

## Review: Biodiversity conservation strategy in a native perspective; case study of shifting cultivation at the Dayaks of Kalimantan

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### ABSTRACT

**Abstract.** *Setyawan AD. 2010. Biodiversity conservation strategy in a native perspective; case study of shifting cultivation at the Dayaks of Kalimantan. Nusantara Bioscience 2: 97-108.* Native tribes generally are original conservationists; they build genuine conservation strategy of natural resources and environment for sustainable living. Dayak is a native tribe of Kalimantan that has been living for thousands of years; they use shifting cultivation to manage the communal forest lands due to Kalimantan's poor soil of minerals and nutrients, where the presence of phosphorus becomes a limiting factor for crops cultivation. In tropical forests, phosphorus mostly stored in the trees, so to remove it, the forest burning is carried out. Nutrients released into the soil can be used for upland rice (gogo) cultivation, until depleted; after that, cultivators need to open a forest, while the old land was abandoned (fallow) until it becomes forest again (for 20-25 years). The consecutive land clearing causes the formation of mosaics land with different succession ages and diverse biodiversity. This process is often combined with agroforestry systems (multicultural forest gardens), where the will-be-abandoned fields are planted with a variety of useful trees that can be integrated in forest ecosystems, especially rubber and fruits. These systems of shifting cultivation are often blamed as the main factor of forest degradation and fires, but in the last 300 years, this system has little impact on forest degradation. But, this is relatively low in productivity and subsistent, so it is not suitable for the modern agriculture which demands high productivity and measurable, mass and continuous yield, as well as related to the market. The increased population and industrial development of forestry, plantation, mining, etc. make the communal forest become narrower, so the fallow periods are shortened (5-15 years) and the lands are degraded into grasslands. In the future, shifting cultivation remains one of the Dayaks option to meet the needs of rice, but agroforestry should be developed because of its higher economic value.

**Key word:** shifting cultivation, agroforestry, Dayak, Kalimantan, conservation, biodiversity.

**Abstrak.** *Setyawan AD. 2010. Review: Strategi konservasi biodiversitas dalam pandangan suku asli; studi kasus perladangan berpindah Suku Dayak di Kalimantan. Nusantara Bioscience 1: 97-108.* Suku asli umumnya konservasionis sejati, mereka membangun strategi konservasi sumberdaya alam hayati dan lingkungan yang berkelanjutan. Dayak adalah suku asli Kalimantan yang telah tinggal selama ribuan tahun dan menggunakan sistem perladangan berpindah untuk mengelola hutan ulayat, karena tanah Kalimantan miskin hara mineral, dimana keberadaan fosfor menjadi faktor pembatas budidaya tanaman pangan. Di hutan tropis, kandungan terbesar fosfor tersimpan dalam pepohonan, sehingga untuk melepaskannya dilakukan pembakaran hutan. Hara yang terlepas ke dalam tanah dapat digunakan untuk bertanam padi gogo, hingga terserap habis, lalu peladang membuka hutan baru, sedangkan lahan lama ditinggalkan (bera) agar menjadi hutan kembali (selama 20-25 tahun). Pembukaan lahan yang berurutan, menyebabkan terbentuknya mosaik-mosaik lahan dengan umur suksesi dan keanekaragaman hayati beragam. Proses ini seringkali digabungkan dengan sistem agroforestri (kebun hutan multikultur), dimana ladang yang hendak ditinggalkan ditanami berbagai pohon berguna yang dapat terintegrasi pada ekosistem hutan, terutama karet dan buah-buahan. Sistem perladangan berpindah sering dikambinghitamkan sebagai faktor utama degradasi dan kebakaran hutan, namun dalam 300 tahun terakhir sistem ini berdampak kecil pada kerusakan hutan. Namun, produktivitas sistem ini relatif rendah dan subsisten, sehingga tidak sesuai dengan pertanian modern dimana produktivitas harus tinggi, hasil panen harus terukur, masal dan kontinyu, serta terkait dengan pasar. Peningkatan penduduk dan perkembangan industri kehutanan, perkebunan, pertambangan, dan lain-lain telah mempersempit luasan hutan ulayat untuk perladangan berpindah, sehingga masa bera diperpendek (5-15 tahun) dan lahan terdegradasi menjadi padang alang-alang. Di masa depan, perladangan berpindah tetap menjadi salah satu pilihan suku Dayak untuk memenuhi kebutuhan padi, namun agroforestri perlu dikembangkan karena bernilai ekonomi lebih tinggi.

**Kata kunci:** perladangan berpindah, agroforestri, Dayak, Kalimantan, konservasi, keanekaragaman hayati.

### INTRODUCTION

Borneo (or Pulau Kalimantan in Indonesian) is the third largest island in the world and has a very high biodiversity compared to many other areas. On this island lived about 15,000 species of flowering plants with 3,000 species of

trees (267 species of dipterocarp), 221 species of terrestrial mammals and 420 bird species (MacKinnon et al. 1996). In addition, there are still many new species waiting to be found and named. In 1994-2004 in Borneo, it is discovered 361 new species (Rautner et al. 2005), even in-depth exploration for 18 months in 2005-2006 found 52 new

species (WWF 2007). This area is home to large mammals which is very rare, such as Borneo orangutan (*Pongo pygmaeus pygmaeus*), Asian elephant (*Elephas maximus*), Sumatran rhinoceros (*Diccorhinus sumatrensis*), Borneo clouded leopard (*Neofelis nebulosa diardi*), Borneo banteng (*Bos javanicus lowi*) and sun bear (*Helarctos malayanus*), etc.

The high biodiversity in Borneo is due to diverse ecosystem on it, where there are seven different ecoregions. Most of the island is covered by lowland rain forest; the other lowland areas are peat swamp forest, heath, and freshwater swamp forest in the southwest, and also mangrove forest. In addition, there are also mountain rain forest highlands, above 1,000 m asl., which is located in the center and northeast of the island with its mountain peak of Mount Kinabalu, Sabah. In the region there are alpine meadows and bushes that keep many endemic species, including orchids (Setyawan 2002).

There are several native tribes in Kalimantan based on ethno-linguistic (Figure 1); one of them is the Dayak tribe. This tribe mostly lives in the hinterland and is still dependent on forest livelihoods. Actually, the original tribe spread across the island of Borneo, from coastal to mountainous areas in central and northeast. But the tribe who lived on the coastal area generally has acculturated with the Malays tribe and Muslims, such as Banjar and Kutai clan, so they are often identified as a clump of the Malays. Moreover they do not practice the Dayak culture. Dayak tribes who embraced Islam generally no longer identify themselves as DayakS except in West Kalimantan.

Dayak tribe has lived in Borneo since thousands of years and practice management systems of natural resources and its ecosystem sustainably. They practice shifting cultivation (slash-and-burn or swidden agriculture) to produce gogo rice/dry land rice (gogo paddies) and form mosaics of agroforestry lands with different age for biodiversity managing. The practice, which sometimes is called as slash and burn, is chosen because the Kalimantan soil is generally poor of mineral nutrients, due to the absence of volcanoes, so the main source of mineral nutrients is plants that accumulate these mineral nutrients. By burning trees and shrubs, it is expected that minerals will return to the soil and then, they can be absorbed by would-be-planted food crops. In 4-5 times of rice harvest (1-2 years), the minerals in the soil usually start to thin out, so the cultivators have to move and open new fields. The old fields are abandoned in order to become forest again as nutrient accumulators, and they will be cut down and burned again to provide nutrients for crops. This system requires sufficient land area, with relatively limited results (subsistence), so it is considered ineffective and inefficient by the government and entrepreneurs who need land.

This paper aims to express the conservation of biological diversity, associated with shifting cultivation practices conducted by the Dayak tribe in Kalimantan.

## DEFORESTATION OF KALIMANTAN FOREST

Species richness and diversity of the ecosystems of Borneo are threatened by high rates of deforestation and

habitat conversion throughout the island. Extensive tropical forests of Borneo have the most rapid rate of extinction in the world (Sunderlin and Resosudamo 1996) due to logging practices, forest plantations and oil palm plantations, mining, forest fires, dam building, creation of wetland peat and others (Notohadiprawiro 1998; Rautner et al. 2005). This encourages the high rate of biological extinction in Kalimantan. Therefore, sustainable forest management and conservation initiatives become more important in tropical forest which deforestation rates continue to be worried about (Joshi et al. 2004). In addition, the inclusion of various economic activities in the above often leads to conflict with Dayak tribe which its community land sometimes is taken without proper indemnity or compensation (Javan 1996; Bujang 2005; Rousyikin 2005; SAM 2007). In the past, such disputes can be settled down by customary law, but nowadays, with the capital power, plantation and forestry companies do not admit customary law, so the case of destruction and violence are often happened (Gonner 1999; King 1999).

Timber industry, such as plywood, timber, furniture, paper pulp rapidly evolving in the 1980-1990s led to a large number of natural forest in Borneo to be cut down (Velasquez and Shimizu 2001; Buttler 2005; Engel and Palmer 2008). Furthermore, palm oil plantations and forest industry plants quickly loot the last remnants of primary forest (Majid-Cooke, 2002; Henson and Chang, 2003; Fitzherbert et al. 2008; Koh and Wilcove 2008; Marti 2008). Palm plantation is one of the greatest threats to the forests of Borneo (Wakker 2006). In 2003, in Sabah and Sarawak, its area reached 1.6 million hectares, while in the Indonesian part of Borneo about 1 million hectares (Rautner et al. 2005). Another threat is the mining, because Kalimantan has the largest coal deposits in the world, and the rich variety of other minerals such as gold, lead, and precious stones (Maunati 1998; Fatah et al. 2007). Large dam construction in Bakung, Sarawak which will soon be operated is worried about having an impact on local ecosystems (Rousseau 1995; Williams et al. 1995). The failed project of clearing peat lands for food crops in Central Kalimantan is proven to alter the natural landscape, causing drought and fires (Vayda 1999; Boehm and Siegert 2001). All economic activities above are real threat to the preservation of natural resources and ecosystems of Borneo.

Forest fires from land clearing activities are other threats to wildlife in Kalimantan. Burning forests is a traditional way of the Dayak tribe to open agricultural land and it has been done in a sustainable manner for thousands of years, where the burned area is limited and the burning frequency is 20-25 years (Ave and King 1986). The procedure for land clearing has also been regulated and supervised by customary law leaders. But the growing number of people either by birth or migration entrants, such as transmigrants, company workers, government officials, and others, causing land area for each resident narrowed, so that the frequency of burning land becomes shorter (5-15 years). This is compounded by the entry of various forestry companies, plantation, mining and others which took over a large number of customary land previously used for shifting cultivation.

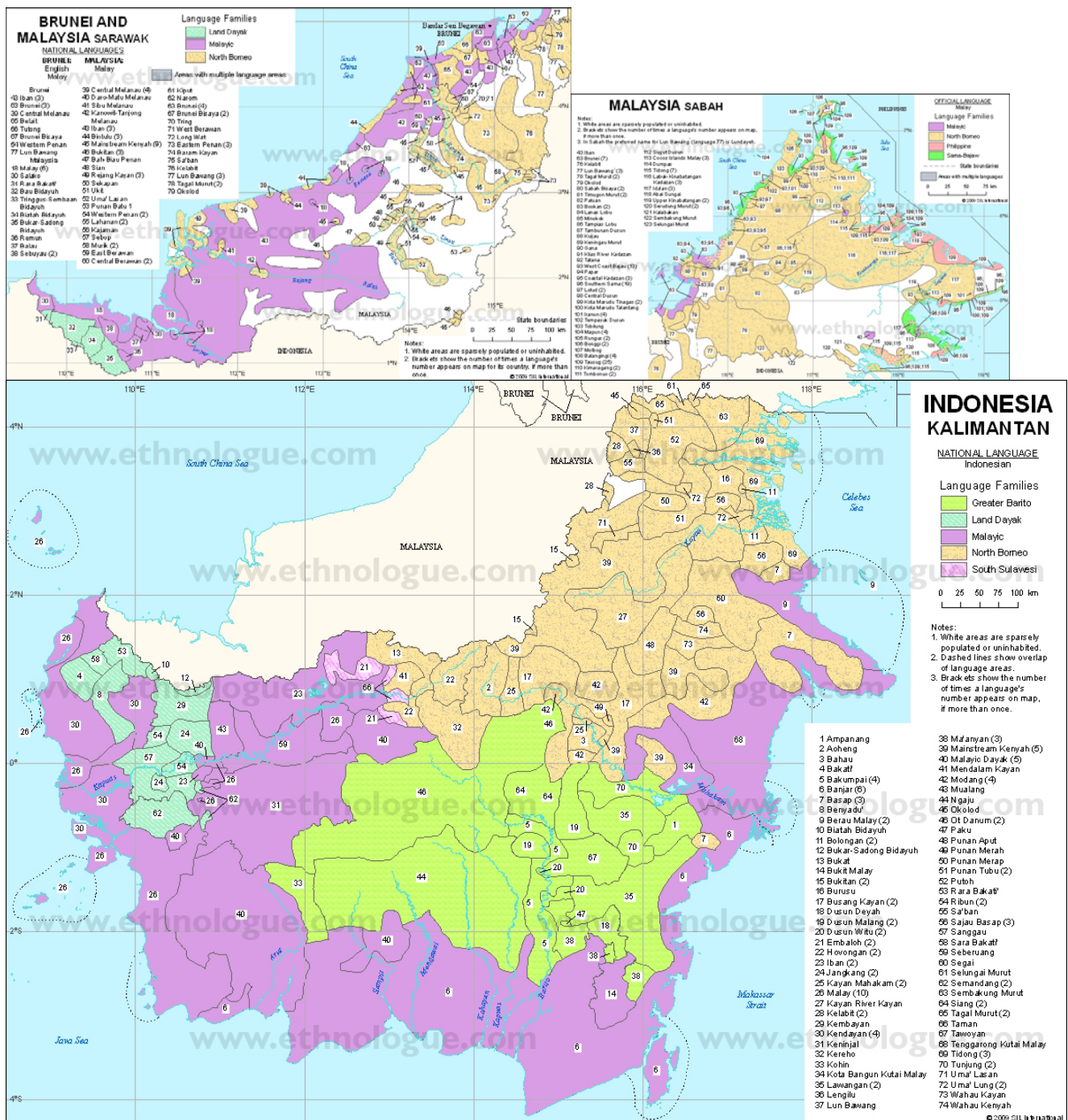


Figure 1. Ethno-linguistic classification of the natives of Kalimantan (www.ethnologue.com)

A number of plantation and forestry companies are also suspected doing land burning, because this is the most effective, fast and inexpensive way to clear land, though it causes the release of carbon compounds into the atmosphere that affect global warming. The land burned by the company is certainly far more extensive than the one burned by individuals shifting cultivators. Regulation on prohibition of open burning of land for plantations has been made, but every dry season the burning is repeated. Long dry season due to El Niño in 1997-1998 led to burning to clear land turned into the biggest fire in the whole of

Kalimantan (Vayda 1999; Sisawati 2000; Fuller et al.2004; Butler 2005), of which 6.5 million hectares of land burned (Rautner et al. 2005) and thousands of orangutans died.

The rate of deforestation in Indonesia is very high. In 1950-2000, 40% of Indonesia's forests have been cleared, equivalent to a loss of 2 million hectares of forest each year (Engel and Palmer 2008). In Kalimantan, in the mid-1980s forest cover was about 75%, but in 2005 left only 50%. In 1985-2005, Kalimantan lost an average of 850,000 hectares of forest every year. In 2000-2002 deforestation throughout

the island of Kalimantan rose to 1.3 million ha per year, of which 1.2 million hectares per year occurred in Indonesia and 100,000 hectares per year in North Borneo (Sabah and Sarawak). If this continues, the forest cover will decrease to less than one-third by 2020 (Rautner et al. 2005).

## THE DAYAKS

### Origin of the Dayaks

Dayak tribe is descendants of Austronesian sailors who gradually moved from Taiwan to the archipelago since the 4000-6000 years ago and reached Borneo 4,500 years ago (Blust 1984/1985 1999; Gray and Jordan 2000; Diamond and Bellwood 2003). They replaced or assimilated with the Austro-Melanesians who have inhabited the Borneo from 35000-45000 years ago (King 1993; Rautner et al. 2005). In genealogy, the assimilation of ethnic Dayak and other Borneo population causes the formation of several strains, namely Mongoloid Dayak, Dayak Malayoid, Dayak Austro-Melanesoid and mixed (Lumbut 1992).

Dayak, which means upstream or inland, is the collective name for various indigenous groups on Borneo Island. Dayak tribe has a loose grouping, where there are many sub-tribes, each of which has a dialect of the language, customs, laws and culture of its own territory, but their general appearance showed the same characteristics and is easily identified (Grimes 2000). This tribe is to share physical features, architecture, language, oral traditions, customs, social structure, weapons, agricultural technology and similar views of life (Davis, 1993). They have a genuine belief of Kaharingan (animism), although many are now an official religion follower (Kana 2004; Winzeler 2008). Dayak tribes practicing shifting cultivation generally live along the river in the outback of Borneo, sometimes they live communally in a traditional long house (a kind apartment in modern society), and apply customary law (Harrisson 1984; Deschamps and Hartman 2006). They are traditionally highly dependent on hunting wild animals to satisfy protein needs. The main wild animals hunted are wild boar (*Sus barbatus*) (Deschamps and Hartman 2006).

Dayak tribe is divided into six major clusters, namely: Kenyah-Kayan-Bahau generally living in the eastern part of Kalimantan, OtDanum in the southern part of Kalimantan, Iban (Sea Dayak) in the northwestern inland to the coastal area of Borneo, Klemantan (land Dayak) in the northwestern outback of Borneo, Murut in northern Borneo, and Punan (Penan) in the center to the east of Borneo (Lontaan 1975). Dayak tribes generally live in the outback of the island, especially on the banks of the river by making use of about 200 rivers that flow into the inland as transportation routes, but many who live in the hills (Jessup and Vayda 1988). There is also a tribe that lived in the hinterland to the coast, for example Dayak Iban in West Kalimantan and Sarawak. As descendants of sailors, initially Dayak tribes are suspected living along the coast, but the arrival of the Malay-Sriwijaya of Sumatra and Malaya as well as the arrival of the Javanese at the Majapahit era and at the Islamic sultanate of Demak-

Pajang-Mataram cause them to move into hinterland part of Borneo.

Dayak language is an Austronesian language family (Grimes 2000). The language is divided into about 450 different ethnolinguistic groups, with speakers of about 3-4 million, with a density of about 14 people per square kilometer (Cleary and Eaton 1996) spreading across four provinces of Indonesia, West Kalimantan, Central, South, East and; two Malaysian states, Sabah and Sarawak as well as in the Sultanate of Brunei Darussalam (Davis, 1993). In the Indonesian part of Borneo, there are more than 140 languages are still used, whereas there are 50 languages in Sabah and in Sarawak for more than 30 languages (Rautner et al. 2005). But no language is spoken more than 100,000 people; even some of the language is only spoken by about 500 people, making it very vulnerable to extinction. One of the Dayak languages, namely OtDanum-Hamlet-Manyaan of Barito river valley located in the northern part of South Kalimantan and the eastern part of Central Kalimantan has a compatibility with the Malagasy language used in Madagascar, so it is suspected that from this region is the origins of the population of Madagascar (Dahl 1951, 1977; Dewar and Wright 1993; Bellwood et al. 1995).

Kalimantan has a population of about 15 million people, with the main composition of the Malays, Dayaks, and Chinese. Dayak tribe has a number of about 3-4 million, of which the largest group is the Iban Dayak consisting of 710,000 people living in the northwest of the island. In addition, there are also ethnic of Javanese, Madurese and Bugis in significant quantities. Most of the inhabitants of Borneo live in coastal cities, while in rural areas; they generally live along the river (MacKinnon et al. 1996). In the hinterland, there is also Dayak Punan, which some members still live subsistence lifestyles and practice life of nomadic hunter-gatherers (Arnold 1958; King 1964; Whittier 1964; Langub 1975).

### Dayaks as the indigenous tribe

Generally, original inhabitants (tribe) are genuine conservationists; they build a strategy for biodiversity and environment conservation to sustain the needs of sustainable living. Since thousands of years ago, the Dayak people of Borneo use technology and traditional knowledge, namely shifting cultivation to manage natural resources and biodiversity in the forest. They build and use certain steps as a strategy for the conservation of natural resources and environment. At first, they learn the limitations of natural resources, where the excessive and unwise use of it will reduce its availability and sustainability. Traditional knowledge is the unique local knowledge owned by a particular culture or society. This knowledge is the accumulation of human knowledge and understanding of the universe, including the spiritual relationship with the Almighty, the relationship with nature, and relationship with humans, and it is reflected in language, organization, values and law system, to be the ethics that govern the behavior of a society. Dayak tribe always believes that there is a limitation of natural resources, thus requiring conservation, except for certain types of resource availability which exceeds demand (Uluk

et al. 2001). Review of the literature shows that people who intentionally build conservation strategy usually has limited natural resources and easy to decline. The strengthening conservation strategies in the traditional culture is very important to help surviving in the limited natural resources, especially when natural resources run out.

Dayak are the indigenous tribes of Borneo. According to the World Bank, indigenous people have the following characteristics: (i) live in ancestral territory, (ii) are an entity separate from other groups, (iii) use the native language, (iv) has a traditional political and social institutions; and (v) subsistence (Colchester 1999). Biodiversity conservation strategy of indigenous tribe is part of knowledge and traditional technologies of the tribe. Local wisdom is often more appropriate to apply to the local environment than the western system of knowledge and technology that is "scientific" (Slikkerveer 1999). Traditional knowledge and technologies are developed and are accumulated over generations within the scope of certain cultures and regions, including: health, agriculture, plants, forestry, irrigation, and others. Traditional knowledge has the potential to support the development of rural areas, such as traditional herbal medicine, livestock medicine, intercropping agriculture, garden of *talun*, disease management, wild food plants, architecture and others (Richards 1989; Warren et al. 1989; 1994).

In the world of agriculture, a holistic point of view of traditional knowledge has been developed for food production and natural resource management, including: concept, perception, belief, cosmology; attitude, experience, skills, technology, artifacts, seeds, plants, crop type, and also institutions, procedures, and processes used (Slikkerveer 1994). Recent research in traditional systems of knowledge and technology in various fields produces inter-disciplinary approaches, including anthropology, ecology, sociology, science, and ethnoscience, which include ethnobotany, etnosejarah, and etnoekologi. Dayak tribe owns all of the terms of indigenous.

#### **Native tribes and the destruction of Indonesian forests**

Indonesia has 10% of tropical rain forests of the world, ranking third after Brazil and Zaire. Most studies of deforestation in Indonesia stated that about one million ha of about 100 million ha of remaining forest lost each year (World Bank 1990; FAO 1990). Some authors assume that shifting cultivation is a major cause of deforestation (FAO 1990; World Bank 1990; Barbier et al. 1993). Though admitting a significant influence of shifting cultivation on deforestation, other authors give a greater emphasis on government policy and development projects in forestry and plantation sector (Dick 1991; WALHI 1992; Ascher 1993; Dauvergne 1993; Porter 1994; Thiele 1994; World Bank 1994; Angelsen 1995; Dove 1996; Ross 1996). The latter group of researchers assumes that the effects of shifting cultivation have been exaggerated. Traditional shifting cultivation is not a threat for forests, even necessary for the conservation and management of Indonesian forest remnants in the future (Colfer 1993; Hasanuddin 1996). These debates often occur because of unclear concepts and terminology used. So, it needs to be

made clear the parties that affect the forest as well as key terms and concepts used, such as forests, deforestation, degradation, and causes of damage (Sunderlin 1997).

Dayak and other Indonesian tribes have endured for decades to gain recognition of civil rights, and rights to manage forests and water residence. At first the state has no special protection systems against indigenous people, but now there is a significant progress so that the strategies and tactics used are imitated by many indigenous tribes in other countries (Alcorn and Toledo 1998; Alcorn 2000). Dayak tribes face two typical problems of worldwide tropical forests, namely the struggle to adapt to new technology and to withstand the onslaught of entrants, employers and governments who claim their natural resources (ILO 1996). The Dayak tribes are the remnants of natural ecosystems dwellers (ecosystem people), namely the people who adapt to and dependent on local ecosystems to meet the intent of his life (Dasmann 1991). Collective identity, cultural traditions, and practices of management developed are capable of maintaining the ecosystems productivity resilience (Berkes 1999), although there is pressure of changes both on a local scale from members of the society itself, as well as on a national scale from the government (Alcorn 1991). Unlike most people associated with the global economy (biosphere people), the native tribes are dependent on local ecosystems and are affected directly by changes in the ecosystem (Dasmann 1991). The failure of indigenous tribes in adaptation of pressure to change often causes them to be marginalized and brings out violence.

#### **Dayak tribes and their habitats**

Humans began to build settlements and adapt to ecological and political changes in the forests of Borneo since 35,000-45,000 years ago (King 1993; Rautner et al. 2005). The indigenous people who live in the interior of Borneo are collectively known as Dayaks. Dayak indigenous territory is rich in natural resources, and it becomes a habitat for large numbers of fish, birds, plants, including many endemic species and 300 species of Dipterocarpaceae which has high economic value, and also a large number of mammals such as orangutans, Borneo banteng, Sumatran rhinoceros, wild buffalo, sun bears, and Asian elephants (Potter 1993; Cleary and Eaton 1996). For centuries, the Dayak tribes develop various forms of agriculture, fishing, hunting, and forest products harvesting, which are the move-turn in accordance with environmental changes. These changes follow the general pattern that constantly changes the forest environment (Padoch and Peluso 1996). Dayak natural resource management has adapted to suit a variety of natural and anthropogenic events, such as drought, famine, fire, flood, war, and fluctuations in the population, making it possible to live and survive.

Indigenous Dayak tribes as in other Southeast Asian develop agricultural systems (agroecosystem) which are adapted from the tropical forest ecosystem. It is governed by customary law, i.e. regulations made and enforced according to the consensus of indigenous peoples. Dayak indigenous institutions play an important role in managing

ecosystems (Folke 1997). Dayak vision of prosperity suggests that rivers, soils, and forests are very important for ethnic identity. Same vision is shown in the mosaic patterned of shifting cultivation system in the forests they live. In shifting cultivation, mosaics patterns are formed consisting of a collection of natural forest, artificial forests, vacant land, and the fields in accordance with ecological conditions and local topography, namely hills, wetlands, or river valley. The only land without forest is wetland. Landscape lands have different shapes, but forest cover is substantially always there. Research in 1996-1999 shows that of the 21 communities that lands are mapped, with an area between 900-126000 ha, where the community has made an agreement to preserve the forests from logging or mining, forest vegetation covers around 50-99% of the communal land, where approximately 29% of primary forests (Sunderlin 1997). Kalimantan is designed as a logging concession area, but around 63% is still forested plains, and about 35% is the remaining forests of Indonesia (Potter 1993).

Kalimantan forests are mostly located in areas claimed by the Dayak tribe (communal land). Most of these lands are the forested hills that can not be penetrated. In some places, this communal forest is isolated in fragments surrounded by very large monocultures lands belonging to oil palm plantation companies (Alcorn 2000). In the past, millions hectares of land are covered by a mosaic of shifting cultivations which form the landscape with high resilience. But now, many Dayak tribes follow the entrants and turn the land into oil palm plantations, so the mosaic pattern of shifting cultivations which are rich in biodiversity are difficult to be applied again (Potter 1993). National centralization of land use decisions led to the establishment of plantations, agriculture, and degraded land which are poorer than the ecosystem biodiversity in shifting cultivation (Alcorn 2000).

### Shifting cultivation and agroforestry systems

Shifting cultivation is a traditional way of farming that is very old. Shifting cultivation is mainly found in highland forests. In a system of shifting cultivation, the main crops cultivated are gogo rice. First, the selected land is cleared by burning, and the ash is used to enrich the soil. It is followed by brief periods of rice cultivation (about 4-5 times of harvest). After the soil fertility is depleted, the farmer leaves the land in order to let secondary forest grow or converts it into agroforestry by planting rubber trees, fruit trees and other crops. After an interval of 20-25 years, soil fertility will return, so a new cycle of shifting cultivation can start (Lim 2001). Given the importance of gogo rice and rubber in this system, it is very important for the government to provide both superior strain of this species, so that local communities can be more effective in managing forest resources sustainably (Arifin 1998).

Agroforestry is done by changing the primary forest into artificial forests planted with various species of beneficial plants. This system has a high density of species with a relatively diverse and complex structure. This system combines productivity, biodiversity and economic value (Belcher et al. 2005). Dayak tribe has long practiced

agroforestry systems. When the fertility of the land in shifting cultivation started to decrease, they plant various useful crops, so when the land is completely abandoned, the planted trees is already quite high and can compete with shrubs and grasses that grow later. In West Kalimantan, agroforestry is known as *tembawang* which based on the rubber tree (Ansari 1996; Sardjono 1990, 2003), in East Kalimantan agroforestry is known as *lembo* which is based on fruit trees (Sundawati 1993, 2003) and *simpukng* which is based on fruit trees, rattan, bamboo, wood and other useful plants (Mulyoutami et al. 2008). With the formation of canopy, agroforestry systems can be used to suppress the growth of grasslands (Hairiah et al. 2000; Purnomosidhi and Rahayu 2002).

The traditional systems above require very little or no agrochemical inputs at all, and the only sustainable way of cultivation of rice to poor areas of mineral nutrients such as Borneo (Dauvergne 1993). According to Lawrence and Schlesinger (2001), land infertility in Kalimantan is caused by low phosphorus content. The trees which are deep-rooted and grow on fallow land can raise levels of organic phosphorus significantly, so they can improve soil fertility. This research is supported by Sanchez and Buol (1976) and Richter and Babbar (1991) which state that phosphorus is the limiting factor in agricultural production in the tropics. The productivity of gogo paddies in shifting cultivation system is far below the wetland paddies. Most government officials blame this system, consider it inefficient, unable to raise living standard (subsistence), cause damage, and become a source of forest fires and a major cause of deforestation. So, they all become the reasons to forbid shifting cultivation and settle the cultivators to some settled villages (Dauvergne 1993; Faithful 1999). It is prevalent in indigenous tribes throughout Southeast Asia (Padoch et al. 2007).

Adverse effects of deforestation has been widely recognized, that is a major cause of land degradation, biodiversity loss and threatening of species extinction, as well as contributing to global warming (Gillis, 1988; Dick, 1991). WCED (1987) shows that deforestation and environmental destruction are positively correlated with poverty and shifting cultivation, especially in developing countries. Those who are poor and hungry often damage the environment to survive; they will cut down the forest and cultivate marginal lands repeatedly, resulting in land degradation. Arifin (1993, 1998) considers the charge is not fair because it blames the victim and ignores the role of shifting cultivation in conserving the environment. Even if poor people do environmental vandalism, mostly because it is the only choice left to live.

### Dayaks shifting cultivation system

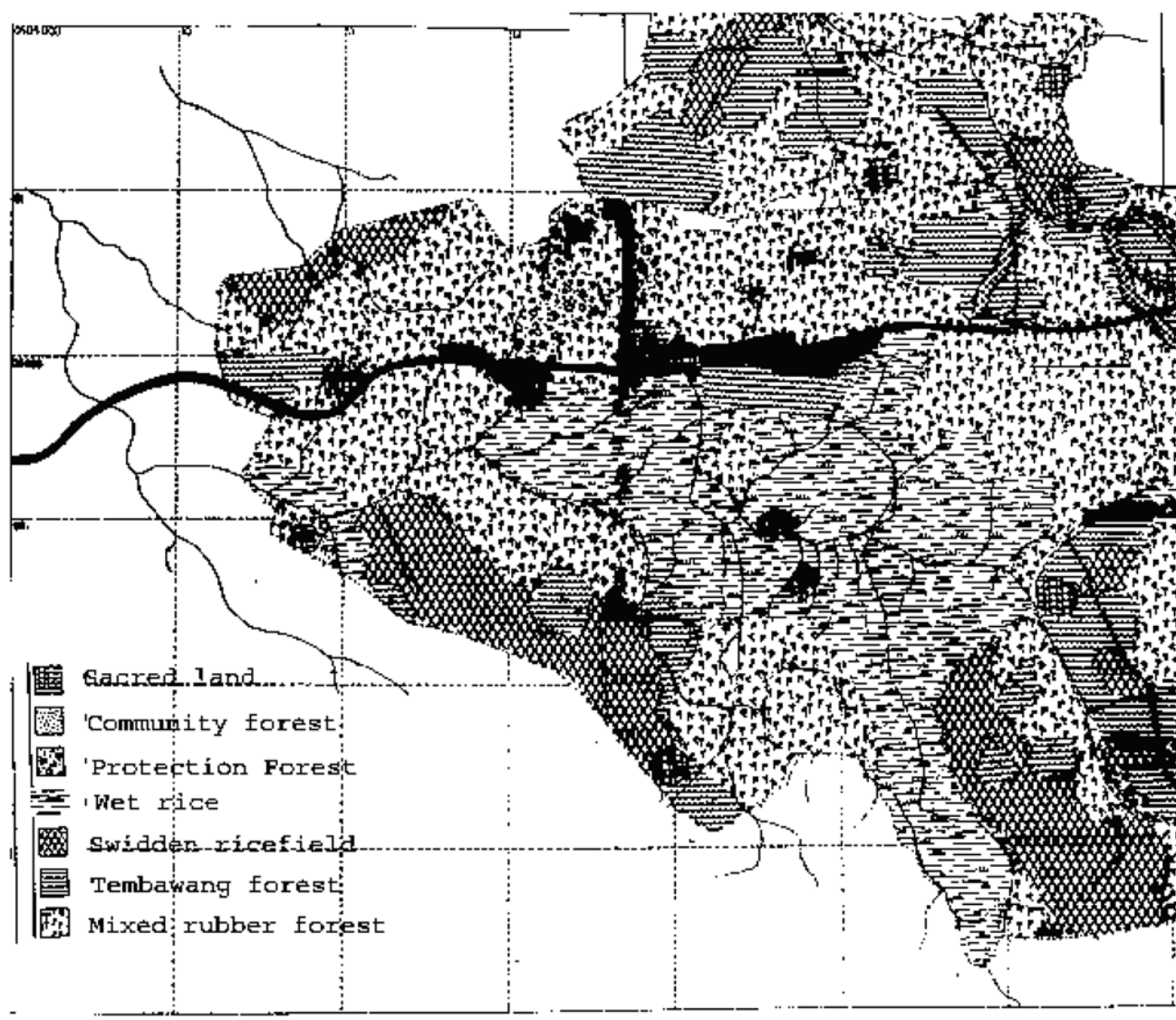
Native tribes in the tropics generally practice the shifting cultivation system, by forming mosaics of land to ensure the availability of resources in the future (Figure 2). Dayak tribes historically have practiced shifting cultivation system by planting gogo paddies, followed by long fallow periods, intensive agroforestry and natural resource extraction. Shifting cultivation is a complex system in which forest land is cleared in rotation for a certain

frequency. This system is also marked by the burning of land to restore minerals to the soil from forest plants, thus increasing fertility and then it can be planted with gogo paddies and other food crops such as maize and cassava (Crevello 2004).

Dayak tribes use shifting cultivation system that forms the mosaic with high resilience, and has a richer biodiversity due to low population density. This system can survive because it has a broad market for non-timber products, a diverse and extensive ecosystems and is exploited only by one community, and also strong traditional institutions that are resistant to the colonial administration (Alcorn 1990; Alcorn and Toledo 1998; Messerschmidt 1993; Warner 1991). Description of Dayak traditional knowledge in natural resource management has been widely publicized (Cleary and Eaton 1992; Colfer

1993; 1997; Dove, 1985; King 1993; Padoch and Peters 1993).

Dayak tribe use disturbance to form a space for food crops and use forest succession process as a resource of production (Alcorn, 1989). Gogo paddies occupy a principal position in a shifting cultivation system, so highly respected, and is surrounded by various rituals and they can cause the formation of work activities that bind communities. Dayak tribe has a dependency on a variety of natural resources such as fishing, hunting, forest production, and agriculture, but their social ties play a role in maintaining the integrity of the entire system against various disasters such as droughts, fires, and floods. The use of natural markers and augury to determine the location of shifting cultivation land cause random locations are chosen because of the lottery and experience (Dove 1996).



**Figure 2.** Shifting cultivation system shows the land use mosaic of two adjacent communities (2500 ha) surrounded by oil palm plantations (white area) in West Kalimantan. Adapted by Alcorn (2000) from maps provided by PPSDAK Pancur Kasih.

Dayak tribe generally establishes a permanent settlement at a place and (formerly) lives together in a longhouse (van Beukering et al. 2008). There is also a community that moves from one place to another to follow the shifting cultivation field (Joshi et al. 2004). Dayak indigenous territory usually consists of settlements, rivers and ponds, dry farm field, undisturbed primary forests as a source of regeneration and animals hunting, bush and secondary forest which is the remnants of shifting cultivation, various agroforestry, such as mixed fruit orchards, rubber and rattan, and woody plants. Gogo paddies remain the center of land use change and management of shifting cultivation systems (Joshi et al. 2004). The position of the fields is sometimes far from the settlement so they make huma (newly cleared dry field) for temporary shelter and keep main fields from wild boar attacks. *Huma* is left as the soil fertility started to deplete. When left behind, this land often has been planted with a variety of useful plants that will form agroforestry.

Customary law regulates the establishment and harvesting of forest landscapes, where the conservation, biodiversity and sustainability is very important. Dayak tribe has traditional knowledge to maintain soil fertility, they also know the species of wild plants, economically useful plants, plants which are ecologically useful, plants as indicators of soil fertility, plants having medicinal value etc. (Joshi et al. 2004).

In Loksado, South Kalimantan, every Dayak family has a duty to process the fields of 2 hectares per year for rice farming. Families who do not comply with these provisions are prohibited following the ceremony. This customary law is still an obligation to be carried out, although some families have saved quite a lot, so much that his family can not spend it for 15 years, even if they stopped planting rice. Increased population causes the land needed to fulfill customary obligations also increased, while most of the shifting cultivation land should be left fallow temporary to avoid land degradation. It is necessary to open new land in primary forest. In Loksado, every year an area of 10-40 hectares of primary forest was opened to meet the obligations of this law (Boer 2006).

Hardwood plant regeneration in former shifting cultivation land may be failed if fallow periods are shortened and the frequency of land clearing is increased. In Loksado, narrowing of the land due to population growth and other modern pressures cause fallow periods to be shortened from 20 years to 5-15 years, so the soil fertility can not be regained and erosion happened. Natural regeneration of timber plants as a signal of the return of fertility has failed to form; otherwise the reed dominates because of its resistance to fire. secondary forest is difficult to grow naturally on this land and thus require the help of tree planting to assist the process of succession (Boer 2006). The similar thing is happened in East Kalimantan where soil characteristics are also prone to erosion, so that the opened forests must be reclaimed (Stadtmueller 1990). Primary forest damage due to shifting cultivation is much smaller than the extraction of timber and oil palm plantations (Lawrence 1998).

The practice of shifting cultivation is the most dominant type of land use on a large number of ethnic Dayak. The combination of rubber cultivation, maize, cassava and rice, and harvesting non-timber forest products including wild animals often become the dominant form of land use (Dove 1985; Colfer et al. 1996). In peatlands, the Dayak combines the shifting cultivation system with the burning and is combined with rubber agroforestry using mineral from the riverbed as a planting medium (van Beukering et al. 2008).

There are also several ethnic groups that combine shifting cultivation and agroforestry with extensive agriculture such as oil palm and rubber plantations, as well as hunting, collecting forest products and domestication (Dove 1986; Colfer et al. 1996; Sellato 1996, 2002). In some regions, rattan harvest from the wildwood has to be replaced with the domestication of rattan intercropped with a variety of useful trees (Dove 1985; Colfer et al. 1996). Dayak tribe did not develop animal husbandry despite extensive grasslands in the early stages of succession of shifting cultivation. Livestock do not play a major role in land use patterns in Borneo. Cattle and buffalo as private property is limited and does not have a major impact on the type of land use (Dove 1986; Colfer et al. 1996; Sellato 1996, 2002). Changes in land use patterns are possible, it should be supported as long as it gives benefit to the community and protects the environment (Kartawinata et al. 1992).

Dayak tribes believe that the crop of shifting cultivation depends on the close agreement between the farmers and the world of spirits that control the harvest. Forests and forest products is very important, so a different set of forest is managed with different intensities according to the purpose (Padoch and Peters 1993). Dayak tribes exploit much subsistence of forest products; they use about 200 species of medicinal plants from forests (Caniago 1999). Rituals associated with excess or shortage of fruit crops show the importance of the principle of the exchange and give each other (Dove and Kammen 1997). Because most indigenous fruit crops are seasonal, the scarcity of crops led to public awareness of the importance of relationships with nature and with others (Alcorn 2000).

Dayak tribe has set the balance between economic dependence on forest products with the production of gogo paddies. For Dayak tribes, shifting cultivation is an action to be taken (Dove and Kammen 1997). Most of the Dayak rituals associated with rice cultivation. In the management of shifting cultivation, rice has a spirit that must be treated carefully and appreciated highly (Djuweng 1998). This belief supports the shifting cultivation system resilience. In the 1930s, when rubber prices is uncertain, an indigenous elder's dream about people who are forced to eat the rubber due to the absence of rice spreads rapidly throughout Borneo, and warns the residents to maintain the system of shifting cultivation and integrate rubber plantations in this system (Dove 1999).

Logging concessions have taken over the Dayak indigenous forests and cause ecological damage. Only about 4% of owner of HPH (forest concession) that comply with the regulations set by the government in forest



exploitation (Potter 1993). In 1998, the coalition of the Institute of Indigenous Peoples' Council sued this matter and asked the government to withdraw the status of state forests to renew the boundary between state forests with indigenous forests, and take back all the rules and policies related to exploitation and violation of community rights (Coup 1998). But the Forestry Law No. 41/1999, which was made to respond to this, did not make much change on the situation; it was more like a lip service for indigenous peoples. This shows that the pressure to the government and Parliament should be more powerful, reformation needs to be done in order that the change is bigger, and local leadership must be more powerful to organize the weakened community ties (Anonymous 1998).

People often do not realize the boundaries of their customary forest. Just after the logging by industrialist or the conversion of forest land into oil palm plantations, they claimed that the forest is theirs. On the other hand, the community also helps clearing the forest and supplies the illegal timber to the lumber mills, inter-island shipping, and even exporting to neighboring countries, Malaysia. Unconsciousness territorial boundaries will also cause loss of ecological protection responsibilities, such as forest clearance leads to loss of useful species which are usually abundant. Upstream society does not care about the impact faced by the downstream communities due to logging activities and forest clearing (Alcorn 2000). The spread of smoke in the dry season and floods during the rainy season are the real result of deforestation.

### **Preservation of biological resources in shifting cultivation systems**

In East Kalimantan, after one year of gogo paddies cultivation, Benuaq Dayak tribes often plant their land with a variety of useful trees, such as fruit trees, rattan, and bamboo, so the land is developed into agroforestry (*simpukng*). These artificial forests become an important resource for gathering fruits, medicines, timber, fuel wood, rattan, and wild animals. Various *simpukng* serve the function of ecological, economic, religious and cultural. In addition, they also leave certain areas as protected reserves forest (*bengkar*). With this combination, Benuaq Dayak tribe has built a system of natural resource management that are relatively sustainable. The logging activity and oil palm plantations are the biggest threat to the system (Joshi et al.2004).

System of shifting cultivation and agroforestry and the collection of forest products are relatively sustainable compared to plantations, farms, and forest harvesting. Development of settlement and cultivation activities undertaken during the last 300 years do not cause permanent deforestation and do not cause the extinction of species (Gonner 2001). A total of 35 species of local fruit are harvested from agroforestry forests in West Kalimantan and sold to Pontianak, with a market value in every year more than Rp. 500 billion (Armand 1996). Other native plants produce trade goods such as rattan, resins, and vegetable oils (Peters 1996). Some introduced species become the economic value of forests. Rubber plantations

introduced in the early 1900s has caused Indonesia to be one of the world's largest rubber producing countries (Dove 1996). These rubber-producing forests have extremely high diversity species (Penot 1999).

In West Kalimantan, agroforestry has a high level of biodiversity, and does not differ significantly from primary forest. On transect with the length of 1,500 m in primary forests there can be found 102 species of birds, whereas in the artificial forest 101 species are found. The pressure of hunting activity on both locations is different because of differences in land cover, but the species in both habitats are relatively similar, where the value of Sørensen's similarity index was 68%. Hunting activity provides a high pressure on several species of animals such as wild boar (*Sus barbatus*), deer (*Tragulid* spp., *Muntiacus* spp., *Cervus unicolor*), honey/tree bear (*Helarctos malayanus*), hornbills (*Bucerotidae*), partridge (*Phasianidae*), parrots (*Gracula religiosa*), and freshwater turtles (*Testudines*). All prey species are still survived, due to a reserve forest that is difficult to reach and the annual flood that allow the breeding of waters species (Gonner 2001).

At this time, socio-cultural changes threaten the old practices in conserving forests. The receipt of the official religion and the abandonment of the original trust cause a number of traditional rituals no longer performed, whereas these rituals are part of Dayak holistic perspective in viewing the human and nature. In addition, traditional knowledge about the value use of plants, such as medicine and toxic substances, is declining, where only the older generation and shamans who still understand it. The absence of traditional knowledge that is replaced by more relevant knowledge to survive in today's world, causes ignorance of the benefits of these plants so that conservation efforts no longer exists (Gonner 2001).

### **CONCLUSION**

Traditional knowledge is very useful to preserve the indigenous environment because of the increasingly limited of natural resources, and the increasing of population. Shifting cultivation by Dayak tribe in Borneo is traditionally not only to fulfill their daily lives but also to maintain the balance of ecosystems and biodiversity. The measured disturbance which is done in shifting cultivation system causes the growth of new seeds. On the other hand, forest concessions and large plantations where there has been land clearing and monocultures farming significantly interfere the preservation of ecosystems and reduce biodiversity.

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