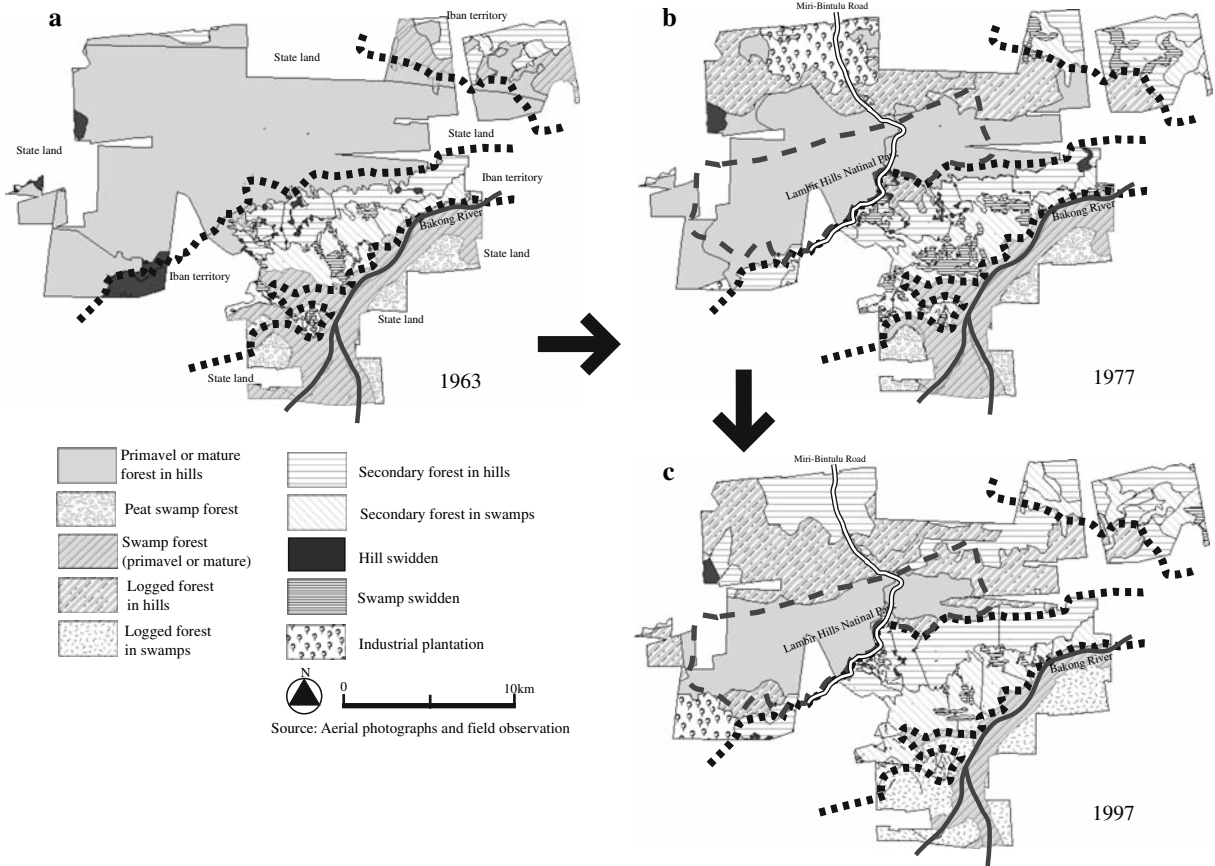


Fig. 3 Land-use changes in the study area, which are drawn from aerial photographs and field observation

about 10 m high (Ichikawa 2005a). Swiddens in swamps are made after cutting and burning forest or grass that grows on wet land (Ichikawa 2000). Only wet rice is produced there. Both types of agriculture incorporate fallow periods, although recently the period of time in which the same land is planted is becoming longer (Ichikawa 2000; 2005a). The area of hill swiddens decreased from 1963 to 1997 (Fig. 4b). In contrast, the area of swamp swiddens greatly increased from 1963 to 1977 (Fig. 4a), but then greatly decreased from 1977 to 1997 (Fig. 4b).

By 1997, the primeval forest and logged forest had almost all disappeared. Therefore, changes in land use today, as indicated by the arrows in the figure, primarily show changes between secondary forest and hill and swamp swiddens (Fig. 4b). As mentioned in Table 1, agricultural fields, such as rubber gardens, fruit tree groves and pepper gardens, are dispersed throughout the areas indicated as secondary forest. In 1995 a 2,600-ha area of the Iban territory containing agricultural fields was surveyed. According to interviews with individual owners, the total area of rubber gardens, fruit tree groves, and pepper gardens was estimated to be 220 ha, 38 ha and 3 ha respectively. Then, the total area of each type of agricultural field in the entire area of the “Iban territory” (7,600 ha) is roughly estimated to be 638 ha, 110 ha and 9 ha, respectively.

Interviews with the Iban revealed the land use changes as follows. Rubber gardens were created in the 1950s and in the early 1960s, although rubber planting started as early as the 1930s. Rubber gardens sometimes contained a few fruit trees in addition to rubber trees. There are also various naturally growing trees in the gardens, especially if tapping is not done for a while. According to Momose K et al. (unpublished data), 19 tree species/0.1 ha were counted in the rubber gardens in the study area. Pepper gardens were created in the early 1970s and in the late 1980s, although peppers were planted by a few families as early as the 1940s. A pepper garden is usually abandoned after about 10 years due to declines in production, and secondary forest grows on that land. The fruit tree groves were made by planting various kinds of fruit trees around work huts used primarily for rice preparation, but from the late 1980s onward, fruit trees were not necessarily planted only around the huts, but anywhere after secondary forest was opened. After 2000, several patches of oil palm gardens (1–2 ha in size) were created near the roads.

Causes of land-use changes in the “Iban territory”

The development of the Miri Division began after 1882 when Brooke annexed it as Sarawak territory (Pringle

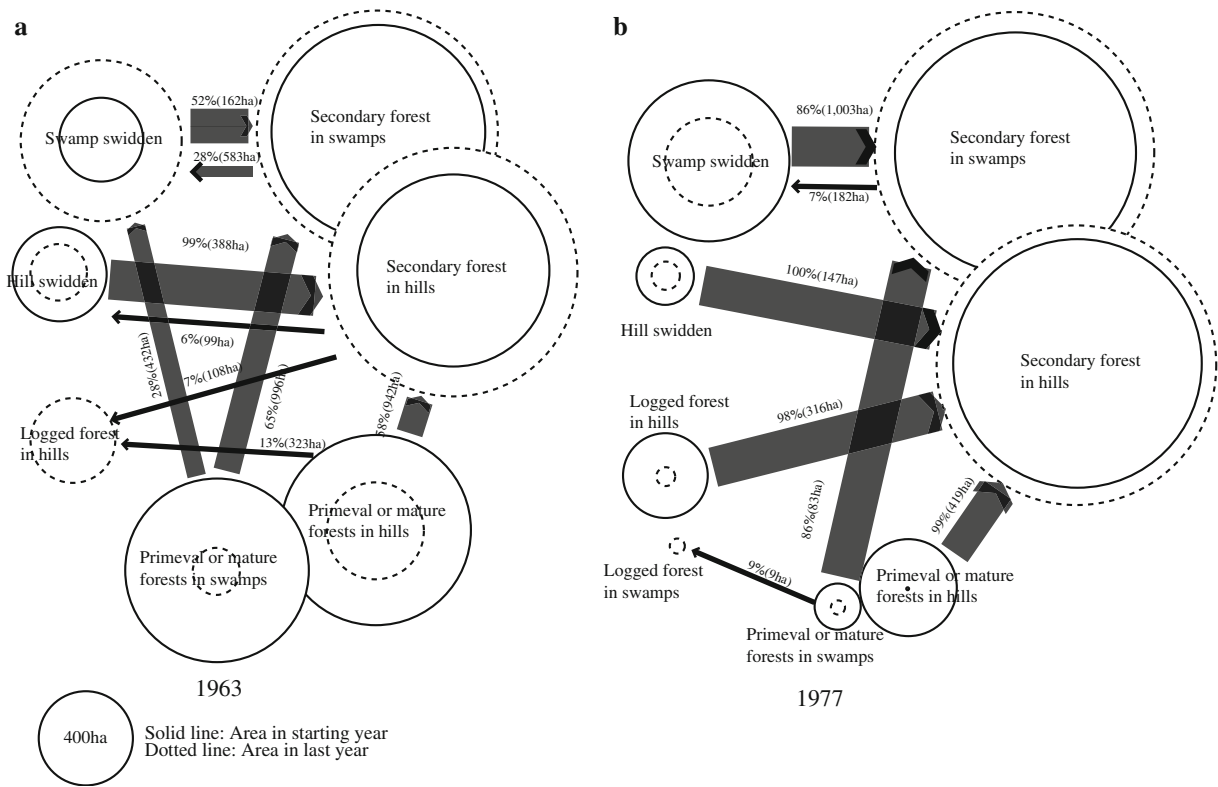


Fig. 4 Land-use changes and transit probability in the “Iban territory”. Some legends on the land-use maps have been simplified to reduce complexity in the figures. The circles are proportional to

the areas used for each type of land use. The widths of arrows are proportional to the percentage of change

1970). Many Iban longhouses are distributed along the upper to lower reaches of the Bakong River. The Iban came from today’s Sri Aman and Sibuhu Divisions and settled there from the end of the 19th century to the early part of the 20th century (Pringle 1970; Sandin 1994). Before they settled there, much of the Bakong area was the territory of hunter-gatherers, and there was extensive forest that had never been cut. The original types of forest in the study area are peat swamp forest in the area south of the Bakong River, mixed swamp forest along the Bakong River, and mixed dipterocarp forest in the hills.

The Iban intentionally settled into the study area about 100 years ago, encouraged by Brooke (Pringle 1970). Due to land shortages, they wanted to move from what is today the Sri Aman Division to the Baram basin, where there was a lot of primeval forest. Brooke wished to stabilize the Baram basin, newly annexed territory, by immigrating the Iban. He also intended for the Iban to work as collectors of forest products, which were important trading commodities for Sarawak at that time.

The immigrants collected forest products, such as wild rubber and rattan, for sale, while cutting the primeval forest to make swiddens around their longhouses. Until the 1960s, hill swiddens were important for the Iban and larger than those in the swamps. This is because hill rice tasted and smelled much better than wet rice at that time, and because other products from hill

swiddens were very important for subsistence under an economy more self-sufficient than that of today.

The reason for the increase in swamp swiddens from 1963 to 1977 (Fig. 4a) is an increase in rice demand, especially in the 1970s, from logging camps appearing in the Baram basin. Responding to the demand, the Iban expanded the swamp swiddens to produce commercial rice. In the 1990s, the field areas declined again (Fig. 4b) because products other than rice, such as pepper and forest products, became more attractive commodities, and there was an increase in opportunities to work for wages outside the villages, such as at construction sites in Miri. The reasons for the changes include the development of Miri, supported by prosperous oil and timber industries, as well as an increasing demand from urban dwellers for agricultural and forest products. The causes of the reduction in hill swiddens (Fig. 4b) include an increase in rice production from swamp swiddens after the 1970s, and a decrease in the importance of hill swidden products as it became possible to buy vegetables and root crops in Miri and other towns nearby.

Commercial logging in the “Iban territory” consisted of selective cutting on a relatively small scale conducted by small Chinese companies after the mid 1970s. Just after the logging, the Iban cut and burned the remaining trees to make swiddens. The companies continued to operate until the end of the 1980s, sometimes cutting the remaining thick trees in the “Iban territory”.

Rubber and pepper have followed international market prices. They were planted when the prices were high, but in contrast, when prices were low, they were not adequately harvested and cared for. The Iban began to sell fruit in Miri after the 1980s, and in recent years fruit tree groves have been created. The reason why oil palm gardens were created was to be able to sell the products to nearby oil processing factories at a good price. The oil palm gardens were made by some Iban who had a certain amount of capital and land near roads where the products could be easily transported out. Therefore, the area of oil palm gardens made by the Iban is not expected to expand greatly in the near future.

Land-use changes in the “Iban territory” after 2000 appear to be of the following two types. In one, some patches of secondary forest are converted to swiddens, and then, after their fallowing, secondary forest regenerates. In the other, as with the example of the oil palm gardens, patches of new agricultural land are opened up, and forest products are collected in the areas shown as secondary forests, depending on social and economic conditions surrounding the study area.

Land-use changes on the “state land”

In 1963, almost all of the “state land” was covered by primeval forest (Fig. 5a). After the mid 1960s, companies conducted commercial logging in the hills. A rubber plantation was developed in the mid 1960s in a part of

the northern area of Fig. 3b. In 1975, the Lambir Hills National Park, which consists of about 7,000 ha, which had been a part of a forest reserve as a water catchment area, was established (Fig. 3b), and logging activities were banned in the area. As a result, primeval forests have been reserved there in good condition until today, although some illegal logging activities have been observed. In contrast, after the 1980s, companies have conducted commercial logging around the national park, not only in the mixed dipterocarp forest, but also in the peat swamp forest (Fig. 3c). The rubber plantation mentioned above was abandoned after some years of planting, and secondary forest regenerated there (Fig. 3c). Meanwhile, oil palm plantations have been developed in the southwestern part of the “state land” (Fig. 3c). Recently, oil palm plantations have been rapidly and widely developed in and around the study area (Fig. 6). After 2000, both logged forests in hills and swamps and secondary forest were clear-cut and converted into oil palm plantations.

Causes of land-use changes on the “state land”

In the study area, the development of forests on the “state land” began rather later than in the surrounding areas because of the steep topography. After the mid 1960s, the Miri-Bintulu road (MB road) acted as a trigger for commercial logging and plantation development (Fig. 3b). This construction project was promoted

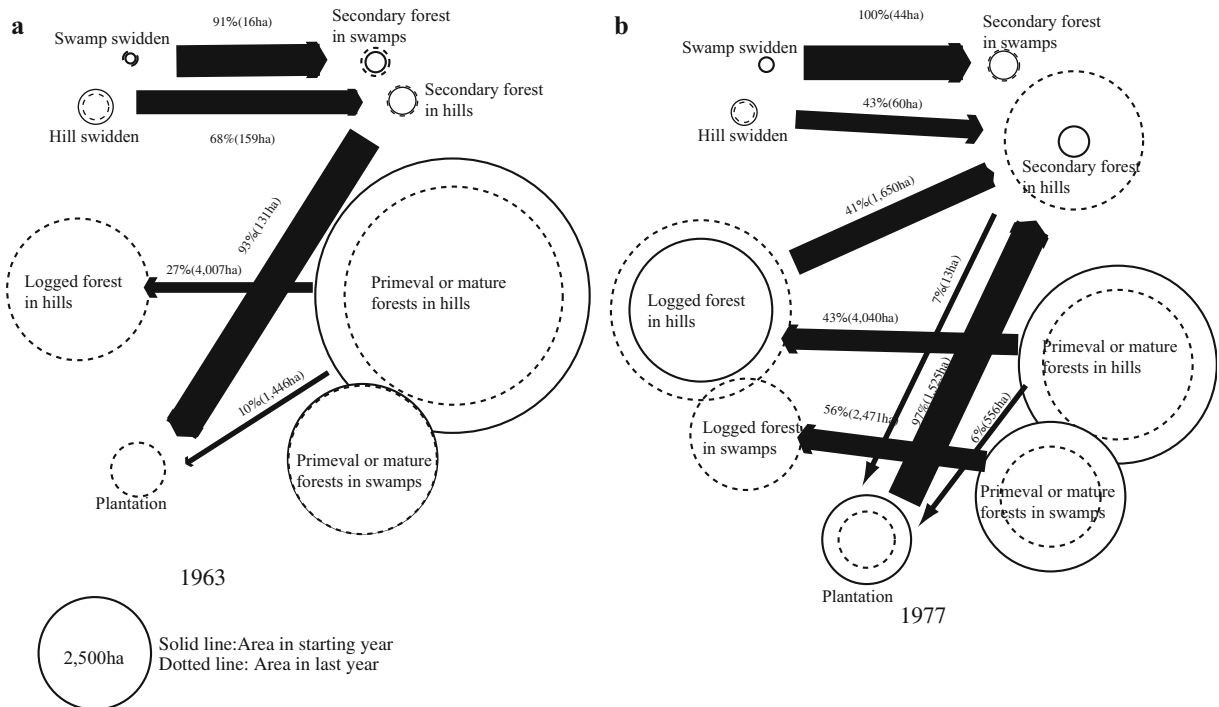
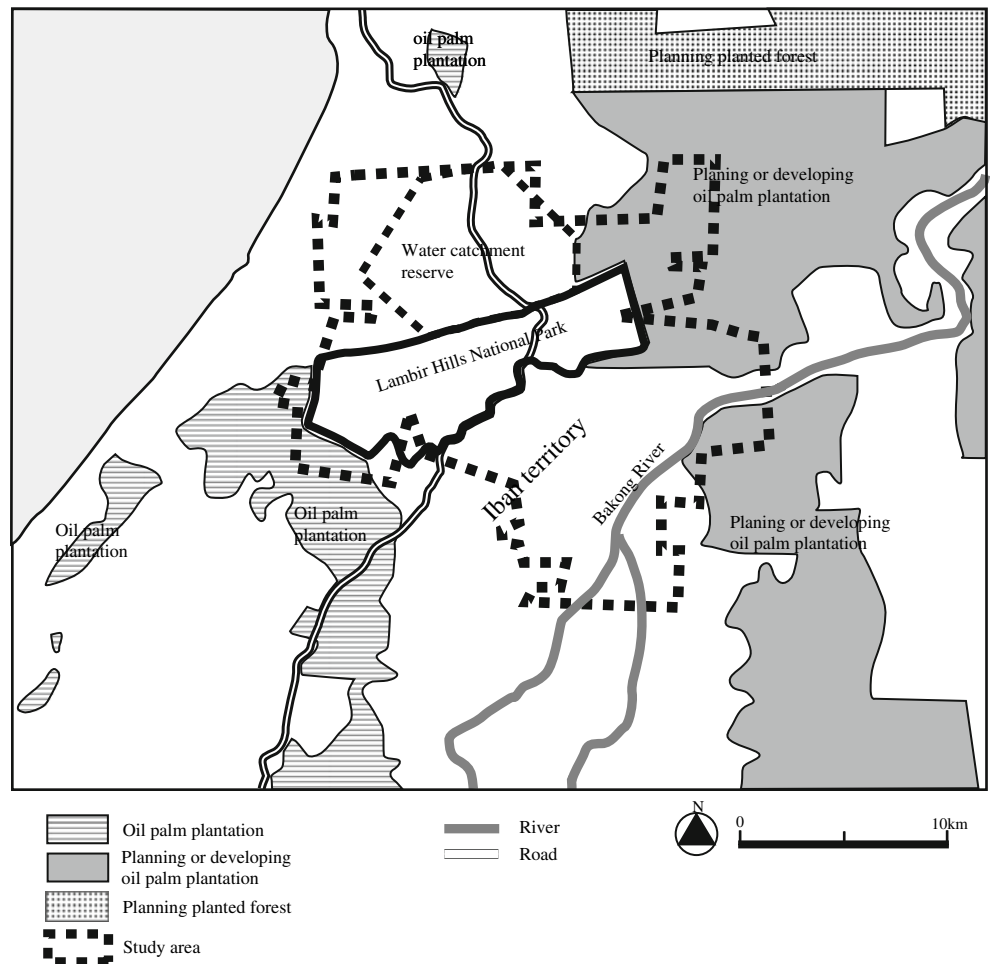


Fig. 5 Land-use changes and transit probability in the “state land”. Some legends on the land-use maps have been simplified to reduce complexity in the figures. The circles are proportional to the

areas used for each type of land use. The widths of arrows are proportional to the percentage of change

Fig. 6 Increasing monocrop plantations in and around the study area in 2002 (Source; Land and Survey Department, Sarawak)



when Sarawak was incorporated into Malaysia in 1963. The road was constructed, and passed the study area in 1965. Soon after the road construction, many logging roads connecting to the MB road appeared in the northern part of the study area, and commercial logging by companies began in the hill dipterocarp forest (Fig. 3b). In fact, commercial logging in the hill areas increased after the 1960s throughout all of Sarawak (Ross 2001).

According to information from the Forestry Department, two logging licenses were issued to two different companies in 1966 and 1967 in the northern part of the study area, one for the western part of the MB road and the other for the eastern part of the road. Then the licenses were renewed several times. The one for the western part was still valid in 2005, and logging still continued. The other license for the eastern part was surrendered back in 1990, and there was no more logging after that. Every year before logging began, the logging companies submitted a “felling plan” to the Forestry Department, and they could cut trees only in the areas (coupes) shown in the plan. In a coupe, logging is not conducted just once, but rather repeatedly with several-year intervals. In the study area, the diameter of the logs gradually became smaller. I was not able to

obtain complete data showing how many times logging had been conducted in each coupe from 1966 or 1967. But some information shows that logging had been conducted two or three times with intervals of 6–8 years in the 1980s and 1990s in the area west of the MB road.

On the other hand, a global trend toward the conservation of nature appeared after the 1970s. According to staff at the Forestry Department, that was one of the reasons why national parks were designated in the areas where no logging and agricultural use had occurred.

Rubber plantation development was a governmental project intended to encourage immigrants from other regions of Sarawak to engage in rubber planting and management. However, the plantation project collapsed because the immigrants found wage-earning jobs, and the rubber plantations were abandoned and/or sold. According to the immigrants who still remain there today, after the mid 1960s, the price of rubber latex dropped, but several opportunities to work for wages arose, such as construction work in Miri and logging work in the Baram basin. After the collapse, secondary forest recovered almost everywhere, while in some areas fruit trees were planted.

Oil palm plantation development also began just outside of the study area when the MB road was

constructed. Today, the largest oil palm plantation areas in Sarawak are found to the south of the study area. After the late 1990s, oil palm plantations began to be developed in the northern part of the study area (Fig. 6) after the logged forests were clear cut, although those do not yet appear in the aerial photographs from 1997 (Fig. 3c).

Discussion

Characteristics of land use on “state land” and in “Iban territory”

Land use changes in the “Iban territory” have generally proceeded more slowly than those on the “state land” (Fig. 7).

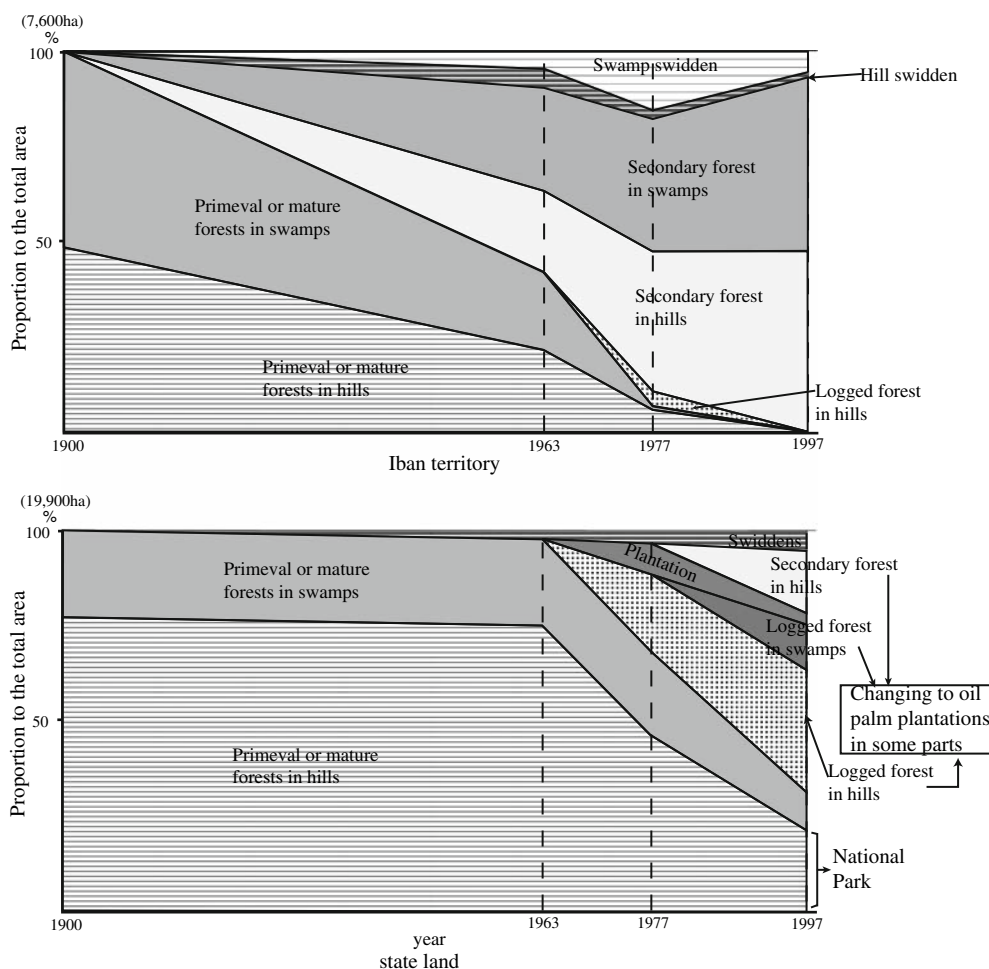
Until the mid 1960s, almost all of the “state land” was covered by primeval forest. After that, we see land use that generated great economic benefit in a short period of time. For example, one such use was commercial logging by companies. Many logging roads were constructed and thick wood was selectively cut using chainsaws. Logging was repeatedly performed in a coupe with short intervals of less than 10 years. In recent

years when logging resources declined, the forest was clear-cut in order to develop oil palm plantations. Developed lands were sometimes abandoned due to social and economic conditions, as seen in the case of the rubber plantation. Therefore, land use on the “state land” is characterized by changes in large areas of forest in a short period of time, as determined by the social and economic conditions of the time.

Economic development, however, has not been the only activity contributing to land-use change. National park gazettement is an example of a large primeval forest being preserved as a result of placing controls on logging activities by companies and agricultural activities by the Iban.

However, protected areas in Sarawak, such as national parks, comprise only 3,777 km² (3% of Sarawak state) (Department of Statistics, Malaysia 2004), and there is no trend toward significantly increasing the area in the future. In contrast, logged areas from 1963 to 1985 are estimated to be 28,200 km² (23% of Sarawak State) (Hong 1987), and after that period, the area increased. Oil palm plantations whose area is expanding rapidly today (Fig. 1) covered 4,648 km² (4% of Sarawak state) in 2003 (Department of Statistics, Malaysia 2004). Today, large plantations of monocrop trees, such

Fig. 7 Change in area for each type of land use: Iban territory (upper) and state land (lower). Areas in 1900 are estimated (Source, analysis of land use maps)



as acacia, have also been developed, or their development is planned for large areas of the middle and upper sections of the Sarawak river system. The state government aims at one million hectares of plantations within the next 15 or 20 years (Chan 1998).

On the other hand, in the "Iban territory", primeval forest was converted to secondary forest over a 100-year period (Fig. 7). However, the characteristics of the changes differ from those found on the "state land". Every year, each Iban household made swiddens consisting of a few hectares in a dispersed manner, opening up primeval forest and/or secondary forest. The swiddens were fallowed after cultivation for between one and several years. In recent years, since there is no remaining primeval forest, swiddens are created only in secondary forests.

The areas shown as secondary forests include small patches of reserved forests (*pulau galau*) which have never been clear cut (in order to ensure the availability of logs for house building), and small patches of various types of agricultural land, such as rubber gardens, fruit tree groves, oil palm gardens, and pepper gardens. Therefore, the land use in the "Iban territory" is based on secondary forests containing patches of vegetation at different stages, mixed in with patches of various kinds of agricultural fields (Ichikawa 2004). The patches form a mosaic pattern (Ichikawa 2004). As with the land use on the "state land", the land use in the "Iban territory" has been changing, influenced by the social and economic conditions around it. The land use there, however, has never resulted in large areas of land changing at once or in a short time, as seen on the "state land". These characteristics of Iban land use are sustainable over generations, and they are supported by the social institutions of the Iban, such as their system of land and natural resource tenure and of land inheritance (Ichikawa 2005b; Ichikawa unpublished data). We should note, however, that these institutions are also changing and are affected by social and economic conditions. The relationship between social and cultural factors and land use needs further study (see Ichikawa 2005b).

Evaluation of land use from the viewpoint of ecosystem and biodiversity conservation

In the rural areas of Sarawak, the best way to conserve the ecosystem and biodiversity may be to reserve primeval forest on a certain scale, because biodiversity of the primeval forest is outstandingly high (Lee et al. 2002). The land-use change with the most negative impact is conversion from primeval forest to large monocrop plantations. Information obtained by ecological research is insufficient to ascertain whether other land use, particularly the logged forests and secondary forests of the Iban, would be desirable for ecosystem conservation and biodiversity.

We may draw attention, however, to some points where the Iban land use is superior. With Iban land use,

relatively small-scale disturbances to the forest occur every year. Unlike the large-scale developments observed on the "state land", large areas of forest have not been converted in short periods of time. This land use, which is based on secondary forests, could be sustainable. Recent research in conservation ecology has indicated the significance of moderate disturbance for maintaining high biodiversity (Washitani and Yahara 1996). Other research revealed that land use by natives generally plays a much more important role in the conservation of ecosystems and biodiversity than do monocrop plantations (Primack and Corlett 2005). In the study area, 15–31 tree species/0.1 ha were observed in secondary forests, depending on the length of fallow period. In reserved forests, 47 tree species/0.1 ha were observed, while in primeval forest, 67 tree species/0.1 ha were observed (Momose K et al. unpublished data).

Today in Sarawak, the areas where commercial logging is finished have been rapidly converted to monocrop plantations, such as oil palm and acacia. In these conditions, the first priority for the ecosystem and biodiversity conservation will be to establish and manage protected areas, with careful attention to local communities around the area. However, the actual possibility of the establishment of protected areas will be quite limited. Considering these limited options for ecosystem and biodiversity conservation, land use by natives such as the Iban, who have often been blamed as vandals of primeval forests, should be reconsidered in a more positive light.

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