AN OVERVIEW OF POST-EXTRACTION SECONDARY FORESTS IN INDONESIA

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KARTAWINATA, K., RISWAN, S., GINTINGS, A. N. & PUSPITOJATI, T. 2001. An overview of post-extraction secondary forests in Indonesia. Indonesia has extensive areas of post-extraction secondary forests and degraded lands arising from intensive exploitation of forest resources in recent decades. Using the area of forests resulting from selective logging practices as an estimate, in year 2000, post-extraction secondary forests covered about 23 million ha, or about 55% of the total concession area. This paper analyses the underlying causes of transformation of primary to secondary forests and degraded lands, including policy and regulations in forestry and forest resources, poor enforcement of regulations, and the lack of recognition of timber exploitation rights for local communities. The government is committed to promoting participation of local communities in managing forests. Recent policy changes for ameliorating some of the degrading factors have resulted in increased pressure on secondary forests due to rampant illegal logging and use claims by local communities and land speculators. While the largest proportion of post-extraction secondary forests has been maintained as part of the permanent forest estate, substantial areas have been converted for swidden agriculture, industrial tree and estate crop plantations and transmigration areas. Local community involvement and an understanding of the underlying degradation pressures would be imperative for the effective rehabilitation and sustainable management of post-extraction secondary forests.

Key words: post-extraction secondary forests – forest policy – selective logging – forest conversion – community forestry – Indonesia

KARTAWINATA, K., RISWAN, S., GINTINGS, A. NG. & PUSPITOJATI, T. 2001. Gambaran keseluruhan tentang hutan sekunder selepas pengekstrakan di Indonesia. Indonesia mempunyai kawasan hutan sekunder selepas pengekstrakan dan tanah usang yang luas akibat eksploitasi sumber-sumber hutan secara intensif pada abad kebelakangan ini. Dengan menggunakan kawasan hutan yang tumbuh selepas tebangan memilih sebagai anggaran, pada tahun 2000, hutan sekunder selepas pengekstrakan meliputi kira-kira 23 juta hektar, atau kira-kira 55% daripada jumlah kawasan konsesi. Artikel ini menganalisis sebab-sebab pengalihan daripada hutan primer kepada hutan sekunder dan tanah usang, termasuklah polisi dan peraturan dalam perhutanan dan sumber-sumber hutan, pelaksanaan yang tidak tegas terhadap peraturan tersebut serta kurangnya pengiktirafan terhadap hak-hak mengeksploitasi balak kepada penduduk tempatan. Kerajaan komited untuk menggalakkan penyertaan penduduk tempatan dalam pengurusan hutan. Perubahan polisi untuk membaiki beberapa faktor pendegradan telah meningkatkan tekanan terhadap hutan sekunder akibat pembalakan haram yang berleluasa dan tuntutan penggunaan oleh penduduk tempatan serta spekulator tanah. Ketika bahagian terbesar hutan sekunder selepas pengekstrakan dijadikan sebahagian daripada hutan simpanan kekal, banyak pula kawasan diubah kepada kawasan pertanian ladang, ladang pokok untuk industri dan estet serta transmigrasi. Penglibatan penduduk tempatan dan pemahaman tentang tekanan pendegradan yang terselindung mungkin penting untuk pemulihan dan pengurusan mapan secara berkesan hutan sekunder selepas pengekstrakan.

Introduction

The forests of Indonesia are biologically diverse, and contain about 10% of the world's flowering plant species, 12% of the world's mammals, 17% of all reptile and amphibian species and 17% of all bird species (BAPPENAS 1993). Indonesia's forests are also native lands to a large but undetermined number of forest-dependent communities. In densely-populated areas, such as Java and Bali, the natural forest has been almost completely replaced by cultivation and man-made ecosystems.

Estimates of the area of forest in Indonesia vary widely depending on the information sources. In 1992, excluding Java, Bali and the Lesser Sunda Islands, the Minister of State for Population and Environment of Indonesia (MOSPE), using data from the Regional Physical Planning Programme for Transmigration (RePPProT 1990) and Dick (1991), gave an estimate of 118 million ha. The National Forest Inventory of Indonesia, utilising 1986–1991 satellite data, recorded that the total forested land covered 120.6 million ha or 69% of the total land area (excluding Java) (GOI-FAO 1996). The Forest Land Use Allocation by Consensus and the Provincial Spatial Plan harmonised their data up to April 1999 and estimated an area of 121.1 million ha (Santoso 1999, Ismail 2000). Recent LANDSAT data, however, indicate a forest area of 99.24 million ha (Santoso 1999).

One of the main factors of change in Indonesia's tropical forests, leading to the formation of post-extraction secondary forests, is logging. Post-extraction secondary forests are defined here as 'forests regenerating largely through natural processes after significant reduction in the original forest vegetation through tree extraction at a single point in time or over an extended period, and displaying a major difference in forest structure and/or canopy species composition with respect to nearby primary forests on similar sites' (Chokkalingam *et al.* 2000). At the end of 1988, the area of logged-over forests was estimated to exceed 34.7 million ha (Gillis 1988). The Minister of Forestry estimated the area of production forest, or forest designated for sustainable logging, to be 41.1 million ha in early 2000, as shown in Table 1. This area is controlled by 320 concession holders (Ismail 2000). Only 45%, or 18.53 million ha, is still primary forest while the remainder consists of 27% (11.1 million ha) logged-over forest and 28% (11.5 million ha) degraded forest, bare land and agricultural land. We use the estimates for logged-over forests in Indonesia as an estimate of the area of post-extraction secondary forests (Table 2). Most commercial logging in Indonesia (including illegal logging) tends to result in significant disturbance of the forest.

In this paper, we present a brief overview of post-extraction secondary forest in Indonesia, primarily a result of logging. We discuss the impact of government policy on forestry and forest resources, logging, the history and ownership of forest lands, and the condition and future development of existing post-extraction secondary forests.

Table 1 Area in forest concessions and estimated area in post-extraction secondary forests (PESF)

Bioregion	Total forest area[1] (million ha)	Area in forest concessions [2] (million ha) Total	Primary forest (%)	Logged-over forest (%)	Degraded forest [3] (%)
Sumatra	23.0	5.9	27	29	44
Kalimantan	36.2	20.4	34	36	30
Sulawesi	12.4	2.7	56	19	25
Maluku	7.0	2.3	49	29	22
Bali, Nusa Tenggara, East Timor	3.9	0.3	40	41	19
Papua	35.4	9.8	74	9	17
Java	3.1	0	0	0	0
Total [4]	121.1	41.1	45	27	28

[1] Santoso 1999
[2] Ismail 2000
[3] Includes empty land and agricultural land within concessions
[4] Regions do not add up to total because of rounding errors

Table 2 Estimated area in post-extraction secondary forests

Bioregion	Estimated area in post-extraction secondary forest[1] (million ha)			
	Total	% PESF degraded	PESF as % of area in concessions	PESF as % of total forest area
Sumatra	4.3	60	73	19
Kalimantan	13.4	45	66	37
Sulawesi	1.2	57	44	10
Maluku	1.2	43	51	17
Bali, Nusa Tenggara, Timor Timur	0.2	32	60	5
Papua	2.6	65	26	7
Java	0	0	0	0
Total [2]	22.6	51	55	19

[1] Logged over forest plus degraded forest within concessions. Post-extraction secondary forests also exist in expired concessions under the control of the state enterprise INHUTANI. Illegal logging in conservation and protection forest also results in post-extraction secondary forests.

[2] Regions do not add up to total because of rounding errors.

Forest policy and ownership

Understanding the legislation and policies affecting Indonesia's forests is important in determining the processes involved in the formation of post-extraction secondary forests. Article 33 of the 1945 Indonesian Constitution stipulates that the State controls forests and the utilisation of the resources therein. Acting on this authority, the government of Indonesia controls, manages and administers the nation's forests under the provisions of the 1967 Basic Forestry Law (Act 5) and the supporting rules and regulations. In 1999, a new Basic Forestry Law No. 41/1999 was enacted, which helps strengthen forest conservation measures. Although recognised in the 1960 Agrarian Law, customary land rights *(hak tanah adat)* were not clearly acknowledged in the 1967 Basic Forestry Law. However, they are given more emphasis in the new Basic Forestry Law of 1999.

The 1967 Basic Forestry Law determines which land will be state forests and for which purposes the forests will be used. However, the government has been relatively powerless to enforce ownership rights and defend the legal status of forests. The lack of provisions on the rights of local communities has resulted in many cases of conflicts between local communities and concession holders. During the 1970s through 1990s, the government granted concessions to logging companies but failed to adequately enforce harvesting and replanting regulations. The logging companies have focused on maximising profits, while the government is responsible for assuring adequate forest regeneration, watershed protection, provision of environmental services, and the sustainability of traditional social values in the concession. Since 1995, however, the government has encouraged local populations to take a more active role in forest management and the establishment of social forestry programs. This was supported by a decree in 1998 that authorised communities to undertake timber harvesting through cooperatives. Another similar programme is the Management of Forest Production by Traditional

Societies, which involves non-government organisations (NGOs) working in partnership with local communities.

Although not comprehensive, the new Forestry Law of 1999 does define some aspects of the property and other rights of local communities with regard to forest land. It defines a customary forest *(hutan adat)* as a state forest on the territory of a customary society *(masyarakat adat)* and acknowledges community rights 'as long as they are evidently in place and their presence is acknowledged and as long as their rights do not conflict with national interests'. In 1998, the Ministry of Forestry also published two decrees in advance of the circulation of a new 1999 Basic Forestry Law. The first transfers central forestry functions in regard to the Management of Grand Forests (*Taman Hutan Raya*) to the governors of each province and the Management of National Parks to district heads. The second decree sets limits on the maximum area that any private company can hold in forest or timber plantation concessions.

Formation of post-extraction secondary forests

Prior to World War II, the lowland rainforests of Indonesia were logged manually using simple selective cutting practices, including the logging method known as *banjir kap*. This logging had little negative impact on the forest as it was mainly confined to harvesting heavy and durable wood (Kartawinata *et al.* 1989). Only trees of more than 35 cm diameter were cut and the forest was allowed to regenerate (Kromosoedarmo & Warsopranoto 1958). Log production was relatively low, reaching a volume of 2.6 million m^3 in 1966 (MOF & FAO 1990). The enactment of the Basic Forestry Law and Foreign Capital Investment Law in 1967 and the Domestic Capital Investment Law in 1968, coupled with the issuance of various forestry regulations and incentives, stimulated investments in the timber industry. Log production increased to 25 million m^3/year and exports to 19 million m^3/year during the 1970s (Bureau of Planning 1991), while log production increased to 36.7 million m^3 by 1987 (MOF & FAO 1990).

The Ministry of Forestry Decree No. 5/1967 stipulated that the management of forest should be in accordance with the principle of multiple use and sustainable yield. Guidelines of the Indonesian Selective Cutting System *(Tebang Pilih Indonesia, TPI)* specify the minimum size of trees to be harvested and the number, spacing and size class of residual trees per ha for stand regeneration (Soerianegara 1971). In general, timber companies cut trees with diameters greater than 50 cm and follow a cutting cycle of 35 years. This forms the basis for determining the 'Annual Allowable Cut', which defines how much timber a company is allowed to extract from a concession. Guidelines for natural regeneration and artificial regeneration were also issued in 1972.

In general, concession holders complied with the stipulation on diameter limit, but ignored other operational requirements, such as residual stand inventories, as well as silvicultural treatments. The latter include enrichment planting, forest tending and the establishment of nurseries (Kartawinata *et al.* 1989, Djamaludin 1991). The TPI guidelines were too difficult and costly to implement, while

competent staff and knowledge on how to adjust the system to particular conditions were lacking (Soerianegara & Kartawinata 1983). One of the other problems was that longer-term ecological sustainability of the selection system was not established.

Selective logging in Indonesia resulted in the extraction of up to 20 trees per ha, similar to those reported from East Malaysia and the Philippines, but much higher than that in West Africa (Jeffrey 1978). In Sumatra and Kalimantan, the disturbance to the forest stand ranges from 25% to 54% of the tree cover (Abdulhadi *et al.* 1981, 1987, Bertault & Sist 1997, Elias 1998; Setyarso 1991). Ground damage ranges from 18 to 54% of the surface (Tinal & Palinewen 1978, Abdulhadi *et al.* 1981, 1987, Cannon *et al.* 1994). The mean annual mortality rate of damaged trees was 5.5%, compared to only 1.1% of undamaged trees (Nguyen-The *et al.* 1998; cited in Sist 2000). Setyarso (1991) noted tree damage of 25.5% and damage to regeneration of 10 to 22.7%.

A common practice among concession holders, *cuci mangkok*, (literally meaning 'cleaning a bowl'), has led to further disturbance and the development of post-extraction secondary forests. Secondary logging is carried out only a few years after, or even within the same year of, the first logging operation and long before the prescribed subsequent cutting cycle of 35 years. The practice is facilitated by the timber target, as specified in the 'annual allowable cut', being based on an overestimate of actual timber volumes existing within concessions.

In 1989 and 1993, the Ministry of Forestry issued decrees stressing tighter control of logging, including pre-harvesting and post-harvesting inventories, diameter limits and post-harvesting treatments to ensure adequate regeneration. However, improvements were negligible, regeneration was poor, growing stocks decreased and environmental degradation continued (DFID & MOFEC 2000). Log production declined to about 25 million m^3 in 1999 (Bureau of Planning 1999). The number of concessions and the area in concessions also declined from 538 concessions in 1987 (Anonymous 1988) to 437 in 1998 (Djamaludin 1998) and 389 in 1999 (Kartodihardjo & Supriono 1999). The reduction in the number of concessionaires in 1998 and 1999 resulted from the revoking of the licenses of the non-performing concession holders and expired logging rights. The Ministry of Forestry is unable to fully control and manage these revoked concessions, rendering them vulnerable to illegal logging. Many have been turned over to the state timber enterprises, the PT INHUTANIs, which in many cases contract out portions of the concessions or timber harvesting operations to private companies. Of the 5.71 million ha under INHUTANI management, 10.9% remain as primary forest, 43.6% as secondary forests in good condition, and 45.2% have been severely degraded and are secondary forests in poor condition or devoid of tree cover (Ismail 2000).

Characteristics of post-extraction secondary forests

The characteristics of post-extraction secondary forests depend largely on the nature and intensity of logging (Kartawinata *et al.* 1989), and also on the subsequent disturbance and pressures on the forest. This paper focuses on the effects of logging practices on subsequent characteristics of secondary forests.

Vegetation

In Indonesia, the selective logging system leads to the formation of large canopy openings, resulting from tree felling, skid trails, haul roads and log-yards. They are mostly bare areas, covering 14 to 50% of the ground, and are invaded by light-demanding, fast-growing and light-wood pioneer species (Fox 1969, Meijer 1970, Tinal & Palinewen 1978, Abdulhadi *et al.* 1981). Only a few species are of commercial timber value. Selective logging results in genetic erosion and the loss of species (Ewel & Conde 1980, Jacobs 1980). It is a process of 'creaming' or 'high-grading' the best trees of commercial species, especially those of dipterocarps. Residual trees which will provide seeds for future crops are, therefore, mostly undesirable, being smaller and genetically inferior (Blanche 1978, Ashton 1980). Also, the residual trees, saplings and seedlings of commercial dipterocarp species in post-extraction secondary forests usually have a low density attributed to repeated and heavy logging (DFID & MOFEC 2000).

The recovery of the logged stand to conditions similar to undisturbed forest is extremely slow, perhaps taking 150 years or more (Meijer 1970, Riswan *et al.* 1986). Damaged poor sites, such as a *'kerangas'* (heath) forest on white sandy soil, recover very slowly and less vigorously (Riswan & Kartawinata 1988b). Blocking of natural drainage leads to flooding, causing the death of trees and other species, with dipterocarp seedlings being particularly vulnerable. Frequently, climbers aggressively invade the bare ground and also overgrow residual trees, suppressing their growth. Because canopy gaps resulting from logging are much larger than most natural tree-fall gaps in primary forests, the micro-climatic changes in the gaps are more drastic and can be injurious to organisms adapted to the less severe regime of natural disturbances. The changes in light, humidity, temperature and wind may influence the growth of residual trees, saplings and seedlings (Whitmore & Wong 1958, Soekotjo & Thojib 1978). A high rate of evapo-transpiration leads to soil desiccation, which may in turn prevent seed germination and may result also in the death of established seedlings. Crown dieback, sun-scalding of trunks and branches, water stress and insect attacks may occur, leading to the death of residual trees (Blanche 1978, Ewel & Conde 1980).

The number of tree species in post-extraction secondary forests has been reported to be lower than in primary forest, but the standing stock is higher and the nucleus trees are sufficient for the future development of post-extraction secondary forests (Gintings 1969, Tarumingkeng *et al.* 1989). An annual increment of 2 m^3 ha^{-1} y^{-1} from a growing stock of 75 m^3 ha^{-1} has been recorded (Sumitro 1991). High logging damage, including crown injuries, has negative impacts on forest recovery and hence on volume increment and the response of the stand depends on the degree of canopy opening which is related to the intensity of logging (Bertault & Sist 1995, Sist 2000). Canopy openings create suitable light conditions for the growth of seedlings of dipterocarp species that grow well in gaps, but slower in the shade of young secondary forest species (Nguyen-The *et al.* 1998). Seedlings of timber species like *Shorea leprosula* and *Dryobalanops lanceolata* grow faster in post-extraction secondary forests of different ages than in primary forests and fastest in

1-year-old secondary forest (Howlett & Davidson 1996, Oorschot *et al.* 1996). On the other hand, various *Dipterocarpus* spp. and *Agathis damara* grow slower (Oorschot *et al.* 1996). Recovery of a clearcut gap of 0.5 ha inside a dipterocarp forest took place mainly through seedling regeneration with a small percentage through re-sprouting. In a heath forest, regeneration of a 0.5-ha gap took place by the re-sprouting of forest trees with insignificant percentage of regeneration by seedlings (Riswan & Kartawinata 1988b, 1991). This suggests variable opportunities for the management of PESF for timber species.

Wildlife

Selective logging and the conversion of primary forests to secondary forests has a negative impact on the populations of arboreal mammals, because it alters their habitat and decreases food supply. The situation for browsing animals may be improved by the luxuriant secondary forest regeneration (Whitmore 1984). The effects on primates and small mammals vary with the degree of disturbance and the primate species (Rodman 1973, Wilson & Wilson 1975). Some species of birds that require a large area of relatively undisturbed forest to maintain breeding populations or mature trees for nesting are seriously affected by the transformation of primary to secondary forests (McLure 1968, Medway & Wells 1971). However, colonising birds prefer to feed in disturbed forest and their numbers increase in the secondary forest (Johns 1985). Insects are severely affected by the nature and intensity of logging, since they tend to occupy more specialised environments (Price 1980). Even a single tree provides insects with a large number of distinct habitats. Certain groups of insects have close and interdependent relationships with certain tree species, hence the removal of the insects or the tree species impinges on the life of the other (Ashton 1989).

Soils

Skidding, hauling and yarding of logs may disturb the ground surface as much as 30% of the logged area (Fox 1969, Abdulhadi *et al.* 1981). The nature of soils, the topography, the logging intensity and technique, as well as the size and number of the equipment used, determine the amount of disturbance. Along compacted roads and skid trails, water infiltration is reduced (Abdulhadi *et al.* 1981) and drains are often blocked. This can lead to an increase in surface runoff and subsequent erosion (Burgess 1971, Liew 1974). In canopy gaps, the quantity of rainwater reaching the soil surface increases and the complete removal of ground vegetation, especially on clay soils, leads to the development of a dense rill network on slopes. Sediment load in rivers and streams in logged-over forests during low-flow periods is two to three times higher than in primary forests; during storm flows, sediment loads can be as much as 20 times higher, depending on forest conditions (Liew 1974).

Clearing primary forest lowers soil organic matter and in turn reduces the cation exchange capacity, which is largely controlled by colloidal organic matter derived

from the aboveground biomass. After several years of secondary forest growth, the nutrient content of the soil returns to or even surpasses original levels (Riswan 1982). In very poor white sands (podzols) nutrient recovery is extremely slow and associated with the very slow vegetation recovery (Riswan 1982). Litter production is higher and the rate of litter decomposition slower in primary forest than in post-extraction secondary forests (Ewel & Conde 1980), which is related to lower soil temperature in the former. Mycorrhizal fungi, on which many tropical forest trees (especially dipterocarps) depend for facilitating nutrient uptake, are severely affected by even slight increases in soil temperature, soil compaction and soil desiccation (Smits 1983).

Silviculture of post-extraction secondary forests

Sound silvicultural treatments designed to achieve long-term forest management to maintain forest ecological processes and meet future industry demands are of great importance. However, data on the silviculture of post-extraction secondary forests in Indonesia are still meagre and scattered. Regeneration experiments have been carried out, including: (1) allowing natural regeneration without any intervention; (2) natural regeneration by opening canopy gaps to allow the growth of suppressed seedlings; and (3) artificial regeneration using the methods of uniform liberation thinning of competing non-commercial species, line planting in areas with low density of regenerating seedlings and lane planting exercises (Adjers *et al.* 1995, Kuusipalo *et al.* 1996, Tuomela *et al.* 1996, Clearwater *et al.* 1999, Nifinluri *et al.* 1999).

Liberation thinning and enrichment planting are necessary and have been carried out over 1.3 million ha of forest land between 1994 and 1997 (Sarijanto 1997). Liberation stimulated the growth of *Eusideroxylon zwageri, Shorea leprosula* and *S. bracteolata* seedlings and saplings (Sastrawinata & Effendy 1991). Up to year 1998, the rate of enrichment planting was 600 000 ha/year and seedling nurseries in concessionaires covered 55 580 ha (Djamaludin 1998). Adjers *et al.* (1996) indicated that the best dipterocarp species for enrichment line planting was *Hopea sangal* with a survival rate of 78% and the next bests were *S. faguetiana, S. fallax, S. leprosula, S. johorensis* and *S. parvifolia* with survival rates of 50 to 70%. Annual height increases were 65 to 72 cm and annual diameter increments were 0.52 to 0.78 cm. Poor performance was shown by *Dipterocarpus* spp. (Adjers *et al.* 1996). Markam (1982) calculated that 17% of the dipterocarp seedlings planted would reach a diameter at breast height of 20 cm in 20 years.

The mean growth rate of dipterocarps ranges from 0.5 to 0.7 cm y^{-1} (Bertault & Sist 1995, Elias 1998, Nguyen-The *et al.* 1998) and the overall growth rate is 0.3 cm y^{-1} (Nguyen-The *et al.* 1998). The mean annual increment for five years after logging was 1.2 cm for light dipterocarp, 0.8 cm for heavy dipterocarp and

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[1]Light dipterocarps comprise the species *Anisoptera, Parashorea* and the red, yellow and white meranti group of *Shorea*, while the heavy dipterocarps include *Dipterocarpus, giam* group of *Hopea, Neobalanocarpus, Upuna* and the *balau* group of *Shorea* (Newman *et al.* 1996).

1.1 cm for non-dipterocarp species (Djamaludin 1998)[1]. Tending post-extraction secondary forests resulted in a mean diameter increment of 1.5 cm y^{-1}, equivalent to a 110 $m^3 y^{-1} ha^{-1}$ increase (Sutisna 1996, 1998).

Secondary logging in post-extraction secondary forests is possible (Supriyatno & Becker 1999). Despite the weaknesses of the TPI system, models for dipterocarp forests show that by managing tree species diversity, adequate economic returns can be achieved (Mendoza *et al.* 2000). By applying Reduced Impact Logging (RIL) techniques, logging damage can be reduced by 50% (Sist *et al.* 1998). Hence, the use of RIL techniques may encourage post-extraction secondary forests to recover faster and the length of the felling cycle may also be significantly shorter than the use of conventional logging methods.

Pressures on post-extraction secondary forests

Post-extraction secondary forests are subjected to numerous external pressures that have different effects on their condition. Substantial areas of post-extraction secondary forests have been converted to other uses. The most common pathways under which post-extraction secondary forests are converted are shown in Figure 1. Here we discuss the effect of illegal logging, transmigration programmes, claims by local and non-local residents, and tree and cash crop plantation establishment. Post-extraction secondary forests are also susceptible to burning and conversion to short-rotation swidden agriculture along logging roads. De Jong *et al.* (2000) discuss in detail swidden agriculture and its effects on forests, and Dennis *et al.* (2000) review the impact of fire on post-extraction secondary forests.

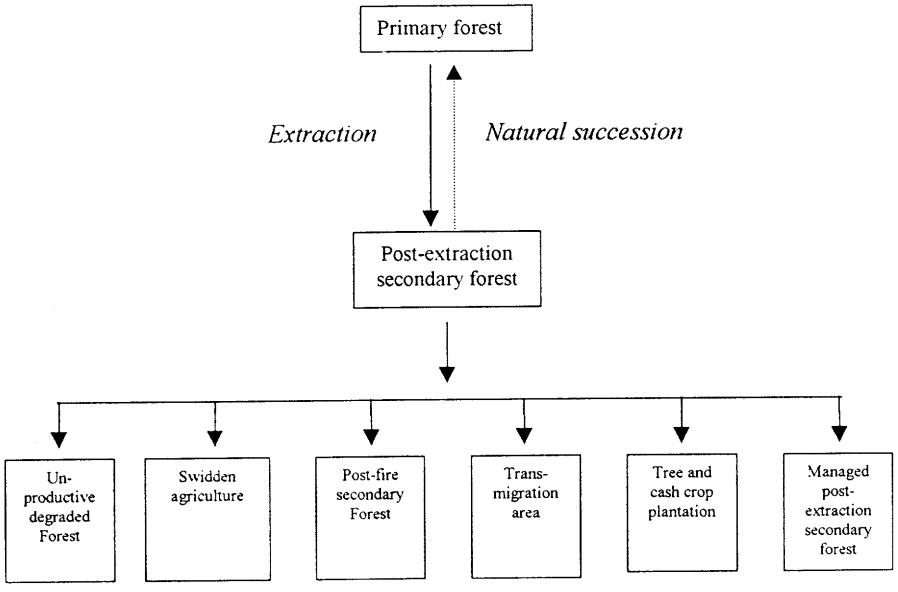

Figure 1 A conceptual diagram of the conversion of post-extraction secondary forests to other uses

Illegal logging

Illegal logging has also increased substantially since the era of the economic crisis and reform and has led to the degradation of post-extraction secondary forests (Ismail 2000). Illegal logging is carried out by local communities living close to forests, people coming from afar, concessionaires, timber traders, sawmill owners, the military, and government officials (Harsono 2000). In many cases, it can be categorized as a highly serious, well organized crime (Harsono 2000). Recent research (Obidzinski & Suramenggala 2000) shows that, in anticipation of decentralisation, district heads have been granting small concessions to community cooperatives. However, instead of community forestry as intended, it has resulted in timber harvesting deals between local communities and illegal operators. As a result, illegal operators acquire a fig of legality, while local communities obtain a minimal share of the profits from their resource.

Transmigration

Since the early 1950s, the government has attempted to reduce the very high population densities in Java and Madura through sponsored and assisted migration to other islands. From 1974 to 1989, about 1.1 million families moved as a result of assisted and spontaneous migration (Dick 1991). The Ministry of Forestry envisaged that, in the period from 1994 to 1999, a total of 350 000 families joined transmigration programmes, while 250 000 families migrated spontaneously (MOF 1995). Each transmigrant family usually receives 2 ha of post-extraction secondary forests, implying that during the period of 1994 to 1999 the area of post-extraction secondary forests clearcut was about 1.2 million ha. Sunderlin & Resosudarmo (1996) emphasised that, in addition to the direct effect of transmigration on forest cover, it also induced land pressures on neighbouring non-transmigrant households.

Tree crop and forest plantation

The establishment of tree crop plantations and industrial timber estates (*hutan tanaman industri* (HTI) has increased considerably during the last 10 years. Millions of hectares of post-extraction secondary forests have been used for this purpose (Bureau of Planning 1999). Tree crop plantations have been established mainly through the government's Nucleus Agriculture Estates Program. The total area of plantations of rubber, oil palm, coconut, cacao and other tree crops established up to 1998 was about 14.52 million ha (Bureau of Planning 1999). Up to March 2000, a total area of 1.8 million ha of post-extraction secondary forests had been given to 259 companies for conversion into new crop plantations. On 22 May 2000, however, the Minister of Forestry and Estate Crops issued a decree stopping the granting of permits for converting forests into tree crop plantations.

Claims by local and non-local residents

Pressures on post-extraction secondary forests also come from claims over and encroachment of forest land by local communities and non-resident claimants. This has drastically increased since the reform era after the overthrow of President Suharto in 1998. The claims by local communities are often genuine customary right claims. Claims by non-residents are often instigated by land speculators (Harsono 2000).

The future of post-extraction secondary forests

In the long term, the Ministry of Forestry's goals (Widodo 2000) are sustainable forest management, the protection and conservation of forests, the rehabilitation of degraded forest land, and the reduction and cessation of forest conversion. Community participation is expected to increase through the development of community forests, partnership in forest management, capacity building, and the utilisation of non-timber forest products. However, the recent accelerated change in Indonesia towards decentralised decision-making will greatly affect the future development of post-extraction secondary forests. The sustainability of post-extraction secondary forests will depend a great deal on how local governments manage forests and allocate them for other purposes. Most local governments do not have natural resource management personnel or experience, but it is anticipated that they will rely heavily on forest resources and mineral resources beneath the forests for much of their revenue.

The Ministry of Forestry designed a Production Forest Management Unit (*Kesatuan Pemangkuan Hutan Produksi* (KPHP) as the smallest unit for managing concession areas, including post-extraction secondary forests, based on conservation, sustainability and business principles (Sarijanto 1997). Community participation is integrated into the management plan (DFID & MOFEC 2000). Up to 1997, 180 KPHPs had been developed (Sarijanto 1997). The formation of Customary Forest Management Units (*Kesatuan Pemangkuan Hutan Alam* (KPHA) will be allowed within production and protection forest areas, and Community Forest Management Units (*Kesatuan Pemangkuan Hutan Kemasyarakatan* (KPHK) in areas where community forests can be established (Toha 2000). Currently, access and opportunities for local communities to achieve effective forest management are inadequate and there is a need to harmonise differing perceptions on management systems between communities, the government and concessionaires (Ismail 2000).

Post-extraction secondary forests in medium-to-good condition may be maintained as a permanent production forest estate while the degraded post-extraction secondary forests, including bare land, could be selected as areas for reforestation with fast growing species (HTI). To date, the annual rate of HTI development is 267 000 ha (Bureau of Planning 1999), implying that it would need at least 43 years to convert the 11 million ha of degraded post-extraction secondary forests into HTI. The development of HTI is also very expensive. It is, therefore, sensible to identify less costly and more rapid alternatives to regenerate degraded

forests. The rehabilitation of degraded lands through protection from further disturbance and the facilitation of natural regeneration may be a more feasible, less expensive option. Partnering local communities and empowering them to protect and manage these forests is essential for success, and there is increasing evidence that local communities and governments are capable of working together towards rehabilitation (Poffenburger & McGean 1994).

Post-extraction secondary forests may be targeted by local communities for conversion to swidden agriculture, especially if they are claimed as customary lands. However, if post-extraction secondary forests are considered as part of customary protection forests, known as *tana' ulen* in East Kalimantan (Panitia 1998), or *repong damar* (resin producing gardens in Lampung) (Tim 1999), they are more likely to be managed as such for the production of non-timber forest products. The government has legally recognised *repong damar* as "areas with special purposes", but has not done so for *tana' ulen* and other similar customary lands.

In many locations, selective logging operations have left a mosaic of unlogged and logged areas. The unlogged areas are primarily on less accessible or commercially unproductive forest areas including ridges, steep slopes and river banks. The logged areas that have developed into post-extraction secondary forests occupy skid trails, log yards and hauling roads. There is substantial spatial variation in the degree of damage, subsequent forest structure and species composition. Left to recover naturally, this habitat heterogeneity can support a diversity of species different from pre-logging conditions. Based on post-extraction secondary forest data, a forest management model has been developed that makes it possible to attain economic returns while sustaining the forest resource and conserving tree diversity (Mendoza *et al.* 2000).

Without additional disturbance, post-extraction secondary forests will develop into forests similar in structure to the original type through succession (Figure 1). The recovery time is estimated to take more than 150 years (Riswan *et al.* 1986, Riswan & Kartawinata 1988a). The recovery may be accelerated through rehabilitation measures while managing natural processes of succession (Kartawinata 1994). If the objective is to obtain useable forest products, it will require favouring a certain group of species; if the aim is to achieve species diversity, a broader set of species would need to be favoured (Lugo 1988). Local community involvement and an understanding of the underlying degradation pressures would be imperative for the effective rehabilitation and sustainable management of post-extraction secondary forests.

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