3. Forest access and land classification

3.1 Historical and international context

The swidden system consists of a crop phase and a transition to woody vegetation as fallow or secondary forest. The direct relationship between the fraction of the area that is cropped in any year and the possible length of the fallow period implies that restricted access to the forest is a primary driver of the intensification and shortening of fallow periods in the remaining, unrestricted area. The dynamics of swiddens are therefore directly linked to the historical emergence of forest institutions that regulate access to the woody vegetation that may or may not have a history of cropping[1]. At low population density, land is considered plentiful and production potential is determined by the amount of labour that can be mustered for clearing land[2].

3.1.1 Brief history of forest institutions in Indonesia

'Forest' derives from the Latin 'forestis', or 'unenclosed', referring to land outside of the direct influence of villages or farmers and controlled by the central government authority, often the king. It originally did not refer specifically to woody vegetation that such land may have (the Latin word 'silva' refers to woody vegetation and is also normally translated to 'forest'). Timber and non-timber forest products (e.g., game) alternated over time as the prime benefits these lands provided to the authorities. With the strategic importance of large trees for shipbuilding, and hence for navies and maritime power, forest management became geared toward trees and timber.

During fieldwork in Indonesia, especially in areas with conflicts over forest delineation and local rights, we frequently hear accounts of discussions with colonial administrators before independence. An historical analysis is needed to appreciate current concerns and expectations. Dutch colonial rule in Indonesia was primarily aimed at trade, the production of export crops and political stability under local rulers who accepted colonial authority. Shipbuilding was indeed a reason to be interested in the teak forests of Java and to establish a forest authority there. On many of the outer islands, however, interest in forest areas was rather limited before 1900. In some of the more densely populated parts of Sumatra, the need for forest reserves for conserving biodiversity and/or future use was recognized. In 1865, the first forestry law for Java was introduced along with the 'domeinverklaring' of 1870 for outer Java, which unilaterally declared all unclaimed land, including forests, as the domain of the state (Galudra and Sirait 2006).

Due to the relatively weak position of the colonial government in most of these areas (Box 3), the delineation process involved local communities and established forest boundaries beyond the then-current economic interests of local communities. In the 1920s, a debate started on shifting cultivation as competing for land with European plantations and thus needing to be controlled.

An early expression of environmental concerns on swiddening was from Marsden (1811), who commented on the burning of a large amount of biomass for a short-term gain in ash and arable land: “I could never behold this devastation without a strong sentiment of regret. … [I]t is not difficult to account for such feelings on the sight of a venerable wood, old, to the appearance, as the soil it stood on, and beautiful beyond what pencil can describe, annihilated for the temporary use of the space it occupied. It seemed a violation of nature, in the too arbitrary exercise of power.”

[1]ASB researcher Andy Gillison provided an anecdote of finding clear traces of previous cropping and terrace development in what was described to him as the most pristine natural forest in Sumatra.

[2]Even in the middle of the 19th century, land was considered to have much less value than the control over corvée labour and a small monthly stipend, as Onghokam (2003) recounts in the history of the relationship between *bupatis* (regency heads) and the Dutch colonial administration that had taken over direct government after the 1830 Java War.

Box 3: Unfinished business of regulation during colonial period

Fluyt (1936), in an internal report on the condition of the Forest Service for the Outer Islands in 1936, provided interesting insights into the attempts to extend to the rest of the archipelago the type of territorial control that the Forest Service had on Java and Madura:

> The process of reserving mountain forests is almost completed for Sumatra, except for Aceh and Jambi. The forest complexes eligible for a reserve status have largely been selected and the formal decisions have been announced. On the administrative side, however, full delineation of the forest area to be preserved is still lacking in many cases.
>
> Lack of trained personnel but especially the lack of general regulation and rules is the main cause of this lack of progress. Still there is no legal basis in the form of a Forest Regulation that could form the basis of a uniform approach to forest preservation in mountainous areas.
>
> In 1934 the advisor Gonggrijp of the Forest Service for the Outer Islands (FSOI) issued a formal regulation on the technical procedure to be followed for forest preservation. The intention of this regulation was to address all grievances of government and local population, mainly by an elaborate process of consultation and formal documentation of agreements, prior to designation of a specific area of forest as reserve. However, the Civil Government objected to the technical procedure as it had been designed without involvement of the Government that has a final say in the area designation process. Nevertheless, the technical procedure is now generally accepted (except for Sulawesi) and various Residents issue regulations that are based on this procedure (Palembang, East coast of Sumatra, Lampung and others) as [the] basis for Memoranda of Agreement, installation of committees to settle border issues, and similar [actions].
>
> …Mr. Gonggrijp describes as the main hindrance to the economic development of forest exploitation that there is till now no proper regulation. Also the leniency of the Central Government to the rights that the Adat communities assume to have, with support of the local civil servants. It will be important to provide more clarity than currently exists through executive prescriptions in a yet-to-be-conceived new Forest Rulings for the Outer Islands.
>
> All forest policies for the outer Islands revolve around the legal aspects. As may have become clear from the above, the current system does not function as it should.…The core issue is the neglect of the 'domain declaration' (Agrarian Law of 1870) by many government employees, some of whom provide fanatical support for Adat perspectives. The Government has decided to have a close look at the current agrarian system, through a Committee of Investigation (Government Decision May 16 1928, No. 17). The 'Advice' of this 'Agrarian Committee' appeared in 1930 in print and received support as well as criticism. Because of the controversy, the Government has so far refrained from expressing any opinion on the issue.
>
> A draft forest ordnance was submitted by the Government to the Parliament ('Volksraad') in 1934.…In its discussion of the draft in Parliament ('Volksraad') in 1935, the local representatives have nevertheless tried to put the rights of the indigenous Adat communities on the forefront. This led to a number of amendments to the draft regulation to the extent that the Government decided not to follow the decisions of the Parliament and apply the so-called long arbitration procedure (article 89 I.S.). On re-discussing the issue in Parliament in 1936, which has not yet been completed, it became clear that 'many members' are not susceptible to the further arguments provided by the Government. The discussions focus on article 4.1 of the draft, which prescribes the sharing of benefits of government controlled forests between the Government and the Indigenous Adat communities.

See Galudra and Sirait (2006b) for a further analysis of the 'unfinished business' of establishing a forest regulation prior to independence of the Republik Indonesia.

In the 1920s, the view emerged that shifting cultivation was sustainable where fallow periods were long enough but led to land degradation once a critical fallow length could no longer be maintained. This concept found its way into the international literature through parallel studies in Africa.

After independence, forest reserves were initially seen as part of a restrictive colonial system that prevented Indonesians' benefiting from their country's natural resources as guaranteed in the constitution. Over time, however, central authority over the forests was reestablished and, after 1965, surpassed the colonial heritage by claiming much larger areas as forest estate ('kawasan hutan'). Global demand for tropical timber, new technology and cheap transport created a logging industry under central control in conjunction with politically well-connected entrepreneurs. Logging concessions often encroached upon local land rights, but the political climate of the day did not recognize these claims, and conflicts were suppressed.

Political change in Indonesia in 1998 with 'reformasi' brought a second wave of independence sentiments to many of the forest areas and a return of the concept that local communities should benefit more from the use of local natural resources. Conflicts emerged openly. The decentralization law delegated more authority to local governments, and the 1999 Forestry Law made a distinction between 'forest estate' ('kawasan hutan') as a land-use designation and 'state forest lands' ('kawasan hutan negara') as a subset of this domain, with a legal process of verification that no other legitimate claims to the land existed. In fact, only 10% of Indonesia's land area is legally state forest lands, according to recent counts. In the other parts of the kawasan hutan the operations of the Ministry of Forestry are in a legal grey zone.

3.1.2 Shifting cultivation is not deforestation by agreed definitions

The internationally accepted definition of 'forest' – in the forestry statistics of the Food and Agriculture Organization and under the Kyoto protocol rules for controlling emissions of greenhouse gasses – combines elements of vegetation, institutional control and the intention of recovery of tree growth. The internationally accepted definition of forest has two components: one that specifies canopy cover and tree height, and one that refers to the institutional framework of forestry, as it includes *'areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest'*. (UNFCCC/CP/2001/13/Add.1 as quoted in van Noordwijk et al., 2008a)

The 'temporarily unstocked' part of the definition is intended to allow clear-felling and replanting as normal forest management, but the definition implies that shifting cultivation and fallow rotations are not deforestation, as long as trees achieve the specified height and canopy cover. Clear-felling for developing fastwood or oil palm plantations is possible within the forest definition, but so is land clearing followed by assisted regrowth of woody fallow vegetation[3]. The usual listing of shifting cultivation as a driver of deforestation is thus not aligned with the internationally accepted definition of forest. As intensification reduces the crown cover and tree height of the fallow vegetation, the forest threshold is crossed and the area no longer qualifies as forest, though institutional claims that the area remains part of the forest domain may persist. In practice, however, slash-and-burn land clearing is still seen as a major threat to the economic interests of the powers that be, and environmental arguments are brought to bear on the discussion with a selective use of agreed definitions, allowing fastwood plantations to be called forest but disallowing areas with other perennial tree crops. The definition of 'forest' is made by 'foresters', rather than the other way around, where society's definition of forests clarifies the role of various forest agents. Smallholder agroforesters still lack recognition, and they usually prefer to call their woody vegetation 'garden' to avoid institutional conflict with forestry institutions.

In the international debate on reducing emissions from deforestation and degradation in developing countries, it may be interesting to note that shifting cultivation, by definition, cannot be a cause of deforestation. It can, however, cause a decrease in carbon stocks, just as fastwood plantations can.

3.2 Current legal pluralism

The change in environmental conditions and the socioeconomic welfare of the people in Indonesia, including that of shifting cultivators, cannot be separated from the legal bases of control over access to land (Contreras-Hermosilla and Fay 2005, Fay and Michon 2005).

Millions of hectares of natural woody vegetation (to avoid the word 'forest') disappeared every decade of the 20th century, with commercial logging opening up the area and creating access, leaving in their wake Imperata grasslands or plantations owned by private companies or foreign investors. 'Adat' (customary) communities saw their rights limited or even lost access to the forests, lost their lands and became labourers on plantations occupying what had been their homelands under community control. Conflicts between local communities and the newly arrived investors and migrants, and between local communities and the government, have occurred in many places in Indonesia. Environmental disasters like floods and landslides are common after changes in land cover and destroy thousands of hectares of rice fields and houses. Government laws and policies in governing the natural resources tend to operate at 'coarse' scale, while local (adat) regulation tended to be more detailed and based on local experience.

Indonesia has 190 million ha of land. The spatial planning process has classified the lands into permanent forest land and non-forest land, with state forest lands as a subset of the permanent forest lands. Permanent forest lands, covering 120 million ha, are defined in the spatial planning process ('rencana tata ruang wilayah') as areas identified by the provincial government in consultation with the Ministry of Forestry as forest land. Actual tree cover is not important for the legal status of forest lands, aligned with the international forest definition, as the intention of tree planting is sufficient to classify land as forest. The permanent forest estate and the state forest lands are the responsibility of the Department of Forestry, whose governing extends to people, their adat rights and the fauna living in the area.

To sustain forests' biodiversity while providing the country with income, the forest area is further classified into forests for conservation, protection, or production. The central government is responsible for managing conservation forests, local governments for protection forests, and timber concessions (under the supervision of the central government) for production forests. Policies are issued for each forest type, including regarding adat communities' access to these forests.

Considerable areas outside the permanent forest estate have actual tree cover (Figure 11), but local ownership is recognized under the agrarian law. Registering land ownership in all of Indonesia, inside or outside forest areas, is the responsibility of the National Land Agency. The process of reconciling the territorial claims of the Ministry of Forestry and the registers of the National Land Agency is slow to progress, as the economic and political interests involved are considerable, even though all refer to the same 1945 constitution.

Adat forest, the forest land managed and at least in the local perspective 'owned' by adat communities, is found in both the 'kawasan hutan' and outside of it. The management of this adat forest within the kawasan hutan must, according to the Ministry of Forestry, follow rules it sets, but this is often contested by local communities. During the repressive Suharto years, there was little opportunity to express discontent or protest other than by lighting a fire, but since the 1998 reformasi conflicts have become more open and visible.

[3] Fastwood plantations are areas intensively managed to produce raw material for pulp and paper plants in production cycles of typically 6-10 years.

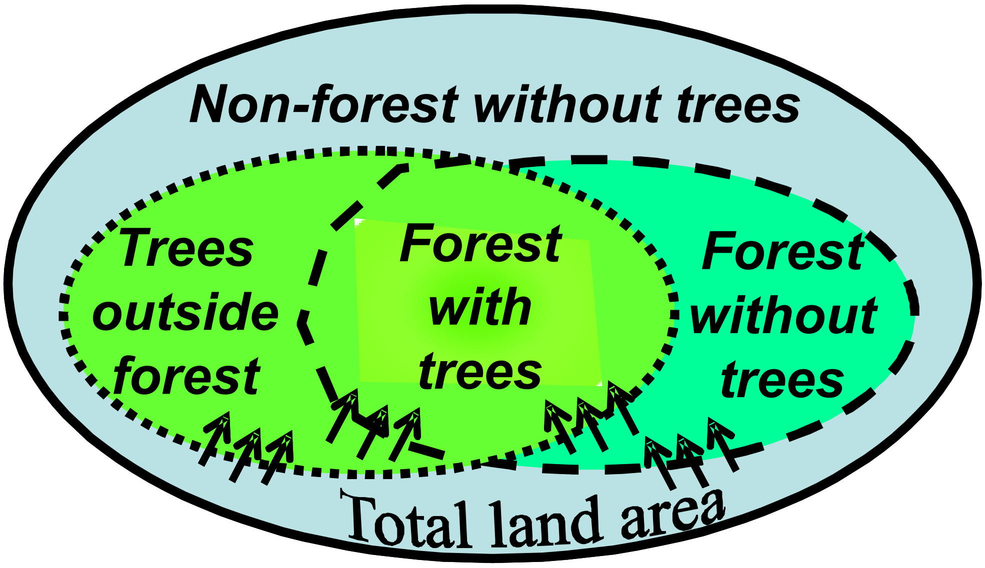

Figure 11: The combination of 'tree-based' (crown cover) and 'institutional' forest definitions creates four categories of land in Indonesia: forests with trees, forests without trees, non-forests with trees and non-forests without trees; the terms 'deforestation' and 'reforestation' have multiple meanings depending on the forest concept used.

3.2.1 Customary land in the state forest land

Most of Indonesia's land area, 63%, is supposed to be forest estate ('kawasan hutan'). The current Forestry law (No. 41, 1999) provides the legal basis for governing forest estate but also defines a procedure to be followed before land can be claimed as such. For most of the land, this process has not been completed. According to the law, adat communities have the right to manage part of the forest estate if they fulfil the following requirements:

1. The communities are still in the form of the 'rechtsgemeenschap' that was recognized before Indonesia's independence.
2. The adat area, adat institution and adat law still exist and are locally respected.
3. The adat communities still collect forest products from their surrounding forest area to fill daily needs.

The conditional acknowledgement of adat forest, adat communities and their right to manage their land creates controversy. To some, supported by a number of academics and nongovernmental organizations, this conditional acknowledgement shows the government's efforts to restrict adat communities' access to forest land that was traditionally theirs. The explanation of the Forestry Law, which states ”in its development, due to many factors, this adat right gets weaker“, is viewed as a means for the government to unify national laws. However, Riyanto (2007, 2008) considers the inclusion of customary forest into the state forest as a consequence of the right assumed by the state in the constitution, and sanctioned by a democratically elected parliament in laws, to control forest land. This does not mean that the rights of the adat communities to manage forests are nullified. Instead, it is how the government tries to protect adat communities and existing forest from encroachers, the ones who are believed to destroy the forest for short-term gain. The debate continues (Simarmata, 2007) along similar lines as in the colonial period (Box 3).

Table 2 indicates that the government recognizes a difference between *adat* and other communities, based on the history of settlement. Unfortunately, the formal requirements for recognition of *adat* forests are quite complicated or nearly impossible to meet. So far no adat community has been able to get an official letter from the minister of forestry acknowledging the *adat* forest, leaving them with insecure access and tenure over *adat* forest. Acknowledgement of *adat* community and its land is in two deferent authorities, ie., the local government for the existence of the community, and the central government for the forest land. The challenge is the procedure is still unclear.

During the colonial era, a specific regulation was developed for swidden agriculture ('huma') in West Java; Kools (1935) discussed the background of this policy that tried to balance local interest and the forest functions prioritized by the government (Galudra 2006a).

3.2.2 Customary land in non-forest land

The Agrarian Law clarifies the rules for land ownership in Indonesia, including of customary lands, and without exceptions for forest lands. This law provides people individually with different rights such as the right to own land, build on it, use it, and manage it. Unlike the Forest Law, under which adat land is considered to be state land, the agrarian law recognizes this adat land as belonging to customary communities. The local community can manage these adat lands, but individual land certificates cannot be issued. The right of individuals to manage and use the land requires a time limit, as land ownership remains collective. The government has in the past ignored the existence of adat rights and provided concessions to private companies, only to find that local claims persisted and conflicts emerged.

Table 2: Typology of the communities living in and around the forests.

	Adat Community	Local Community	Newcomers/migrants
Characteristics	Have lived around the forest for generations Adat law still functional Use local wisdom in managing the forests	Have lived around the forest for generations Do not have adat law Apply traditional and modern practices	Do not live around forest Do not have adat law Apply modern practices
Status	Regency law recognizes their existence	Not regulated by government law	Encroachers
Rights recognized by the state	Manage and make use of forest resources Involved in the planning process	Have access to forest resources Involved in the planning process	Do not have a right to use forest resources

Source: Directorate General of Forest Production 2007.

Indonesia has large land areas where adat communities still practice forms of shifting cultivation. Fallow lands, often incorrectly perceived as being abandoned, do not provide much direct economic benefit when expressed as per unit of area per year, but they can provide indirect benefits such as dietary diversity, medicinal plants and insurance foods in times of stress. Issues related to adat communities and their rights remained while the following questions were not satisfactorily answered:

1. What are the various claims of these adat communities over their adat lands?
2. How can we place adat rights in the context of matters pertaining to the state?
3. What are the roles of adat rights in state affairs?
4. How can adat rights develop and adapt to current concerns about transparency and internal equity?

3.3 Returnees, migrants and ambiguity of land rights

People in Southeast Asia have a long history of migration in search of better livelihood options beyond the current domain. When land was considered plentiful, and before nation states emerged and required passports and visas, this movement was welcomed as contributing to economic growth. Many communities in Southeast Asia have a tradition that young people look 'outside of the box' of local opportunities, but few are as institutionalized as the 'merantau' tradition of outmigration in West Sumatra. Long-term bonding to the area of origin is combined with seeking livelihood opportunities outside, and the result is a constant stream of revenue and new ideas into rural areas. In some areas, the countryside is inhabited by older people who take care of their grandchildren while the middle generation of parents work in the cities. These dynamics need to be accommodated in the local rights system. In the Kerinci valley, for example, young women must declare, before they leave for jobs abroad, their intention to return and take their share in rotational rice field rights in the existing matrilineal inheritance system.

For people from densely populated Java, Bali, South Sulawesi, or North or West Sumatra, merantau can bring them to less densely populated areas, where opportunities still exists to create a new forest margin. In some cases, they enter the local communities as temporary labourers, share-croppers or share-tappers in the case of rubber and gradually acquire land within local institutions. This can be accommodated but may become problematic if conflicts between the state and the local communities arise. In other cases, local entrepreneurs sell certificates that appear to convey land rights to newcomers who find out later that there are multiple other claimants to the land. The ASB research program documented such cases in its North Lampung benchmark. Many people can claim that their grandmother or grandfather once had a shifting cultivation plot in a certain area (Box 4 on page 18).

Merantau maintains low population densities in the heart of Borneo, the inland parts of West and East Kalimantan. People prefer to work abroad in Malaysia to find better living conditions, educational opportunities and healthcare. In the more accessible parts, pressures on land tend to increase from immigration (Colfer and Dudley 1997), whether spontaneous or state-sponsored. Privately held plantations obtain access to land often without the free and prior informed consent of the local community. Where the local people do not want to become labourers on what used to be their own land, external labour is brought in, which may attract new settlers. The space for swiddens as a land-use system can rapidly disappear under such circumstances (Box 5).

Box 4: Relocation of the Punan Tubu in Malinau Regency, East Kalimantan

Punan groups from the Tubu moved into the Malinau river basin and the environs of Malinau city in the early 1970s (Levang et al. 2007). This movement was stimulated by the state because development cannot reach the remote areas. The state moved eight villages from the forest to areas in reach of the Regency capital. Punan people originally were forest dwellers who depended on forest products as hunter-gatherers, while some of them also practiced traditional swidden systems. The new location with different physical conditions induced the Tubu to become more sedentary and intensify their farming system. With a limited amount of land, the price of land rose. Meanwhile, restrictions on Tubu people's clearing forest were imposed by the native Tidung community. In response many of the Tubu came to depend on off-farm activities such as logging and mining. Many young Tubu prefer to go abroad to find better work and more access to markets.

Box 5: Population mobility and land-use change in North Lampung

North Lampung was the last part of the province to become a major destination for migrants, state-sponsored transmigrants (many of them resettled 'squatters' from the forest zones elsewhere in the province) and spontaneous migrants. The percentage of people not born in the province increased from 4% in 1961 to 31% in 1986. During the 1980s, issues of land tenure and ownership became contentious, as communal land ('tanah marga') was used for transmigration, logging concessions, and the development of sugarcane, rubber and fastwood plantations.

Until early in the 20th century, the Tulang Bawang river and the town of Manggala, which controlled its trade, had been an important part of the province and formed the border between areas controlled by Palembang in South Sumatra and Banten. Land along the river was intensively used but graded into forests with low-intensity use for shifting cultivation. As land was sufficient, there was no strong need to clarify boundaries between villages.

North Lampung province was part of the logging frontier of the early 1980s, and land rights were obtained from the local village leadership with the promise of connecting the area to the plantation economy. The local rights of community members to land that their parents or grandparents had cropped were disregarded. The transmigrants were provided legal title to land (2 ha per household), even though it had previous claims to it. The transmigrants learned quickly that most of the land was not suitable for the permanent crop production that was promoted as modern agriculture, and that the local tradition of growing tree crops such as rubber made more sense. Parts of the landscape could be converted into irrigated rice fields and rapidly increased in value. Many of the transmigrants became seasonal labourers on the sugarcane plantation, until that had to stop over the land rights conflicts that erupted after 1998. Many of the resettled transmigrants left, and mortality in the early years of hardship was high. The cropping system of the transmigrants became essentially a rotation of cassava with Imperata fallow. Soil fertility was low, and the incidence of runaway fires high. Shifting cultivation based on upland rice stopped when transmigration settlement and plantation development came to the area.

Spontaneous migrants also entered the area and started as share-croppers on land owned by others. Spontaneous migrants who could afford it, and transmigrants who wanted more than their allotted 2 ha of land, bought land–often to find out later that the seller was not the only claimant to it. The resulting conflicts sometimes escalated to an intercommunity scale and stimulated the migrants to move on and try their luck once more in the mountains of Sumatra, where coffee can be grown on more fertile soils.

Sources: Saleh et al. 1997, Elmhirst 1997, Gauthier 1998, van Noordwijk et al. 1995.

3.4 National parks

Forestry Law No 41 (1999) defines 'conservation forest' as areas set aside to sustain biodiversity. A national park is part of conservation forest, defined in Forestry Law No 5 (1990) as one with its 'original ecosystem' and under a system of zoned management intensity for the purposes of research, education, science, cultivation, tourism and recreation.

Like 'production forests' and 'watershed protection forests', national parks are surrounded by people, including adat communities whose lives depend on their surrounding resources. Many social, economic and environmental problems stem from the rules and the way boundaries are set and maintained. National parks are normally divided into management units, with the sanctuary zone as the most restricted, allowing no human activity and requiring specific permits for research. The 'traditional use' zone of a park allows continued traditional land-use practices by local communities, as long as they respect rules for protected plants and animals.

There are about 50 national parks in Indonesia with a total area of over 10 million ha. The Lorentz National Park in Papua is the largest, covering more than 2.5 million ha, and the Kelimutu National Park in Flores is the smallest, at 5,000 ha. National parks are supposed to be the last fortresses of nature but face a similar threat as other forests of being encroached and logged illegally. Parks have become in many cases the place for illegal loggers and their political protectors to get high-quality timber. The national parks Gunung Leuser in Nangroe Aceh Darussalam, Bukit Barisan Selatan in Bengkulu, Kutai Timur in East Kalimantan, and Gunung Halimun Salak are examples of challenged parks.

The Kutai Timur National Park has an area of 198,629 ha. The signboard announcing 'prohibition to cut trees, to hunt, and to burn' stands next to the houses of the encroachers, and cellular telephone masts support the needs of squatters throughout the park. About 40% of the park has been destroyed, mostly by migrants from other islands who have formed seven villages with a total population of 24,000 and received government administrative support. Some Dayaks are also involved in cutting trees in the national park. A Wehea Dayak, 40-year-old Simon David, said: “Jika tak ikut menebang hutan kita akan dihabiskan pendatang dan kita tidak mendapat apa-apa (If I don't cut the forest, it will be finished by the migrants and I'll get nothing).” This shows that, to some Dayaks, their noble principal 'manyalamat petak danum' (save the land and water for future generations) does not exist anymore (Arif and Saptowalyono 2008). Road construction that was meant to open access to isolated areas attracts people who move in and build a house or farm along the road.

The Bukit Barisan Selatan National Park, measuring 356,800 ha, has been logged illegally since the issuance of permit for a timber forest concession adjacent to the park. The establishment of 'hit and run' coffee gardens is another problem the park faces, with slash-and-burn methods used for establishing the gardens. The Gunung Halimun Salak National Park, measuring 113,357 ha, has also suffered many socioeconomic and environmental problems since its designation in 2003 as a national park for ecosystem richness and hydrological function. About 108 villages and 317 sub-villages were included in the park at its establishment, and residents' rights to land remain unclear (Galudra 2003a).

Before it was designated a national park, the Mount Halimun-Salak forest was under the management of Perhutani, the state-owned forest company. Perhutani focused on the production forest zone and allowed the communities living in and around the concession area to farm under the community-based forest management (Pengelolaan Hutan Berbasis Masyarakat or PHBM) program of forest management by local communities agreed between Perhutani and the local communities. The concession, as it was set by Perhutani rules, taxed local communities for 25% of the yield from 'forest' land, even if it was terraced rice paddies. Designation part of this PHBM area to be a national park, as an enlargement of Gunung Halimun Salak national park, frightened the local communities for their PHBM activities would be restricted .

Designation as a national park was seen by villagers as infringement on their customary rights. The local practice of shifting cultivation became the core of the conflict. In early 2008, the head of Lebak Regency pleaded to the national legislature to exclude 15,000 ha of land from the designated national park. Negotiations continue (Galudra 2008).

The many national parks apparently do not secure conservation. A set of 21 national parks was recently selected to become 'model national parks' based on features such as high potential to attract visitors, high biodiversity, and well-established positive interaction with surrounding communities. Unfortunately, no clear guidelines yet exist on how these model parks should be managed, leaving park managers to interpret the decree on their own.

4. Evolution of the crop phase

4.1 Agrobiodiversity

Depending on local tradition and preference, swiddens can have rice, cassava, sweet potato, beans and other crops as the main component. Swiddeners usually grow several varieties of upland rice for various purposes. For example, in the Iban Dayak village of Kapar, West Kalimantan, rice and glutinous rice ('pulut') have a central place both for daily consumption and for customary healing, burial and other rituals. Glutinous rice is important for making traditional wine and as a symbol of wealth in most Dayak communities (Figure 12). Different rice varieties differ in taste, texture and vulnerability to pests (Box 6).

Figure 12: (left) Pulut is a local variety of glutinuous rice; (right) local upland rice. Credit: Ratna Rismawan 2005.

Box 6: Various species of upland rice: taste and texture

Rice varieties offer different advantages. Some are highly resistant to insect pests and diseases. Some are firm while others are soft, and some are fragrant while others are not. Some rice varieties found in West Kalimantan as described by the Punan Dayak are in Table 3.

Table 3: Some paddy species and their properties, local use and perceived characteristics

Paddy type	Properties	Taste	Yield	Used	Disease resistant
Yase	Fragrant, short grain	Good	Medium yield	Consume on special occasions	High resistance to disease
Kuning	Long grain, hard	Not really good	High yield, good for food security	Daily consumption, but as a last resort	High resistance to disease
Meter	White, long grain	Very good	Low to medium yield	Consume on special occasions	Low resistance to disease

Figure 13: Some paddy varieties found among the Punan Dayak on the Upper Kapuas river, (left) Meter, (middle) Kuning, (right) Yase. Photo credit: Elok Mulyoutami 2008.

Swidden systems in Papua are usually based on sweet potato as the primary staple. Sweet potato cultivation has a social and cultural value for farmers in the Dani an ethnic group in West Papua. Widyastuti (2000) mentions that farmers can achieve high status through a number of strategies associated with deploying sweet potato diversity in their gardens. Sweet potatoes provide food security directly and through use as pig feed (Box 7).

Many swiddeners plant more than one rice variety and sometimes combine rice with other crops on their swidden field. This may have high cultural value for the swiddeners, particularly for most of Dayaks in Kalimantan (Box 8). Moreover, intercropping miscellaneous crop varieties on a single piece of land is a strategy of spreading risk to cope with the loss of any particular crop pests or disease. In the paddy-based swidden system, different species of rice may have different resistance to pests and disease. For instance, 'hama wereng', or planthopper, likes only some rice varieties. Farmers know which rice varieties have high resistance to disease and pests. This fact is supported by Iban Dayak who are involved in community development programs managed by a local nongovernmental organization and issued this statement:

> Bagi masyarakat dayak, berladang itu penting, bahkan proses menanam padi di ladang itu harus dilakukan berurutan dan jenisnya juga beragam, kalau tidak mengikuti aturan adat, panen bisa gagal, dan juga ada hukumannya… panen bisa gagal jika hanya satu jenis padi saja yang ditanam, sebab jika semua terserang hama ya mati semua… tapi kalau tanamannya beragam, ada yang kuat sama hama ada juga yang tidak… jadi kemungkinan gagal panen bisa berkurang.

> (Swiddening is very important for local Dayak people. Crop planting must follow the established pattern with different rice varieties…. If we don't follow the rule, rice cultivation may fail…and also there are forms of punishment…. Harvests can fail if only one variety is used in a swidden. If a pest attacks, the paddy will die, but if we plant more than one variety, some of the rice could be resistant to the pest attack and the possibility of total harvest failure is diminished.)

Box 7: Diversity in sweet potato

Sweet potatoes come with many shapes, skin and flesh colours, maturity periods, and flavours. In a recent interview, a farmer in Wamena, Papua, could identify at least 20 different types that have recognizable properties and were planted in a new field. Sweet potatoes are harvested daily to meet current demand, making the field a storehouse as well as a production venue. Sweet potatoes are used for direct human consumption but also as feed for the pigs that provide protein, status and the wherewithal for traditional ceremonies. Varieties have distinct names and are identified by the colour of the flesh and skin (e.g., purple skin + white flesh, or purple throughout). Some varieties are and especially appreciated by children, and others are used primarily for pigs. Planting patterns in each new crop field maintain this diversity, which buffers risk from uncertainties regarding weather, pests and disease.

Box 8: Swidden rice management by the Iban in Kapar, West Kalimantan

Swiddening is the traditional way of life for the Iban Dayak in the village of Kapar, West Kalimantan, as it is for most others in Kalimantan. Iban Dayak have a bilateral inheritance system by which children inherit land from both parents. Land can be used for hunting and gathering, as swidden or as conservation area. Nowadays, 20 years is a typical fallow period for most Iban in West Kalimantan, though it is the girth of trees, rather than their age, that is used as the indicator (Wadley 2007). Clearing the forest using slash and burn is done to make the soil more fertile, as it is inherently acid. They use firebreaks–strips of lands around the fields cleared of vegetation (locally called 'ilaran api')–to control the spread of fire. Groups of farmers use fire to clear land using a circular pattern for control at the forest margin and lighting fires against the wind direction to avoid uncontrolled spread. Iban Dayak people consider it a disgrace if fires spread to adjacent fields, which brings serious punishment.

Farmers plant a number of upland rice varieties on the same plot in a single planting season. The Iban Dayak in Semalah have about 30 local rice varieties, some for wet, swampy fields and others for dry. They also plant glutinous rice. The intercropping tradition has been retained over generations (Table 4, Figure 15), and each family maintains its own seed bank. Pun paddy is a sacred paddy for most of the Iban Dayak on Borneo, including the Iban in Serawak. For the Iban, this type of paddy plays an important role as a symbol of family persistence, as it can recall the origin of the family (Padoch, pers. comm.). Each family has different types of Pun paddy. Pun paddy is usually planted first and protected by Sangking paddy. Both Pun and Sangking paddy have high cultural value as symbols of wealth.

Using multiple varieties in one plot is a strategy to avoid dramatic harvest failure from pests or disease. Iban farmers who participated in a workshop said that planthoppers usually attack only specific rice varieties, and that other varieties will still provide rice. This aspect of traditional swidden management by the Iban Dayak in Desa Kapar, based on cultural values, contributes to their food security.

Table 4: Paddy diversity and use in swiddens

Category	Planting pattern	Variety	Note
Pun, sacred strains paddy	Planted first after clearing land and always in the first row	Antu, Joarin	First priority, as a source of paddy cultivar, wealth and continuity symbol
Sangking	Plant after Pun in the second row	Jahe, Junti, Kenawit	Secondary priority for ceremonials
Other variety	Planted well in the swidden area, not on border	No information	
Pulut or glutinuous rice	Usually planted on swidden border.	Jamai, Sawa Kijang	

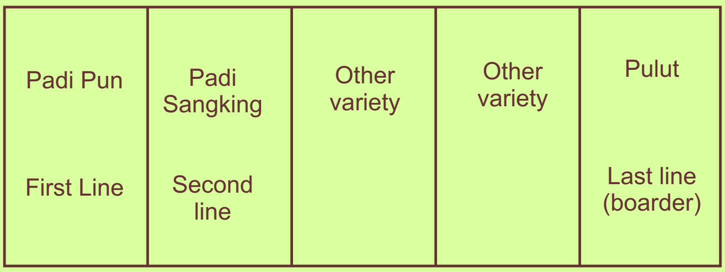

Figure 14: Planting pattern of local paddy inside swidden area.

Echoing the situation with the Iban Dayak in West Kalimanten (Box 4), research by Zhu et al. (2000) in China's Yunnan province shows that crop diversification by intercropping local and improved rice varieties controls disease better than does monoculture.

Farmers actively conserve the diversity of local upland rice varieties and select the highest-quality seed from previous harvest, storing it in airtight boxes to avoid rot and insect damage. Farmers intercrop their field with many varieties of crops to suppress weeds, prevent erosion and buffered risk. Traditional seed conservation supports the continuous adaptation of local varieties to changing circumstances. Benuaq Dayak farmers in East Kalimantan use the centre of the swidden as the nursery area, or 'pukaatn bini'. The species used for pukaatn bini can include bamboo, 'serai' (*Cymbopogun nardus*), 'kunyit' (*Curcuma domestica*), 'lenjuang', 'nenas' (*Ananas comosus*), 'engkudu biang' (*Fragaea racemosa*), 'peleheet' (*Randia* sp.), and 'tuba' or 'tuaq' (*Derris elliptica*) (Mulyoutami et al. 2008).

4.2 Local ecological knowledge

Local communities' natural resource management and farming traditions reflect landscape conditions and gradual learning. Farming started in small openings in the forest, complementing the collection of forest products, hunting and fishing. Swiddens in the forest area created temporarily fertile soil and were initially associated with temporary settlements, usually near a river used for transport and as a source of fish protein. Market integration meant that crop diversity increased when rubber, rattan, coffee and/or cinnamon were added to the food crops in the swidden. When this worked well, cash crops could permanently replace the swidden system with the establishment of a sedentary farming system. Other permanent farming systems, such as those based on flooded rice and palm oil, were imported in that form and did not gradually evolve locally.

Traditional or customary rules combine maintenance of swidden productivity with environmental and ecological concerns. However, in practice, not all swiddeners follow their customary rules.

Some examples of swiddeners' local knowledge are as follows:

- Give priority to old secondary forest to maximize the harvest without disturbing the succession process.
- Avoid wildfire by using firebreaks, accounting for wind direction and slopes, keeping an eye on the fire.
- Work together with manual tools and without mechanization, and use green fertilizers and green pesticides.
- Use different local varieties of rice, including glutinuous rice.
- Follow fallow and rotation principles to let the soil recover and maintain fertility.

5. Intensification of the fallow phase

5.1 Two intensification pathways

More intensive use of plots can increase the total output per ha from shifting cultivation, trending toward permanent cropping with annual food crops, but there may be diminishing returns on labour. Intensification can also cause land degradation and abandonment, as indicated by the interrupted arrows in Figure 15. Agroforestry options and systems based on tree crops can allow high total output per ha with annual food crops grown at low intensity (van Noordwijk et al. 1996).

5.2 Nutrients

Farmers have relied on swidden systems with long fallow periods to produce food crops for their subsistence. The system is ecologically stable only under very low human population density. In recent decades, however, rapid population growth, escalating market demand for agricultural produce, and government policies encouraging land development and settlement have transform swidden into more intensive land-use systems (Myers and De Pauw 1995). The transition has caused negative balances in nutrients because mineral nutrients lost during cultivation can no longer be restored by the shorter bush fallow period (Juo and Manu 1996). The current focus is on how to assist the remaining swiddeners in their adoption of more intensive farming.

Many farmers still use slash and burn to clear the land despite the government's promotion of zero burning. From the study in Sumatra, Ketterings et al. (1999) reports that farmers' preference for burn is because it

1. is a fast and efficient way to clear forest;
2. can suppress weeds and other wild vegetation, especially early in the cycle after planting;
3. turns biomass into a useful natural fertilizer;
4. loosens and crumbles the soil, allowing seedlings to become established quickly; and
5. Is an effective way to kill pests and pathogens (Figure 16).

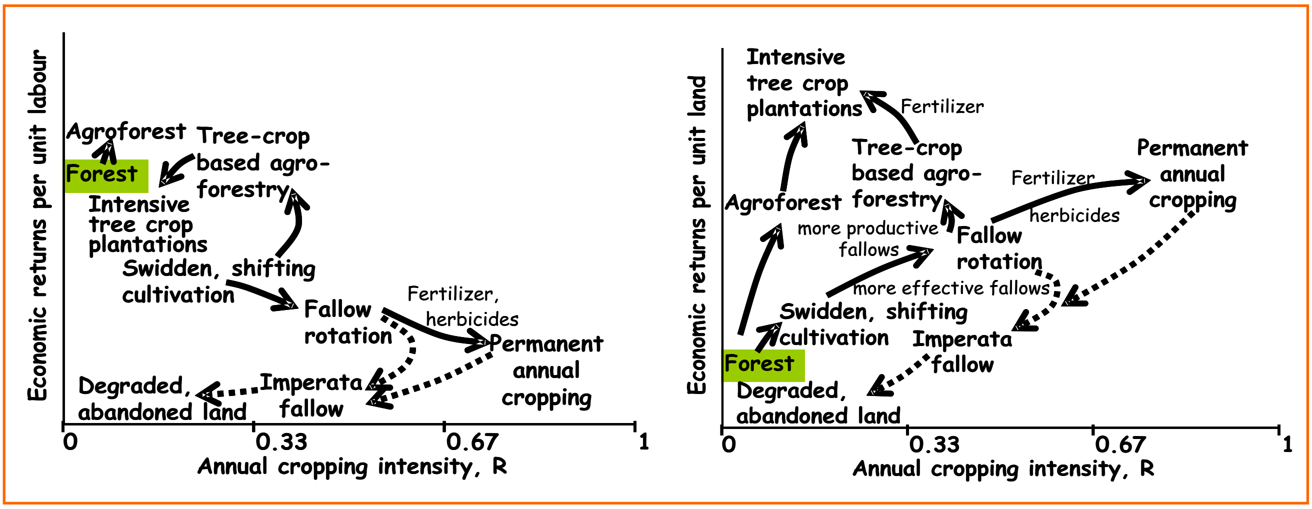

Figure 15: Schematic relationship between the intensity of annual cropping (Ruthenberg's R) and the total economic returns per unit of labour (left) and land (right). Positions of the land-use systems are approximate and depend on the relative value of forest products and annual food crops (van Noordwijk et al. 1996)

5.2.1 Nutrient accumulation during the fallow period

The fallow accumulates mineral nutrients from the soil into the fallow bush and forest biomass. The accumulation of nutrients in plant biomass is affected by soil fertility and crop species. When compared, relatively fertile Inceptisol soil accumulated considerably more nutrients than the less fertile Oxisol (Table 5). A 2-year *Piper aduncum* fallow accumulated twice as much nitrogen (N), three times as much phosphorous (P), almost seven times as much potassium (K) and twice as much calcium (Ca) and magnesium (Mg) than did a 2-year *Imperata fallow*. Table 5 also shows a trend of progressively reduced recovery of the total nutrient stock than occurs in the original primary forest because of the loss of mineral nutrients during burning and cultivation (Juo and Manu 1996).

5.2.2 Fire effects on nutrient supply

Burning converts vegetation biomass into a layer of nutrient-rich ash on the soil surface, and rainfall and cultivation incorporate these nutrients into the soil (Nye and Greenland 1960). Along with the incorporation, changes in surface soil chemical properties take place, including an increase in soil pH and nutrient availability. Heat also affects soil fertility but the effect is hypothesized as smaller than the ash effects (Giardina et al. 2000a).

Besides supplying nutrients, burning paradoxically causes significant, and seemingly the greatest, nutrient loss of any forest disturbance (Dechert et al. 2004). Fine plant materials such as leaves, twigs and small branches contain higher nutrient concentrations than do larger branches, trunks and stems. These fine materials dry quickly following the slashing of forest or fallow vegetation and are the components most readily burned (Kauffman et al. 1993). The percentage of nutrients above ground that were returned to the soil as ash are, on average, 3% of N, 49% of P, 50% of Ca and 57% of K (Giardina et al. 2000a; comparison of Table 6 and Table 5).

Biomass burning causes rapid increases in soil pH, available P, exchangeable bases and cation exchange capacity (CEC) in surface soils (Table 7). In acid soils, ash reduces the level of soluble and exchangeable aluminium (Al) (Andriesse and Schelaas 1987; Sanchez 1976). The chemical composition of the ash and inherent soil fertility determine the changes in soil chemical properties. On acid soils, these changes are very beneficial in increasing the CEC, but this increase is usually short lived, as the cations can easily be lost through leaching, crop removal and erosion, perhaps leaving the soil to acidify again (Figure 17, Table 8) (Juo and Manu 1996).

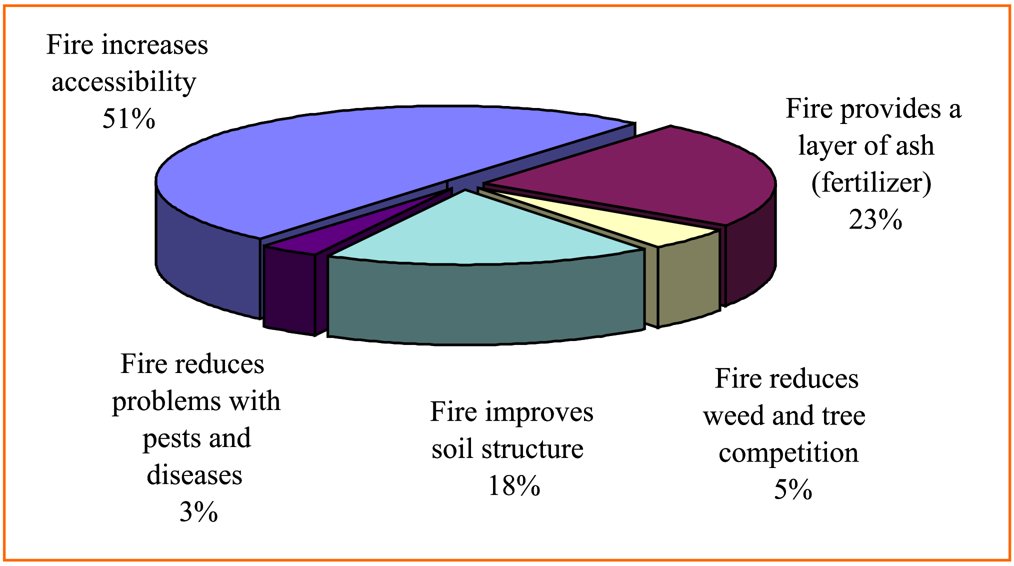

Figure 16: Reasons for using fire to clear land, as reported by small-scale rubber farmers in Sepunggur, Sumatra; modified from Ketterings et al. (1999).

Table 5: Nutrient content in the biomass of secondary forest and fallow plants

Site description	Nutrients (kg ha^{-1})			
	N	P	K	Ca+Mg
Secondary forest, Nam Phrom, Thailand; Inceptisol; annual rainfall 1500 mm (Kyuma et al. 1985)	1567	195	755	3784
Secondary forest, San Carlos de Rio Negro; Oxisol (Uhl and Jordan 1984)	1722	51	300	332
2-year fallow of *Piper aduncum*, Papua New Guinea; rainfall 3000 mm (Hartemink 2001)	222	50	686	255+75
1-year fallow of *Gliricidia sepium*, Papua New Guinea (Hartemink 2007)	356	36	248	312+64
2-year *Imperata* grassland, Papua New Guinea; rainfall 3000 mm (Hartemink 2001); data approx. from graph	100	15	100	85+40
1-year *Imperata* grassland, Papua New Guinea; rainfall 3000 mm (Hartemink 2007)	76	12	89	222+41

Table 6: Estimated nutrient inputs (kg ha^{-1}) from ash at different locations

Sources	N	P	K	Ca	Mg
Yurimaguas, Peru, secondary forest (Sanchez 1976)	3	10	76	730	66
Nam Phrom, Thailand, secondary forest (Kyuma et al 1985)	67	72	455	3373	288
Lua, Thailand (Zinke et al. 1978, cit. Giardina et al. 2000b)	10	nd	24	56	7
Para, Brazil. 7-year-old bush (Mackensen et al. 1996, cit. Giardina et al. 2000b)	5	3	22	112	15

nd: not detemined

Table 7: Changes in soil fertility before and 1 month after burning at selected sites (adapted from Kyuma et al. 1985, Juo and Manu 1996, Giardina et al. 2000a).

Site	Time	pH	Available P (mg kg^{-1})
Nam Phrom, Thailand, secondary forest	Before	6.2	1.4
	After	7.2	7.7
Nam Phrom, Thailand, old forest, 0 5 cm	Before	6.3	3.3
	After	7.2	44.4
Lua, Thailand, secondary forest, 0 5 cm	Before	6.0	2.0
	After	6.7	10.0
Yurimaguas, Peru, primary forest	Before	4.0	12.0
	After	4.7	23.7
Mexico, primary forest, 0 2 cm	Before	6.5	7.0
	After	8.0	32.0

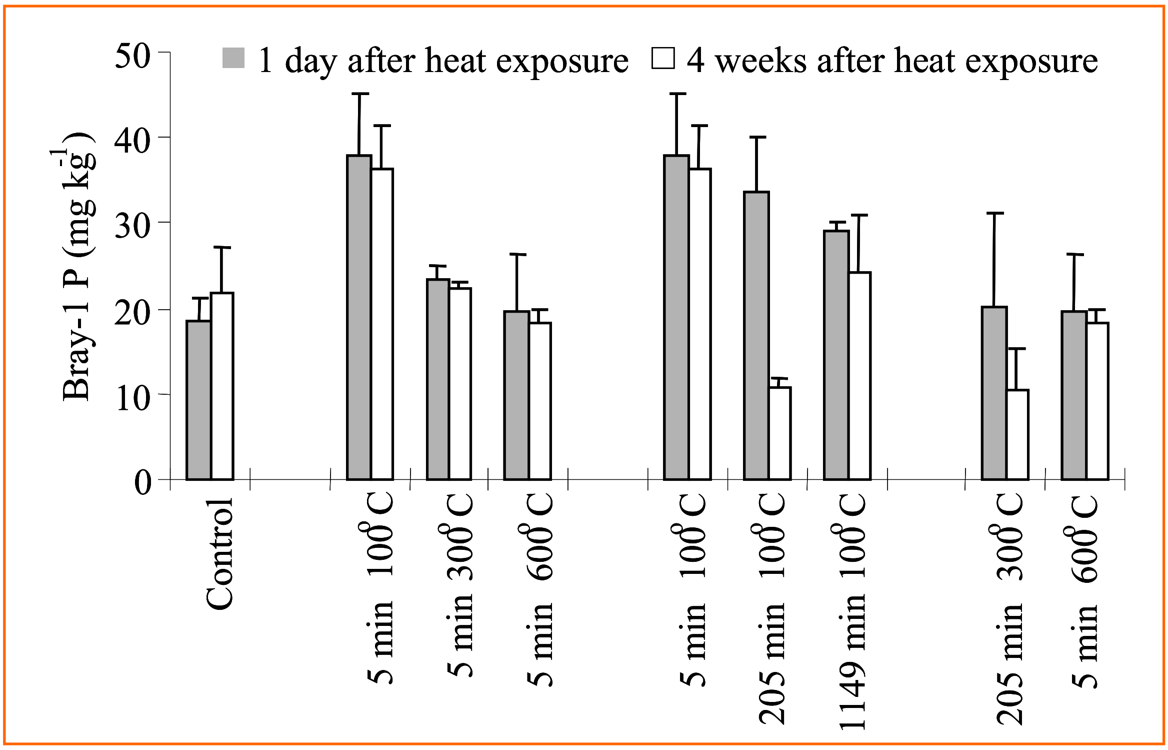

Figure 17: Effect of oven heating (for a variable number of minutes (min) in ovens maintained at various temperatures) of unburned forest soil (0-5 cm) on Bray-1 P 1 day and 4 weeks after exposure. Standard errors of difference are 5.1 for 1 day and 3.6 for 4 weeks. Error bars represent standard deviations. Modified from Ketterings et al. (1999).

Table 8: Soil chemical properties at a secondary burn site with and without ash addition; cations are measured in centi-mol of charge, $cmol_c$ per kg of dry soil

	C	N	Bray-1 P	Exchangeable cations						$Al_{sat.}$	pH_{H2O}
				Ca	Mg	K	Na	Al	Σ		
	|---g kg^{-1}---|		mg kg^{-1}	|----------------$cmol_c$ kg^{-1}--------------|						%	
Before burn	53.8	4.2	36.6	1.2	0.6	0.3	0.05	3.5	2.2	55	4.2
2 wks after burn:											
without ash	48.2	4.7	59.1	1.4	0.6	0.4	0.06	1.6	2.6	34	5.2
with ash	50.4	4.6	78.2	4.3	3.5	2.4	0.11	0.4	10.3	4	6.0
s.e.d.	6.8	0.5	11.0	0.5	0.4	0.3	0.01	0.4	1.1	6	0.3
8 wks after burn:											
without ash	49.1	4.6	46.7	2.4	1.2	0.2	0.01	1.0	3.9	18	5.3
with ash	41.6	4.8	53.8	3.8	2.4	0.7	0.02	1.5	6.9	22	5.7
s.e.d.	3.5	0.6	12.6	1.3	0.8	0.2	0.01	0.7	2.3	12	0.4

Σ = sum of bases (Ca, Mg, K and Na), Al_{sat} = aluminium saturation (% of the total amount of exchangeable bases including Al and H), s.e.d. = standard error of

Box 9: Is it the ash or the heat that increases soil fertility?
(Based on Ketterings et al. 1999)

When forests are converted into agricultural fields, especially when fire is used to clear land, part of the P in the vegetative biomass is lost as particulates are carried into the atmosphere and deposited beyond the burning field, contributing to the fertility of neighbouring sites. The remainder is initially deposited on top of the soil as components of the ash or partly burned organic material. Some of the ash may be lost from the site through erosion, accumulating in terrestrial or aquatic sedimentation zones, while the remainder will enter the soil. Fire may also release P from various soil pools. As organic matter burns, microbial biomass is killed, resilient organic P forms mineralize, and occluded inorganic forms may become more available. Phosphorus that enters the soluble P pool may be taken up by plants, chemisorbed to the surfaces of iron (Fe) and Al oxides, or retained and stored as relatively insoluble Al and Fe phosphate precipitates. The overall effects of fire on the soil P status reflect the combination of inputs from aboveground biomass and the effects of heat and ash on existing soil P pools. These effects should be understood and addressed in the development of successful alternatives to slash and burn on the P-deficient Oxisols of Sumatra.

Most studies have credited the apparent increase in soil fertility to ash addition per se, but our field study in Sepunggur– where a pile-and-burn fire with ash addition was compared to a similar fire in which the ash was blocked from entering the soil by zinc plates –showed that direct heat exposure caused an increase in Bray-1 P accompanied by a reduction in Al saturation and a pH increase 2 weeks after the burn. Eight weeks after the burn, Bray-1 P levels were still elevated, but differences were no longer significant. Carbon (C) and N contents remained unaffected by the ash and the heat, except for a reduced C level in the ash addition treatment 8 weeks after the burn. Ash addition was responsible for gains in exchangeable bases 2 weeks after the burn (Table 6 and Table 8). Eight weeks after the burn, exchangeable base levels for the ash treatment were still elevated but no longer significantly different from preburn levels. An oven experiment in which unburned forest soil 05 cm deep was exposed to static heating revealed that short-term heating, for 0 and 205 minutes at 100°C, increased Bray-1 P levels, but heating at higher temperatures or a long, 1149-minute exposure at 100°C resulted in a smaller increase or even a decrease in Bray-1 P (Figure 17). Field experiments in Jambi (Ketterings 1999) showed that high-intensity fires of >500°C caused net losses in available P, measured as Bray-1 P. Medium-intensity fires of 250-500°C led to a small gain in Bray-1 P, while low-intensity fires of <250°C resulted in large increases. Ash addition was responsible for the increase in available P directly following the low- and medium-intensity burns, but at high intensity the positive effects of ash addition were outweighed by the negative effects of direct heat exposure.

5.2.3 Nutrient removal and dynamics during cultivation

Swidden crop cultivation takes advantage of the nutrients supplied by burning and from the soil nutrient reserve. On less fertile soils, the cropping period lasts only for 12 rice crops, and a 7-15 year fallow is needed to restore soil fertility for supporting the following crop. On more fertile soils such as in Sulawesi, soil fertility could be maintained at a reasonable level for 4-5 years of crop production (Dechert et al. 2004).

The amount of nutrients that typically accumulated in rice grain and straw, fresh bunches of oil palm, and rubber latex is presented in Table 9. For rice, crop removal at harvest may include both the grain and straw or just the grain, with farmers leaving the straw to decompose on the soil surface or burning it. The removal of straw affects K and Ca balance in acid, low-CEC soils because of the high concentration of these nutrients that it contains. Under continuous cultivation, about the same amount of nutrients removed during harvest need to be replenished to maintain the total nutrient stock of the system.

N and P are concentrated in the rice grain. In most areas, regardless of straw management, substantial amounts of P and N are removed. Their replenishment during the fallow period is thus the key to successful crop production.

When the system transforms into permanent agriculture, the use of organic matter, inorganic chemical fertilizers or a combination of both are necessary to support satisfactory crop production (Juo and Manu 1996, Sanchez 1976, Cramb 2005). In many cases, especially on sloping upland, the use of a shrub hedgerow is recommended to control erosion (Agus et al. 1997 and 1999). This is less important on flatlands, as the cost of hedgerow establishment and maintenance cannot be offset by nutrient recovery (Lal 1991)

In general, we can conclude that traditional swidden systems inherently supply enough nutrients to support crop production. However, at the same time, burning the biomass under the slash-and-burn system volatilizes substantial amounts of nutrients, especially N and P. As the fallow period shortens, the systems suffer negative nutrient balance, requiring external inputs. Various managed-fallow systems alleviate the systems' dependence on external inputs..

Table 9: Selected nutrient element contents in harvestable products

	Nutrient content (mg g^{-1} harvestable product)					
	N	P	K	Ca	Mg	S
Rice grain	15.0	2.8	3.8	0.3	1.0	0.8
Rice straw	7.5	0.5	23.3	2.5	1.5	0.3
Oil palm	3.0	0.6	4.0	0.6	0.9	0.6
rubber	20.0	5.0	25.0	4.0	5.0	2.0

Source: Adapted from Dierolf et al. 2001.
Note: Estimated yields of rice grain is around 4-6 t ha^{-1} yr^{-1}; rubber 1 t ha^{-1} yr^{-1}; and fresh fruit bunch (TBS) of oil palm 15-25 t ha^{-1} yr^{-1}.

5.3 Imperata as a sign of overintensification

Imperata cylindrica ('alang-alang' or 'cogon grass') is an efficient colonizer of open spaces on a wide range of soils. Once it has established its rhizomes, the grass is tenacious and can survive repeated fires, which usually do not kill the growth tips of the leaves at the surface level. Even if they do, *Imperata* still has the capacity to regenerate from buds on rhizomes in deeper soil layers and establish ground cover again before most other plants. This capacity to rapidly regenerate from rhizomes allows the grass to survive soil tillage, unless a repeated cycle of ploughing, drying the soil and reploughing is used. The ecological success of *Imperata* has given it a reputation as one of the world's 10 worst weeds, even though it provides cover to soils that otherwise would become badly eroded. While fast-growing leguminious cover crops such as *Mucuna pruriens* can allow initial control, they may not provide enough sustained shade to reduce the vigour of *Imperata* rhizomes (Hairiah et al. 1993).

The first steps in controlling *Imperata* in the agroforestation of grasslands can be achieved by either mechanical or chemical control. Farmers employ a herbicide, soil tillage or 'pressing'[4], depending on their resources and the current cost of the technique (Purnomosidhi et al. 2005). Food crops can be grown within the first few years of planting most tree crops or agroforestry systems to maintain income and pay for the suppression of Imperata regrowth. However, the gap between the last food crop interplanting and canopy closure creates a major risk of *Imperata* regrowth and fire occurrence.

Four aspects of Imperata can influence the growth and performance of trees, though other mechanisms remain debated in the literature:

1. Light capture by grass 12 m high affects small trees.

2. The grass's capture of water and the nutrients N, P and K reduces what is available for trees. Nitrogen concentration in the foliage is quite low, such that the competition for N not excessive. The subsequent decomposition of Imperata leaf and root residues involves microbes' immobilizing mineral soil nitrogen, further depleting generally poor soils.

3. Fire is a risk in dry periods, as the dry biomass above ground is a well-connected, well-aerated fuel that readily burns and spreads. While Imperata itself survives such fires, and may benefit from their nutrient mobilizing before other plants respond, trees' survival depends on their size, the height above the ground of the growing tips, the thickness of the tree bark that protects lateral buds, and such qualities of the fire as the height of the flames, the temperatures reached, and whether or not the fire spread to the tree crown.

4. The roots and rhizomes of *Imperata* release organic compounds that inhibit the germination and early growth of many plant species. These compounds tend, after the establishment phase of other plants, to stiffen N-immobilization in *Imperata* soils. Enriching the soil with nitrogen can alleviate this allelopathic effect.

Fire is, in practice, the most problematic consequence of the presence of Imperata in agroforestry systems, because a single fire can destroy several years' investment in establishing trees. Control of Imperata is thus an important prerequisite for tree establishment. Four types of control have been developed in practice:

1. **Mechanical control.** Soil tillage that exposes the rhizomes to the sun and dries them out has to be repeated several times to be effective, as some of the rhizomes may survive below the usual depth of hoeing or animal-drawn ploughs. Mechanized ploughing can reach the required depth.

2. **Herbicide**. The most popular and cheapest herbicide is currently glyphosate, which is available under a range of trade names.

3. **Pressing**. Pressing the biomass above ground has a remarkable slowing effect on regrowth through mechanisms that are not fully understood. The technique can be used selectively around newly planted trees (Murniati 2002).

4. **Shade**. Shade reduces the growth rate and, in combination with removing the biomass above ground,

[4] Farmers press *Imperata* low to the ground by trampling on it or rolling a weight, such as a log, over it, thereby reclaiming the land or preventing fire (Friday et al. 1999).

gradually depletes the rhizomes' capacity for regeneration (Purnomosidhi et al. 2005). *Imperata* biomass decreases drastically when relative light intensity of 20% was reached. When more than 20% of sunlight reaches the ground, *Imperata* still has a chance in agroforestry systems.

In practice, a combination of these techniques has to be used at the various stages of a developing agroforestry system:

1. Land preparation for food crops uses tillage, herbicides or preferably a combination.
2. At the stage when there is too much shade for profitable intercropping but too little shade to control *Imperata*, a combination of the pressing and selective herbicide use is effective.
3. Farmers can rely on shade-based control once canopy closure has reduced light at the ground level.

Van Noordwijk et al. (2008b) discuss how the length of the period described in 2 above depends on the growth rate and planting pattern of the trees.

5.4 The 'fallows' may become the primary source of cash

Pure subsistence systems hardly exist anymore, as most forest dwellers and farmers have at least some economic exchange with the outside world. But the transition to fully market-integrated systems tends to be gradual, adding a cash crop such as rubber or rattan to the existing system. Swiddens are often used to grow rice only for local consumption, not for sale, but growing enough food often conveys social status beyond the direct financial benefits. Elmhirst (1997) reported how Way Kanan villages in North Lampung interacted with nearby transmigration villages, allowing people to buy rice without being seen by their neighbours to do so. In Kasepuhan, West Java, the swidden system still plays an important role in social status, as people are not considered wealthy or of high status if they do not have a swidden plot (Galudra 2003b). One workshop participant from Rimbauan Muda Indonesia, an organization of women foresters, who was also a Kasepuhan community representative, said:

> Huma atau ladang mempunyai arti penting bagi masyarakat Kasepuhan. Padi ladang itu simbol kesejahteraan masyarakat, karena itu padi ladang tidak boleh diperjualbelikan. Masyarakat percaya jika melanggar aturan ini maka mereka akan terkena bencana.
>
> (Upland fields are very important for the Kasepuhan community. Upland paddy plays an important role as a symbol of wealth for the community, so selling or buying any kind of upland paddy is not allowed. People believed a calamity will befall them if they break the rule.)

In some parts of Indonesia, swidden fallow systems became enriched with fruit trees, rubber trees and rattan. The economic lifespan of rubber trees–about 30 years, but depending on the tapping regime–then determines the fallow length (Penot 2007, Cramb 1993). Farmers plant rubber soon after the first rice crop and may obtain rice yields for 2 seasons. In swidden-based rattan cultivation, farmers plant rattan seeds almost at the same time as they plant rice. While the field is used for rice cultivation, the rattan seedlings are protected. Rattan gardens established in a swidden system need little maintenance, just slashing undergrowth and killing some trees (Sasaki 2007). After rice cultivation, this area slowly reverts to secondary forest, and farmers wait for the rattan to grow. They generate cash income from the rattan during the forest fallow period (Belcher 2007).

The transition to reliance on cash as the basis of food security tends to have ups and downs. Prices for export crops may follow boom-and-bust cycles, pests and diseases may catch up with widespread cultivation of a cash crop, or the urban economy may hit a slump or suffer from a global recession. Suddenly, growing one's own food has direct survival value, and one can be thankful for a local tradition that valued it. Interestingly, in the transition of much of the lowland forest area of Sumatra and Kalimantan to rubber-based livelihoods, the relevance of maintaining swiddens was recognized (Sulistyawati et al. 2005). In the local tradition, planting trees secures land tenure, so the common pool of land for swiddens reduced when rubber was planted and locked land up in a long production cycle. Many villages established rules that forbade planting trees on the remaining land available for swiddens to keep this communal land, or 'sesap nenek' (Box 10), available for local food production. Given the economics of it, only the poorer members of the community found this an interesting option, and the institution became a social safety net.

Suyanto 1999 found the individualization of the land tenure institution to be common in the area, particularly for rubber plots and bush and fallow plots. Collective ownership by the extended family evolved into individual family ownership, and the matrilineal system of inheritance to daughters evolved into the bilateral system to daughters and sons alike. However, ownership of upland paddy is the least individualized, and joint family ownership still prevails in many areas (Table 10).

Box 10: Evolution of swiddens and jungle rubber systems in Jambi

Several phases can be recognized in the transformation process of shifting cultivation in Jambi. Shortly after Jambi province was brought under Dutch colonial control in the early 20th century, the first para rubber (*Hevea brasiliensis*, derived from Para state in the Amazon) was planted close to Muara Bungo. The rapid growth in global demand for rubber during and after World War I (1914-1918) brought a rapid expansion of rubber to virtually all farms along the Batang Hari river. The area could afford to import rice, as the rubber price was high. Chinese entrepreneurs who controlled the processing plants provided free seed to increase rubber production. According to some accounts, rubber seeds were catapulted into secondary forests, bypassing the rice swidden stage. A situation was rapidly reached in which there were more trees than could be tapped, and the area attracted labour from the highlands, where coffee production was less interesting at that time, and from Java, including contract labour migrants returning from North Sumatra who decided to stay in Jambi on their way through. With various ups and downs in price, rubber remained the mainstay of the rural and urban economy in Jambi. The construction of the Trans-Sumatra Highway, logging concessions and transmigration programs brought more people into the area and provided opportunities for expanding rubber. Planting rubber trees was sufficient to claim land in the local tradition, even if few trees survived, and local claims on land carved up the area. Many newcomers, without a local right to swidden systems, were employed as share-tappers of jungle rubber. During the 1990s the rubber price fell, and upland rice production regained importance, but only few people planted upland rice without rubber (Penot 2007).

Previous surveys found that jungle rubber trees stayed in production for a mean of 27.9 (± 3.9) years, of which only 14.8 years yielded stable production. The initial 2.7 years of the 'learning stage' and the remaining 10.4 years of post-stable production yielded less latex. The average age of rubber agroforest plots when they stopped being tapping was 39.8 (± 3.8) years, and they were left untapped for 3.9 years. However, 48% of plots were still under production. The average period of abandonment for actually abandoned plots was 9.0 (± 1.9) years, with a maximum of 19 years. It was interesting to note that all plots over 60 years old were still under production at the time of clearing, but that plots much younger but still in production were also cleared (Joshi pers. comm.).

The existence of communal land management, whereby households are given access to land where they can return to paddy cultivation but still produce some of their food and medicine from fallow products, is probably the most important part of the social safety net in Muara Bungo. In the foothills of the Kerinci Seblat National Park in the Rantau Pandan valley, as well as in the lowland peneplain, villages developed regulations that reserved some land, locally known as 'sesap nenek', for swiddening; without the right to plant trees the fallow land returned to the communal pool of land and became a safety net for the poorer households.

Rantau Pandan village, for example, has 800 ha reserved as sesap nenek on land that is relatively fertile but a 1-2 hour walk from the village centre. The village leader decides on requests from the local community to open plots. No tree crops are allowed on the communal lands, and land cannot be sold, pawned or inherited. Generally, one household is able to cultivate about 1-2 hectares of upland rice per year on this land with shifting cultivation.

Table 10: Tenurial system on Muara Bungo, Jambi

Land tenure	Performance
Communal or sesap nenek	Bush fallow, used only for rice cultivation
Joint family	Usually upland area used for rubber
Single family	Wet paddy (inherited along the female line), rubber, oil palm, bush fallow

Box 11: Emergence of sisipan and slash-and-mulch regeneration of rubber agroforests without upland rice

At the start of rubber expansion in Sumatra around 1920, rubber came in as an enriched fallow tree in systems driven by upland rice production (see Box 10). But the economic results of the emerging rubber agroforests made the tree phase of the system more important than the crop phase.

With the 1990s ban on the use of fire for slash-and-burn clearing, farmers in Rantaupandan, Jambi, now rely on a slash-and-mulch system to clear land, letting the trees decompose where they fall and planting large rubber saplings among them (Figure 18). The benefits are young rubber's decreased exposure to pigs, which are the main pest, and avoiding the problems of smoke and haze. A drawback is this disappearance of upland rice from the rejuvenation stage, leaving people fully reliant on the market or on paddies operated by women on land with use rights inherited by either a matrilineal or mixed system.

Figure 18: In the late 1990s, rubber farmers in Bungo, Jambi, started to use large rubber planting material for slash-and-mulch and patch-level ('sisipan') type rejuvenation of their rubber agroforests. A market developed rapidly for seedlings collected as wildlings in grafted clonal rubber plantations at some 50 km from the site. These bare-rooted and leafless saplings, 2-4 cm in diameter and 2-3 m tall, are rehydrated in streams and planted after buds are seen to swell.

5.5 Fallow management network experience

When the swidden system transforms into a more intensive one, negative nutrient balances in the soil tend to increase (Juo and Manu 1996) because of burning, harvesting, leaching and erosion. New fallow systems are therefore needed, often involving more careful management of the fallow phase. The range of managed fallow options, described in Cairns (2007) and elsewhere, include using *Chromolaena odorata* (Roder et al. 2007), *Piper aduncum* (Hartemink 2007), *Leucaena leucocephala* (Agus 2007, Piggin 2007, MacDicken 2007). The more complex systems are discussed by Lawrence et al. (2007) and Wadley (2007).

In the case of leucaena fallow in South Sulawesi, Agus (2007) suggests planting leucaena in contour hedgerows to control erosion more effectively under the more intensified system.

6. The fallowcrop transition in the landscape

6.1 Fire and smoke issues

Historical records show that episodes with thick smoke blanketing areas of Indonesia occurred hundreds of years ago, but the forest and peat land fires of 1986 and 1997/1998 became notorious for the smoke and haze they produced. In the political climate of 1986, all the blame was put on the 'slash-and-burn farmers'. In 1997/1998, the role of plantation companies was openly discussed, and there was some recognition that fire was used as a weapon in conflicts over land (Tomich et al. 1998). With better remote sensing and the availability of 'hot spot' data that can view fire locations at night, the blame game has changed considerably. The locations of fire become known, and concession holders are held responsible for the area they supposedly manage. Well-managed swidden fires that are extinguished before nightfall can still escape notice.

The response to the issue of smoke and haze can be differentiated by type of concern. The direct health impacts of the haze, and low visibility and interrupted air traffic, are mostly caused by peat land fires that do not get very hot but smoulder for a long time. Concerns over greenhouse gas emissions depend on the temperature of the fire, with cooler, wetter fires producing methane, which has a much greater greenhouse gas effect than CO_2. Where the concern is loss of biodiversity and terrestrial carbon stocks, the nature of the fire does not really matter. For some environmentally concerned stakeholders, efforts to obtain more controlled burning tackle only the symptoms and not the cause of the problem, but others consider it a real solution.

6.2 Hydrology

At the landscape scale, the swidden system maintains a portion of land well covered by vegetation. This helps to reduce surface runoff and thus regulates stream flow. In a study in Southeast Asia, Bruijnzeel (2004) demonstrated that the threshold for a significant increase in stream flow is when more than 30% of forest vegetation is removed from the landscape. The wet season peak flow increases dramatically with the decrease in land cover. The dry season base flow also increases, though at a lower rate than the peak flow (Figure 19). However, Ziegler et al. (2007) demonstrated that, as the proportion of quick flow increases as a result of vegetation removal, the proportion of deep percolation and thus base flow decreases (Figure 19). This causes more severe droughts downstream.

This finding in relatively small catchments was not reflected in large river basins. Wilk and Anderson (2001), studying the 12 100 km^2 Nam Pong catchment in northeast Thailand, did not detect changes in water flow despite the reduction in forest cover from 80% in 1957 to 27% in 1995.

6.3 Erosion and sedimentation

A study of steep uplands in Vietnam revealed that under the continuous cultivation of upland rice or cassava, the amount of soil lost was consistently high at more than 30 mg per ha per year. However, under swidden farming, high soil loss was observed in the first year (cultivation) and the second year (first year of fallow). In the following fallow years, soil loss was essentially zero (Table 11).

A long-term analysis of soil surface subsidence (Figure 21) in Vietnam was consistent with Table 11. Before collectivization, when the fallow was a relatively long 15 years and rice cultivation was a short 2 years, the rate of soil loss was relatively low. In the postcollective period, starting in the late 1980s, soil loss accelerated.

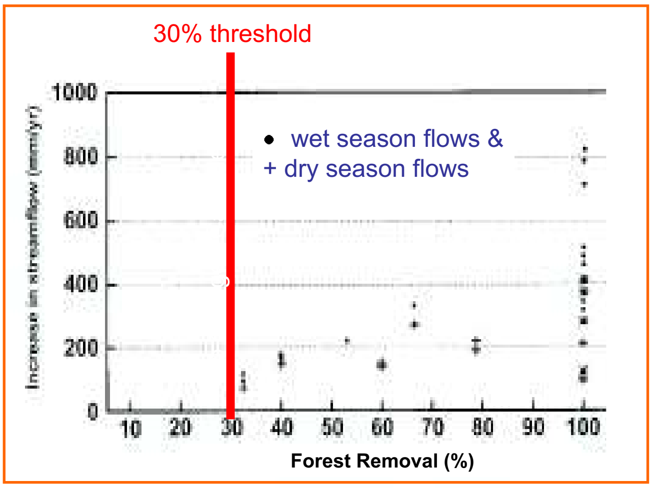

Figure 19: Increase in stream flow as a function of forest removal (Bruijnzeel 2004).

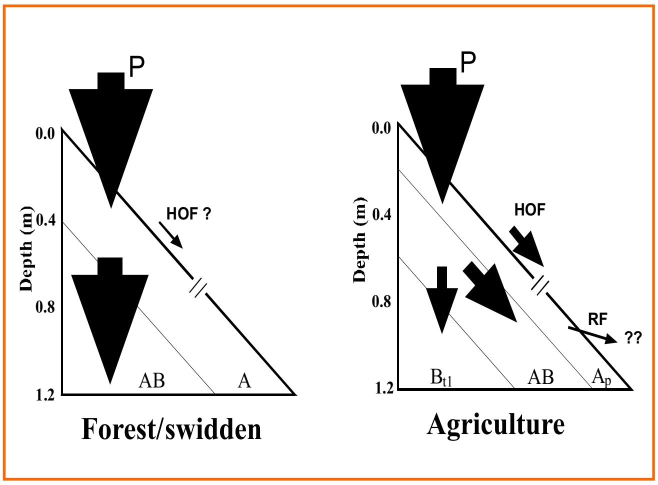

Figure 20: Schematic representation of precipitation (P) partition into deep percolation, lateral flow, Horton flow (HOF) and return flow (RF).? refers to the insignificance of the flow component (Ziegler 2007).

Table 11: Soil loss under upland rice, cassava and swidden on 0.81.2 m m-1 in Da Bac Tay, Vietnam

Land use	Year	Water erosion ($Mg\ ha^{-1}$)	Tillage erosion ($Mg\ ha^{-1}$)
Upland rice	1st	69	6
	2nd	72	6
Cassava	1st	39	4
	2nd	35	4
Fallow	1st	92	0
	2nd	39	0
	3rd 15th	0	0

Source: Ziegler 2007

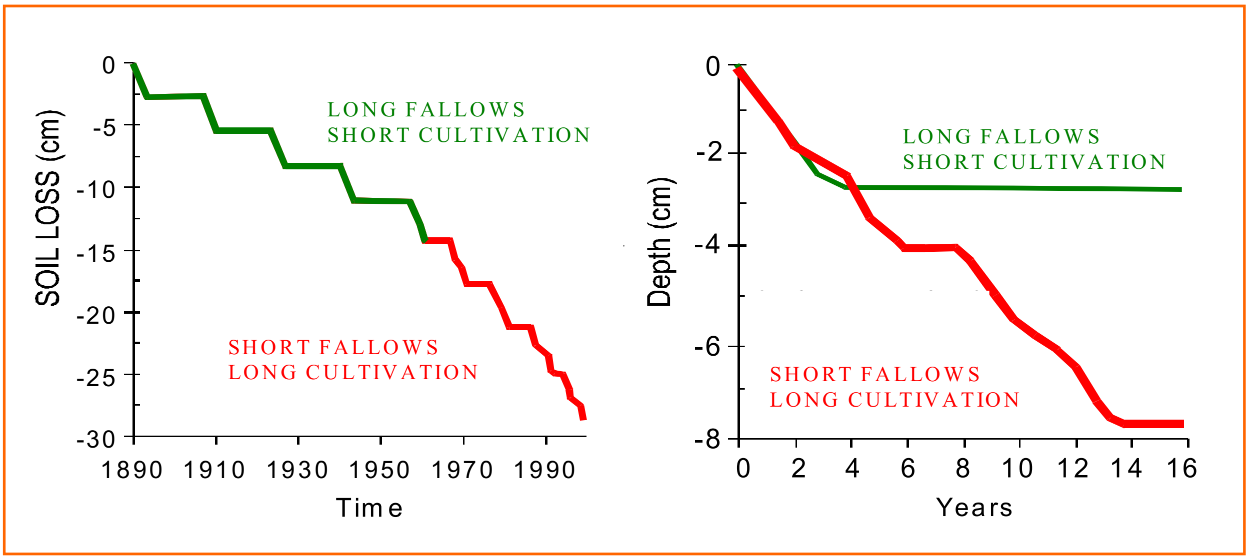

Figure 21: Change in soil surface as affected by erosion under long fallow (black line) and short fallow (red line). At left, notice the slow reduction in soil surface prior to 1960, when the fallow was long, and more rapid change afterwards, which coincides with fallow shortening. The figure on the right shows rapid soil subsidence in the first 4 years after cultivation but almost no change during the long fallow. Under short fallow, however, erosion became negligible, as indicated by the flat line, after more than 5 years of fallow.

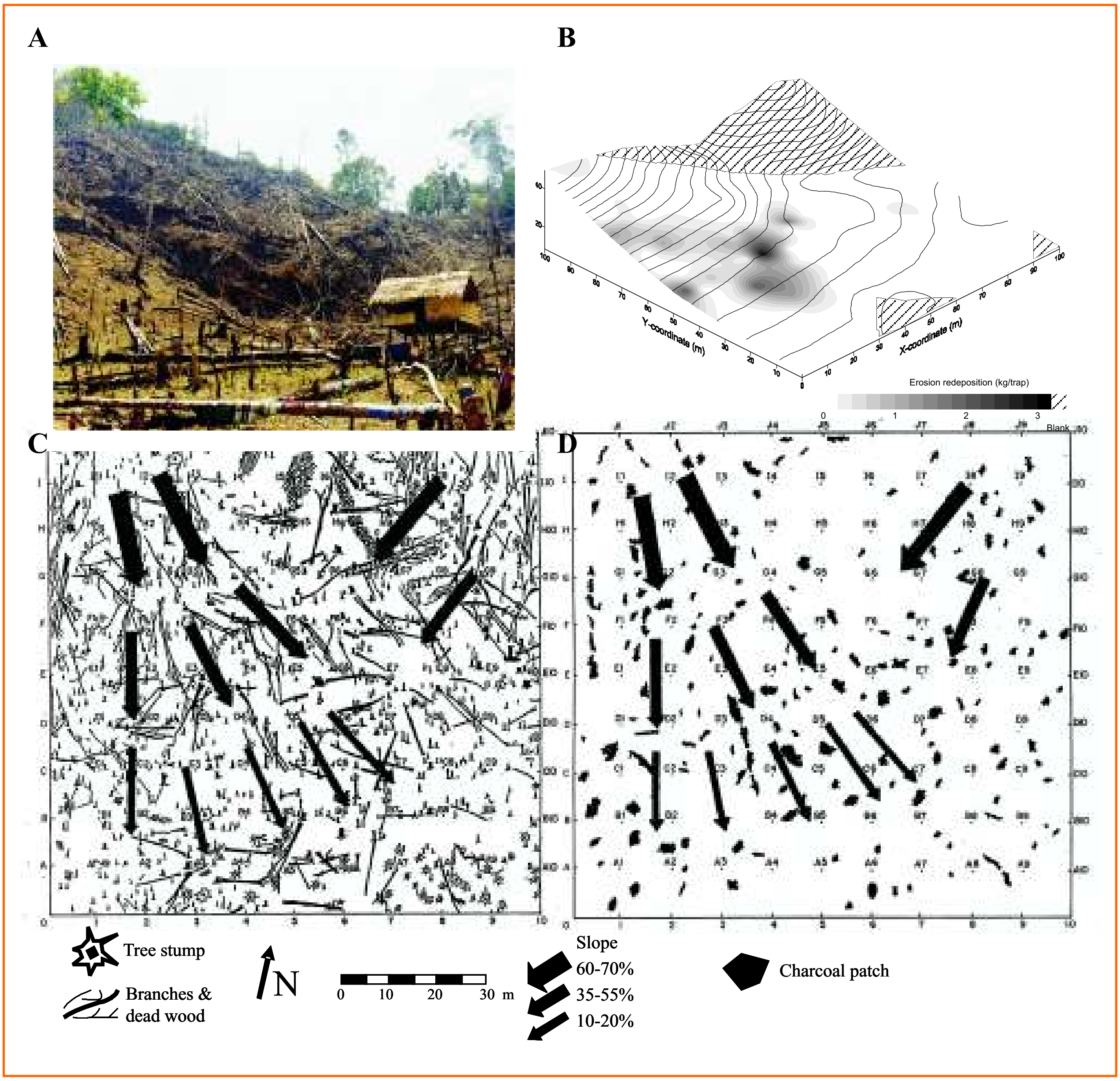

Figure 22: Quantifying erosion and the movement of surface material on a steep slope cleared by slash and burn for planting rice + rubber in Rantau Pandan, Jambi (A); C and D show the orientation of felled logs and major charcoal patches relative to the main direction of overland flow on a steep hill cleared for planting rice + rubber in Rantau Pandan. Using a simple system of collecting sediment from the overland flow, researchers were able to map the local sediment flows and areas of deposition (B). Source: Rodenburg et al. 2003 and unpublished field maps.

Box 12: Process of soil movement on slash and burn

Jonne Rodenburg and Cahyo Priyono quantified the process of soil movement following land clearing for new rubber + rice planting in Rantau Pandan, Jambi, Sumatra (Figure 22). Slash-and-burn land clearing on sloping land may cause increased soil runoff following the disappearance of protective vegetation. Soil runoff and deposition affects soil fertility and spatial patterns of fertility parameters in a field. This study seeks to clarify the role of spatial patterns of postburn dead biomass (necromass) in soil runoff and deposition and their combined effect on spatial patterns in soil pH and resin-extractable P. The study is carried out on a postproductive rubber (*Hevea brasiliensis*) agroforest. Soils are classified as Dystric Fluvisols. After slash and burn, the field was planted with rubber seedlings and rice. For comparison, the adjacent rubber agroforest site was sampled. Soil runoff is expressed here as the quantity of downward-moving soil that passed the specific location of a flow trap. Existing physical soil runoff barriers and crop performance were scored. Despite serious soil runoff from the steeper upper slopes, little soil was actually lost because of the sloping form of the field, presence of natural soil runoff barriers, and planted crop. The spatial variability of soil pH decreased at the expense of small-scale, within-strata variability mainly because of the patchy distribution of soil runoff barriers. Soil runoff, aggravated by slash and burn, did not develop a clear soil-fertility gradient down the slope. In areas of high soil runoff potential, clear burns should be avoided because soil runoff barriers like remnants of slash and burn and surface litter maintain the soil and its fertility. Source: Rodenburg et al. 2003

6.4 Biodiversity and carbon stocks

6.4.1 Carbon stocks

Carbon content in the soil is an indicator of soil fertility. Sequestration of atmospheric carbon dioxide in plant tissues and soil organic matter is an important factor affecting greenhouse gas concentration in the atmosphere. High carbon stock in the soil and plant biomass is an indicator of effective sequestration.

The transition from forest to swidden and to continuous cropping has the tendency to lower the organic matter content of the soil. Bruun et al. (2006) found in Sarawak, Malaysia, a slight decrease in soil carbon as forest is converted to swidden. However, further transition of swidden into permanent agriculture depleted soil carbon by nearly 30 Mg C ha^{-1}, from 56 to 29 Mg ha^{-1} (Figure 23).

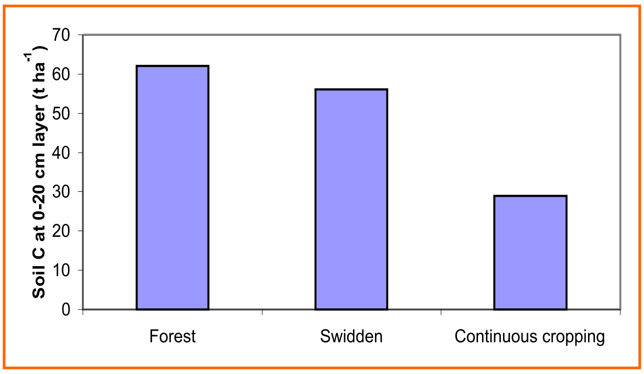

Figure 23: Soil carbon in the layer from the surface to 20 cm down under different land uses (Bruun et al. 2006).

The trend in the stock of C above ground is similar to that below ground, except that the magnitude of the decrease is much higher as forest is converted to swidden and swidden converted to permanent cropping (Table 12). Fallow length determines the stock of carbon in the system (Table 13).

Table 12: Above-ground carbon stock and number of plant species under different land-use systems

Land use	Carbon (Mg ha^{-1})	Plant species per plot
Primary forest	254	120
Rubber forest	116	90
Monoculture oil palm	91	25
Shrub (about 8-year fallow)	74	45
Vegetables	2	16
Cassava	4	15
Imperata	2	15

Table 13: Fallow age in relation to carbon stock in Sarawak, Malaysia, and South America

Site	Fallow age (years)	C stock (Mg ha^{-1})
Sarawak, Malaysia	2	1.7
	4	22.4
	6	28.6
Brazil	12	54.0
Bolivia	25	67.5
Brazil	59	90.0

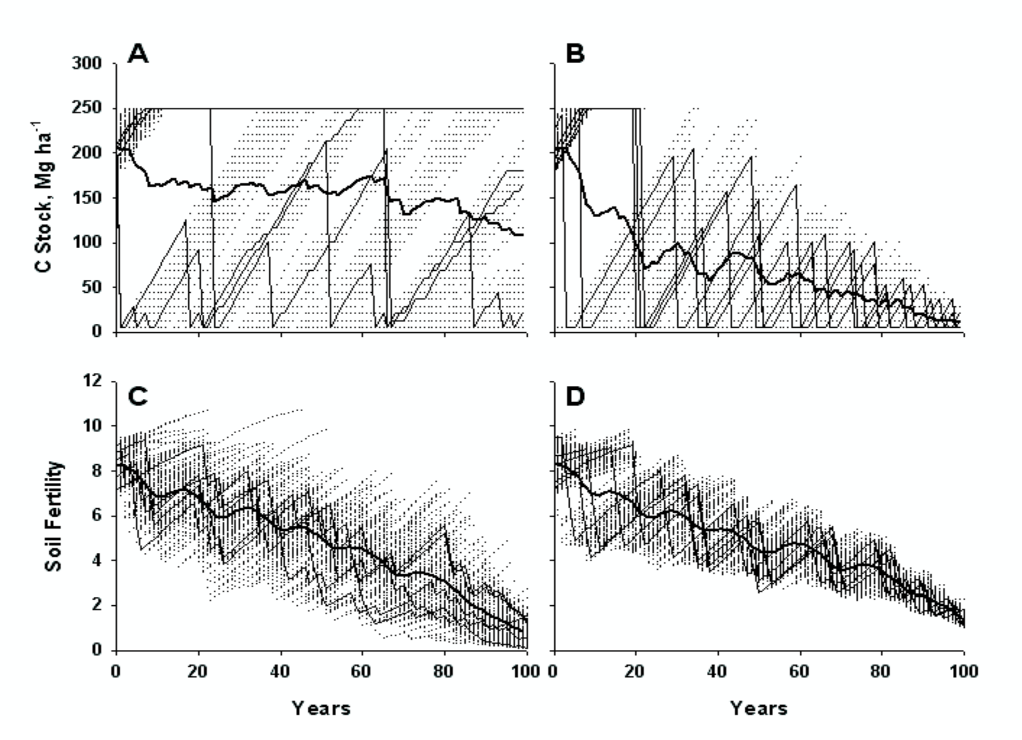

Figure 24: Predicted decline, using the FALLOW model, of soil organic matter content in a swidden landscape, with individual plots showing asymmetric saw-tooth patterns of slow recovery and rapid decline (van Noordwijk 2002).

6.4.2 Biodiversity

Biodiversity is an important natural resource for economic development, technological advancement and human life. In a swidden system, longer fallow periods tend to have higher biodiversity. Furthermore, as the swiddens transform into permanent systems, there is a significant loss in biodiversity (Table 12, Figure 25).

Swidden transitions in Indonesia may have been triggered primarily by increased market integration for native non-timber forest products and the introduced tree crops rubber and coffee, which were initially compatible with the woody fallow vegetation. Market integration starts when market sources of income complement local food production, and attractive prices can lead to reliance on the market for staple food. As many forest and agroforest products have relatively high value per unit of weight, they provide options for fairly remote communities. Market integration through the intensification of food crops may be a challenge unless roads are good. The agroforestry solution, which combines high landscape-level biodiversity with medium market integration, is not an end point of evolution, however, and may transform into more intensive tree crop monocultures, as is the current trend for rubber agroforests.

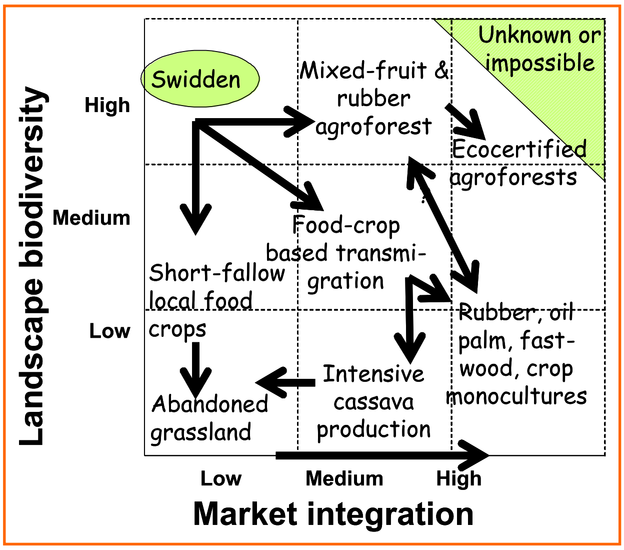

Figure 25: Schematic relationship between degree of market integration and landscape-scale biodiversity of swiddens and its derivative land-use systems.

7. Rural development programmes

The 120 million ha of Indonesia's permanent forest estate were supposed to provide the country and its people with a prosperous life. But the reality is different. These forests are degrading and losing their natural forest cover at an alarming rate that has reached over 1 million ha per year. This leaves local communities living in and around the forest in a difficult position. Large-scale logging started in the late 1960s, operated by timber concessions with foreign investment and good political connections. Since then, billions of cubic meters have been cut. The highest-quality wood is used as timber, the next category down for plywood, and the remainder for pulp and paper. The concept of selective logging and natural regeneration has been virtually abandoned for an approach based on monoculture fastwood plantations.

To improve livelihoods in degraded forest areas, the government has initiated various development programs. Two programs will be discussed here: (1) permanent food-crop agriculture in the forest village development program and (2) oil palm plantations.

7.1 Permanent food-crop agriculture

While high-quality agricultural land continues to be converted for urban and industrial development, and agriculture on existing irrigated and rainfed fields is challenged by climate change, the government of Indonesia sees extending the area used for permanent agriculture as part of the response to avert a national food crisis and to contain rising food prices. The government has recently declared that a further 15 million ha of land in the permanent forest estate should be reallocated for permanent food-crop agriculture. Details are still under discussion.

Permanent food-crop agriculture has been the government's choice to increase rice production, not leaving to farmers or local communities the choice of intensification pathways based on tree crops. In 1991, the Department of Forestry initiated the Village Forest Development Program as a way to offset the negative effects of logging and improve livelihoods in forest communities living in and near concessions. Many timber concessions chose to support demo plots, where a few selected farmers received help in building irrigation infrastructure, as well as agricultural tools and inputs. It was expected that other villagers would see the success of demo plots, copy the technology and stop practicing shifting cultivation.

The case study in Tanjung Paku shows that the development program involves drastic technological and cultural changes. With rapid changes in policies and market prices for inputs and the timeframe of a logging concession that moves on once the attractive timber has been harvested, the changes may not be sustainable (Box 13).

7.2 Oil palm plantations

Following the success of oil palm plantations in Malaysia since the 1960s, with the introduction of high-yielding, low-stature palms, Indonesia is now becoming the country with the largest oil palm area. In addition to expansion by national and private companies, investors and technical know-how from Malaysia have come to Indonesia, with Sumatra as the core area and Kalimantan as the secondary area of expansion (Figure 26).

In 1968 the area with productive palm was only 0.12 million ha. By 1978 it had reached 0.25 million ha, in 1994 1.8 million ha and in 2006 6.2 million ha. With growing world demand for vegetable oils, options for use as biofuel and rising prices for crude palm oil, further increases are planned (Anonymous 2008). The oil palm plantation area is projected to reach 8 million ha by 2010 and as much as 9 million ha by 2025 (Direktorat Jenderal Perkebunan 2007).

Oil palm expansion is taking place mainly in areas where it replaces food-crop shifting cultivation and smallholder rubber production, but the pattern is different between Sumatra and Kalimantan. In Sumatra, oil palm is rapidly becoming a smallholder crop, but in Kalimantan expansion still depends on private companies with local monopolies on processing facilities and strong support from local government for land acquisition, often causing conflicts (Colchester et al. 2006).

National statistics on oil palm in Indonesia recognize three strata: smallholders, private companies and state companies. Out of a total planted area of 6.2 million ha in 2006, smallholders controlled 41% of the area and produced 34% of the crop, private companies 48% of the area and 52% of the crop, and state companies 11% of the area and 14% of the crop (IPOC 2006). The government plantations have 1 ha of immature plantation per 20 ha of mature gardens, which is below the replacement level of 1:10 if we assume 3 years of immature garden and 30 years of production. Smallholders have 1 ha of immature garden per 4 ha of productive garden, and private plantations 1 ha for 3 ha, indicating rapid expansion. The postproductive category is 1 ha per 65 ha of mature area for smallholders, per 95 ha for private companies and per 83 ha for state companies. This suggests that there is little scope for more active replanting within the existing oil palm area.

The relative share of smallholders in the immature, newly planted area in 2006 was 51% in Sumatra, which as an island represents 76% of oil palm area in Indonesia. The share was 44% in Papua and only 15-20% in Kalimantan and Sulawesi, indicating a substantial difference in pattern. Kalimantan and Papua are the areas with the highest relative growth rates, with 1 ha of immature plantations per 3.5 ha of mature plantations in Kalimantan and per 1.9 ha in Papua, compared with per 4.1 ha in Sumatra, per 8.4 ha in Sulawesi and per 4.0 for Indonesia as a whole. The production data for

Box 13: Tanjung Paku: return to shifting cultivation?

A case study conducted by Nugraha (2005) of Tanjung Paku village in Central Kalimantan, at the border with West Kalimantan, provides an example of the ups and downs of efforts to introduce permanent rice-based agriculture to Dayak communities. The area of Tanjung Paku was classified as limited production forest, as it is between Bukit Baka National Park and Bukit Raya National Park. The village had a population of 198 (33 households, with 6 people per household) in 1984, increasing to 384 (76 households with 5 each) in 1994 and 403 (95 households with 4.2 each) in 2004. Population growth has been mostly natural, rather than by migration.

Before a timber concession obtained logging rights from the central government, the villagers depended on shifting cultivation, using traditional knowledge to maintain environmental sustainability. Each family managed 2-3 ha of agricultural land (the 'ladang'), which produced on average 5.4 tons of rice per year per family. They also collected non-timber forest products like rattan. In 1990 the timber concession came in and introduced chainsaws, generators and television, followed by satellite dishes and video compact discs. Houses had electricity, and at night communities would gather together to watch television in a village hall ('balai desa'). The concession offered jobs such as chainsaw operator, day labourer, concession employer, night guard and teacher. Most of the villagers had at least part-time off-farm employment, and 45 villagers worked for the timber concession. They also obtained livestock. In response to the 1991 government policy establishing the Village Forestry Development Program, the timber concession introduced irrigated rice fields, tree crop plantations (rubber and *Shorea* sp.), fish ponds and vegetable gardens. The irrigated rice area increased from a demo plot of 0.18 ha in 1991 to 6.7 ha in 1994, involving 35 households, and 8.3 ha in 1997. They planted rice twice a year, yielding about 7.2 $t\ ha^{-1}$ per year-. This yield compensated for a 25% reduction in ladang area. The development program was considered successful in creating jobs and increasing villagers' income. The villagers were able to meet their rising economic needs. The concession also subsidized for households such basics as salt and sugar. In return, these people had to help to create a safe working environment for the concession. The area opened each year for new ladangs decreased from 1.65 ha per year per-household in the 1980s to 0.65 ha per year per household in 2004. However, because the number of households had almost trebled, a larger total area was farmed.

Unfortunately, the success of the irrigated rice did not last long. The forest concession policy to reduce farm subsidies to discourage dependency did not work as expected, while rising fertilizer prices made the high-input mode of production less attractive. Local institutions for managing irrigation had not developed, and the transfer of technology to villagers had been incomplete. Farmers started to abandon the irrigated rice fields. By 2005 two-thirds of the households relied again on shifting cultivation in secondary forests for their rice.

Figure 26: Oil palm distribution in Indonesia in 2006, covering 1015% of the area in Riau, North Sumatra and Jambi; 510% of the area in Bangka, South Sumatra, Bengkulu and West Sumatra; 15% of the area in Banten, Lampung, Aceh, Kalimantan and West Sulawesi; and <1 % of the area in the rest of Indonesia (IPOC 2006).

Table 14: Geographical distribution of oil palm plantations in Indonesia and the fraction of land in different stages of production that is managed by smallholders

	Smallholders as percentage of total					
	% of Indonesian total area	Immature area	Mature, productive area	Damaged, post-productive, area	Total area	Total yield
Sumatra	76.4	51.1	42.3	47.2	43.9	43.2
Java+Bali	0.4	0.0	29.1	62.9	24.7	27.2
Kalimantan	20.2	19.5	37.3	72.3	31.3	33.8
Sulawesi	2.1	14.5	23.1	0.0	21.7	22.3
Nusa Tenggara+Maluku	0.0	0.0	0.0	0.0	0.0	0.0
Papua	1.0	43.5	43.1	0.0	42.9	42.7
Indonesia	**100**	**39.3**	**41.0**	**49.6**	**40.8**	**34.0**

Source: IPOC 2006

smallholders are approximately proportional to smallholders' share of the productive area (which may indicate the way the statistics were a derived and estimated rather than reality on the ground). Smallholder statistics are considered less reliable than those for private plantations.

The interest of local governments in promoting oil palm plantation as a development strategy is significant in most of Kalimantan. Kutai Regency, East Kalimantan, currently has 180,000 ha of oil palm plantation but plans to reach 350,000 ha in 2010 and 500,000 ha between 2015-2020 (Hartiningsih et al. 2008). The government plans to develop in Kalimantan a contiguous oil palm area of 1.8 million ha, the biggest in the world (Arif 2008b). To fill the need for labour in the plantation area, the government initiated a transmigration program to bring in people from outside. With this pattern of expansion, oil palm is not attractive as an alternative to shifting cultivation of food crops. The way land is acquired, operating in the grey zone of forest lands claimed by the state but not legally gazetted as such, the net effects on the welfare of local communities can be negative. Local people perceive an increase in flood frequency triggered by relatively small rainfalls. Oil palm development in West Kalimantan is reported in Box 14 as a case study based on reports by Colchester et al. (2006), Potter (2008), and a personal interview with Budi, a World Agroforestry staffer in West Kalimantan.

As current prices are high, many growers have become happier with the arrangements, but disappointment emerged when a company takeover led to the doubling of the debt calculated for planting palms. Some farmers attempt to create a mixed cultivation system and retain elements of swidden, but this may be more for symbolic and social needs than economic ones.

7.3 Government officers' understanding of shifting cultivation

Government officers from Dinas Kehutanan and Perkebunan-Bungo Regencies in Jambi province, Dinas Kehutanan and Perkebunan-Malinau Regencies in East Kalimantan province, Bapedalda in Papua province and Bappeda in West Aceh define shifting cultivation as having the following characteristics:

1. shifting from one place to another and therefore not permanent;
2. involving burning for land preparation to ease planting and, it is believed, to raise and neutralize the pH;
3. reliance on fallow periods to restore soil fertility; and
4. focusing more on subsistence farming for local consumption and preferring annual crops over perennials.

Considering this definition of shifting cultivation, there is a little confusion among government officers on the currently evolving practice of the farming system and whether it can still be considered shifting cultivation. In Aceh, local communities cut the forest to plant 'nilam', a mint from which the perfume oil patchouli is distilled. They prepare the land with burning, leave it fallow and open other forest area when nilam production decreases, and the cycle continues. This nilam farming is similar to shifting cultivation, but the crop is not for food and this is not subsistence farming but, rather, growing a commercial species for cash income.

Shifting agriculture is practiced by both poor and rich, and practitioners do not consider village, Regency or provincial boundaries when they farm. This has a consequence when the government of a certain Regency plans to reallocate the land for development. Government officers from one Regency sometimes face communities living in other Regencies because the land in question traditionally belongs to them. In this farming system, the shifting cultivators consider adat law above administrative boundaries set by the government.

This farming system takes place in both forested and unforested lands. In Aceh, shifting cultivation takes place in a mountainous area that is environmentally fragile. In Papua and Malinau, where the population is sparse, shifting cultivation is considered a sustainable system. Local government officers agree that its sustainability or unsustainability depends on where it is practiced, whether on sloping or relatively flat land, or in a sparsely or densely populated area.

Box 14: Oil palm in West Kalimantan

The first oil palm in Kalimantan was planted in Sanggau, West Kalimantan province, in the late 1970s. The crop was introduced to restore 'critical lands' or 'sleeping lands', that is, the fallow land of swidden cultivation covered with Imperata grass. The maps show government land use policy in favour of oil palm and the excessive growing of oil palm in West Kalimantan and Sanggau.

Oil palm plantations tend to occupy more accessible areas, as roads are essential to transport the crude palm oil to the factory within 24 hours of the harvest. Swidden lands tend to occupy less populated hilly lands far from the main roads. The plantations are different in many ways from the ones of local Dayak communities. Dayaks practice dry and wet shifting cultivation, tapping jungle rubber and harvesting fruits and nuts from communal fruit groves locally called 'tembawang'. These tembawangs are rich in biodiversity. Some of the Dayaks have adat forests, from which rattan and timber can be extracted for own use. Strict sanctions are applied on the unauthorized felling of certain trees such as the honey tree (Koompasia excelsa). In the minds of local people, the land in West Kalimantan belongs mostly to the adat community. One type of adat land can be distributed to or owned by individual people. Other kinds of adat land, such as tembawangs, cannot, as they belong to the adat community jointly. Tembawangs can have an area of hundreds of hectares, and the production from tembawangs is for everyone, with some arrangements for its distribution.

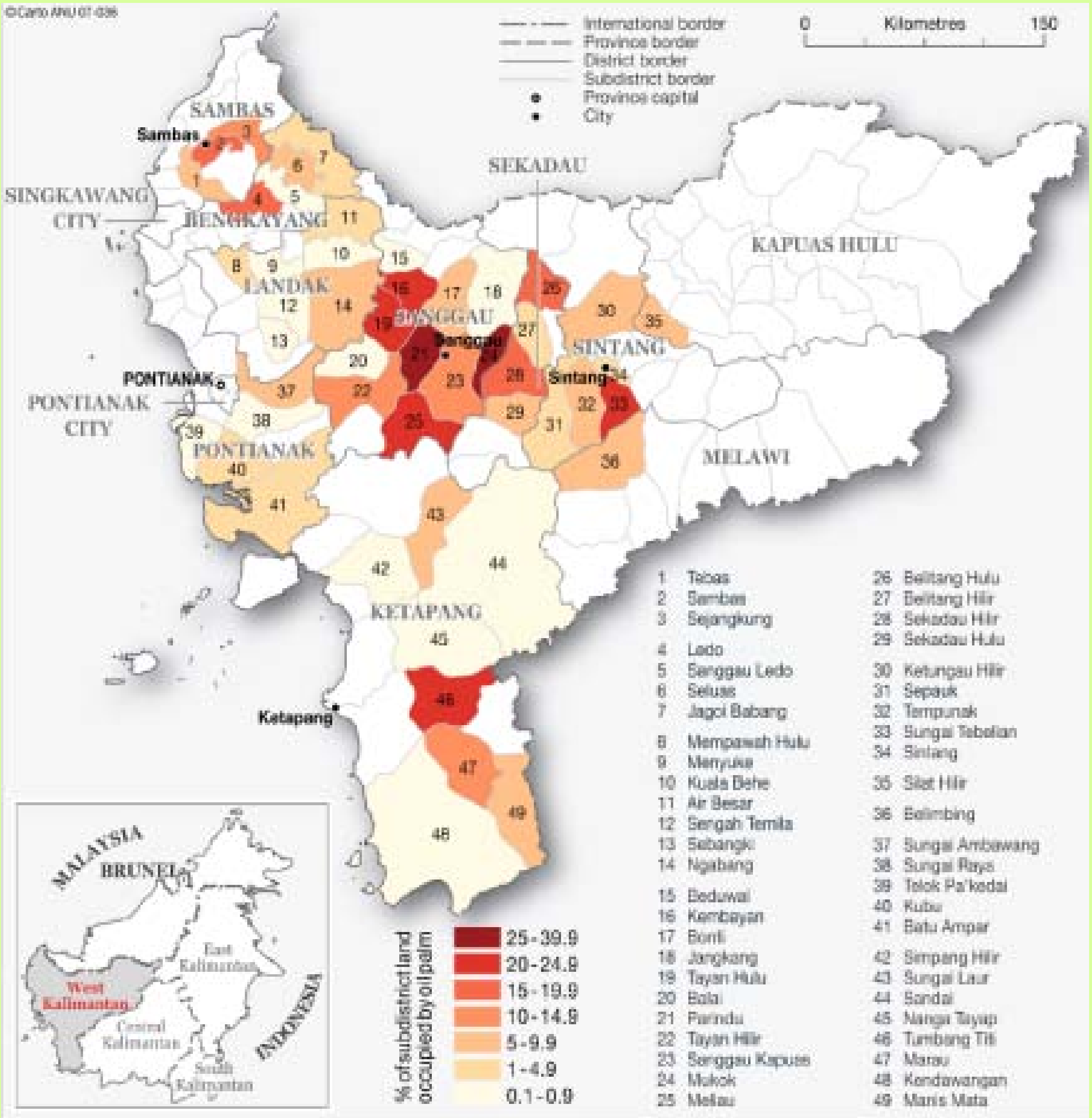

Figure 27: Land allocation for oil palm plantations in West Kalimantan in 2007 (Potter 2008).

Box 14 (continued): Oil palm in West Kalimantan

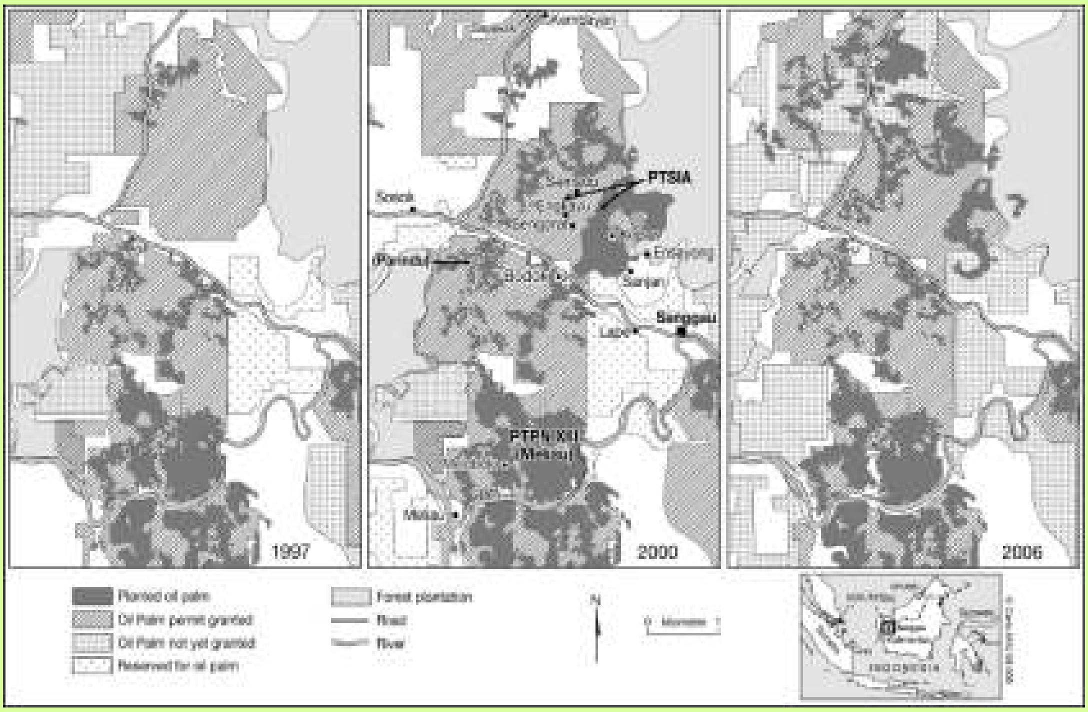

Figure 28: The trend of oil palm plantations in Sanggau Regency, West Kalimantan (Potter 2008).

Oil palm plantations need large areas. The plantation companies target adat lands that have been distributed to individual households. In the beginning, it was not easy to convince the local communities to plant their lands with oil palm trees because they did not know the benefits of them. But, since 2000, community interest in planting trees has increased because (1) there is regular income from their palm plantation and/or from working as a day labour in the nucleus palm plantation and (2) managing the palm plantation is easy.

Various arrangements exist between oil palm companies and adat people interested in planting oil palm. In Sanggau, the oil palm company set a condition that families who want to get involved in the plantation must have 7 ha of land and be willing to give 5 ha to the company for free, to be managed by the company. In Sintang, the palm company bought community land for 500 rupiah per m^2, is managing the land for 30 years, and is scheduled to return it to the local government thereafter. Local people can work in the nucleus palm plantation for 15,000-20,000 rupiah per day. The 2 ha of remaining land still belong to the community members to manage as so-called plasma palm plantation. The company provides credit to them for seedlings, fertilizer and insecticide, etc., until the trees can be harvested for the first time, after about 4 years. These people also get a land certificate after they pay off their debts to the company. From year 5 to 20, each family can earn around 1.5 million rupiah net per month from their labour and previous investment. Problems arose when oil palm production failed to meet expectations. After year 20, these people earn only 300-500 thousand rupiah net per ha per year. The ones who are not able to manage the money earned from palm production are disappointed. They not only lose their land but also have to buy vegetables, fruits and rice, and they cannot get their land certificate if they still owe the company. But some villagers are able to retain areas of swidden rice, tembawang and rubber, mixed with oil palm, while giving up some land to the estate, but not as much as demanded.

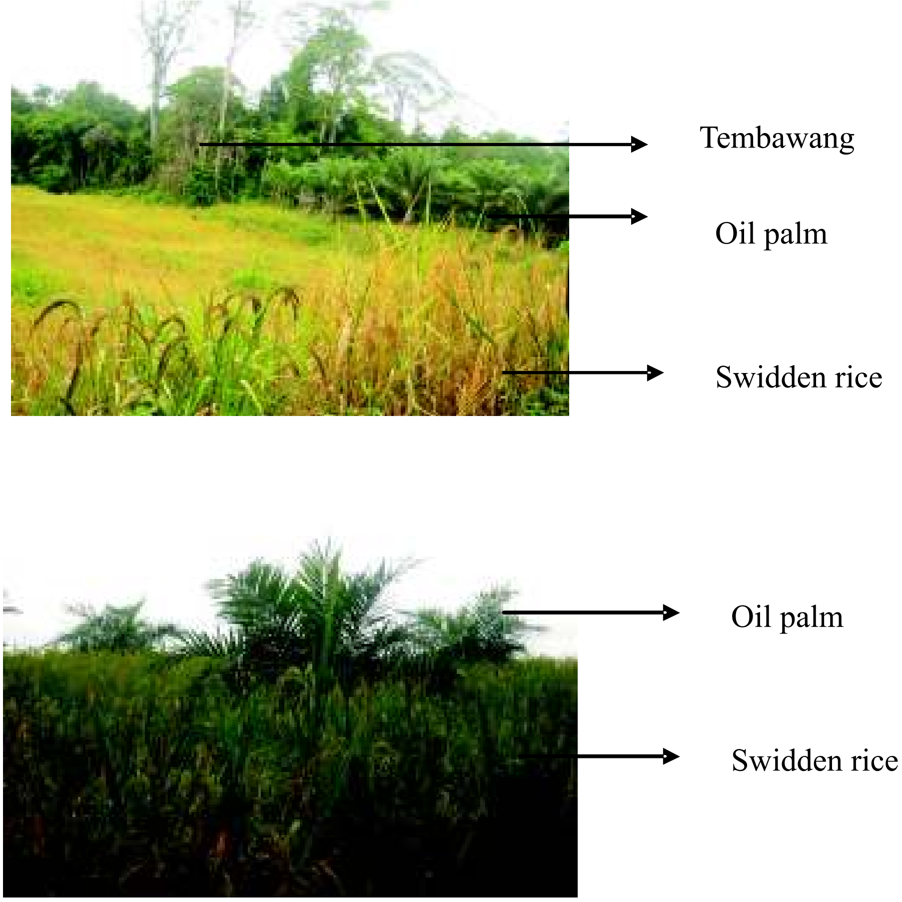

Figure 29: Swidden rice, tembawang and oil palm in West Kalimantan (Potter 2008)

7.4 Shifting cultivation, the current condition

Government representatives do not know the number of shifting cultivators in their Regency, or the area being used for this farming practice. They do not have the budget or human resources to find out.

Shifting cultivation, as defined above, is still practised in Malinau and Papua. Local governments in these places consider this farming system not to be an environmental threat. People in Malinau practise it in the Area Penggunaan Lain. In Papua, shifting cultivators also work on plantations or in timber concessions to earn cash income.

In Aceh, shifting cultivation is considered a potential threat to the surrounding environment, particularly when done on slopes. Shifting cultivation in Aceh is predicted to increase as the price of nilam rises and because of the belief that nilam grow best in newly opened forest. This belief drives people to cut down forests to farm nilam, moving on to other forests when nilam production starts to fall.

In Aceh, the practice of shifting cultivation is used by some people as a means of occupying and owning land under the government restoration program following the December 2004 tsunami. The price of land is increasing, and people compete to occupy land to sell in the government restoration program.

The government officer of Bungo Regency indicates that there is no shifting cultivation, as defined above, practised in his area. Farmers in the area plant rubber trees and do not shift from one place to another. The ones farming in the forest area and on state land, he says, are encroachers.

8. Policy discussion: voluntary or imposed change

After discussing the trends in the way swidden systems have evolved throughout Indonesia, we now come to the main questions in the policy debate: Is there a problem? If so, what is the nature of it? What are the consequences of not dealing with it? What are the options to mitigate the problem or deal with it? Different stakeholders have a very different perception of what the problem is, describing it variously as

1. environmental destruction and loss of natural forest,
2. persistent rural poverty and backwardness for lack of economic growth, or
3. interference in local affairs and disrespect for local culture.

We may distinguish situations in which swidden systems are still appropriate and seen as the best form of locally adapted land use (situation C in Figure 30) from situations in which swiddens are evolving into other land uses spontaneously (as in situation A) or by force (situation B). In various phases of their political history, governments throughout Asia have attempted the approach described in B by combining forest protection with the backwardness argument, which has met with considerable resentment. Yet, with time, more voluntary change would often have emerged if the alternatives had become or been made sufficiently attractive. Roshetko et al. (2008) and van Noordwijk et al. (2008c) discussed barriers to farmer tree planting in the context of sustainable forest management and the need for a paradigm shift in the approach to forestry.

8.1 An example of spontaneous transformation, followed by forest destruction

An example of situation A is the historical emergence 100 years ago of rubber agroforestry in relatively remote parts of Sumatra and Kalimantan, which did not require any formal research, extension or policies. It was driven by booming prices and active marketing agents who provided rubber seed free as investments for their rubber-processing plants. This change allowed economic welfare to improve, while local systems adapted to keep swiddens in 'sesap neneks' in the local portfolio of options. The main government intervention was a largely unsuccessful attempt to protect the large plantations from competition from more efficient smallholder producers. The effect of the transformation on forest resources was mixed: the rubber agroforests allowed for sustainable livelihoods on 35 ha per household, the area that can be tapped with household labour, and natural forests remained part of the landscape while population density grew to some 50 people per km2 by both attracting migrants and contenting local youths to stay in the area. All accessible parts of the landscape, however, were transformed into rubber agroforest, and the portion of the local flora and fauna that could survive in this habitat was the only portion that survived. Natural forests beyond community-controlled rubber agroforests were logged with a supposedly sustainable selective logging system sanctioned by the state. In fact, they were logged beyond recovery and then replaced by fastwood monoculture plantations, again sanctioned by the state. The voluntary transformation of swiddens did not in the end protect forest resources, but it allowed for the survival of part of the local flora and fauna, while the agencies that were supposed to actively protect the natural forest failed to do so.

In response to land degradation and to cope with weather, farmers in West Timor have improved their practices in fallow management through the use of Sesbania grandiflora and Leucaena leucocephala in the so-called Amarasi system. Amarasi adds soil fertility and provides high-quality fodder for cattle. Since the psyllid outbreak in the 1980s destroyed Leuceana, alternative legumes were planted, such as Calliandra, Gliricirdia and psyllid-tolerant Leuceana. The dynamics of farmer tree planting are still not fully appreciated (Kieft pers. comm.).

8.2 An example of forced transformation: Aceh during and after the conflict

Relative to other provinces of Sumatra, Aceh has maintained its forests well. Forest protection, however, was not so much a deliberate choice as a consequence of internal security problems that restricted villagers to the immediate surroundings of the village and slowed external resource extraction. After the peace agreement, the rate of forest clearing increased to open up fields for agriculture.

The tsunami that hit the coastal zone of Aceh on 26 December 2004 brought a dramatic shift in social, economic and political conditions across the province. Demand for wood for house construction in the rehabilitation process skyrocketed. However, the political debate about the sustainability and legality of wood sources provided a counterbalance. The attraction of clearing land at least partly to sell the wood increased. Time series data on land cover in

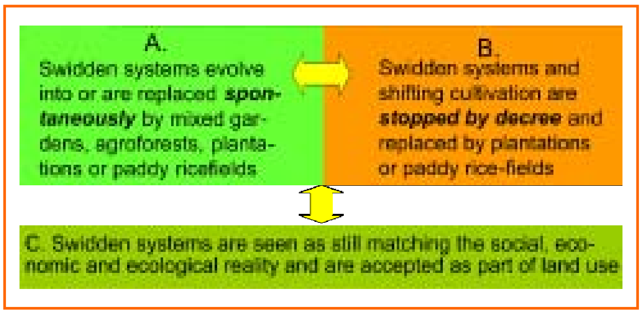

Figure 30: Three policy domains with regard to swidden systems and their transformations.

Table 15: Net present value of upland rice systems derived by slash-and-burn land clearing before the 2004 tsunami and subsequent peace agreement in Aceh

	Revenue	**Tradable**	**Domestic factor**		**Profit (Rupiah ha^{-1})**	**Return on labour (Rupiah day^{-1})**
		Input	Labour	Capital		
Real Price 2007, 2006=100						
Private price	34,386,188	68,661	10,680,646	0	23,636,880	41,554
Social price	24,661,020	105,230	16,369,233	0	8,186,557	25,155
Divergence	9,725,168	(36,568)	(5,688,587)	0	15,450,324	
Real Price 2004, 2006=100						
Private price	32,206,339	68,781	11,004,900	0	21,132,658	37,134
Social price	25,752,383	107,676	17,228,109	0	8,416,599	27,548
Divergence	6,453,956	(38,895)	(6,223,208)	0	12,716,059	

Note: Standardized on 2006 prices for inputs and outputs.
Data source: Budidarsono et al. 2007

West Aceh show that deforestation increased after the tsunami and peace agreement to over 4,400 ha per year-. Two thirds of the deforestation took place in the conserved forest zone, most of which is located further inland (Budidarsono et al. 2007).

Paddy cultivation also increased after the tsunami and peace agreement in response to a near-doubling of the rice price from, 4,500 rupiah per kg in late 2004 to 8,000 rupiah per kg in early 2007. The peace agreement calmed farmers' earlier fears about going into forests to clear them and cultivate annual crops.

A financial profitability calculation for upland rice production in Aceh Barat did not show a major difference in the bottom line between 2004 and 2007, as the opportunity cost of labour increased with new reconstruction jobs in the coastal zone providing wages substantially above the going rate across the province. With the efforts of external supporters of house building to avoid using wood from illegal sources, demand for bricks increased, and many sites in the foothills started to respond to that demand, increasing the opportunity costs of labour further inland.

The governor of Aceh declared a logging ban and stopped all logging and land clearing with fire. The impacts on local livelihoods are not yet clear but likely will become clearer as subsidized reconstruction in the coastal zone comes to an end. There has been little investment in making tree crops or agroforest management more attractive for the inland areas, so the forced ending of anything that looks like swiddens or shifting cultivation may put Aceh in situation B of Figure 30.

8.3 Socioeconomic transition

Market integration and rural development have an ambivalent relationship with cultural traditions. The learning process of local communities in adopting new technologies and adapting them to their specific environment and cultural condition determines the winners and losers among communities. In South Kalimantan, Dayak and Banjar people follow different development trajectories in peat swamp areas, even though they live in the same environment. While Dayaks prefer their fallow fields to evolve into jungle rubber and rattan systems, Banjars combine intensified rice production with coconut. The different preferences have consequences for landscape functions and the environment.

The knowledge and social networks of migrant Buginese farmers in the uplands of Central Sulawesi allowed the successful expansion of cocoa. Local communities were pushed out of land ownership because their forests were sold to migrants and converted into cacao gardens (Savitri 2007). The local Kaili communities could get access to land with tree crops only through sharecropping arrangements. To find alternative livelihood sources, some of the local community started to encroach the Lore Lindu National Park. Although such differences can be interpreted as evidence of different cultural backgrounds, they tend to coincide with differences in access to land, knowledge and market networks that determine the profitability of land-use alternatives. It is important to note, however, that success stories cannot be directly extrapolated from one context to another and that scaling up local successes has often not worked.

8.4 Criteria for situation C

Criteria for the sustainability and appropriateness of swiddens (situation C) are incomplete. As a simple guideline, a population density of 10 people per km2 in the humid tropics may be a threshold. The dynamic landscape model Forest, Agroforest, Low-value Landscape or Wasteland? (FALLOW) suggests with its default parameters that, at more than 15 people per km2, recovery during the fallow phase becomes deficient and changes are needed to avoid collapse. Rubber agroforests can provide for about 50 people per km2, according to current productivity data. To support more people in a rural area, labour intensive but productive paddy rice systems may be the only option.

In reality, however, efforts to attract people to permanent residences with access to schools, health services and clean water have intensified pressure on local resources, even in landscapes where sufficient space is available overall. Local degradation can be accompanied by forest preservation in more remote parts of the landscape.

8.5 REDD and swiddening

Since the global community realized that it cannot ignore that the 20% of global greenhouse gas emissions that arise from land use and land-use change in the tropics, opportunities for reducing emissions from deforestation and degradation in developing countries (REDD) have been hotly discussed. It is easy to blame shifting cultivators for forest degradation, and there is a well-founded fear that implementing REDD initiatives may bar farming communities from their resource base.

Linkages among deforestation, development and poverty are complex and context specific. However, the use of fire for clearing land is often blamed as the main culprit of deforestation, while in fact land-use change that does not use fire can cause as much loss of carbon stocks. Banning the use of fire can have significant impact on local livelihoods, with financial benefits not likely to be provided to offset legitimate opportunity costs. If implemented without consideration of local livelihood impacts, REDD can worsen conflict and rural poverty, with the real risk of the increased use of fire as a weapon, negating any environmental gains (Kieft pers. comm.).

8.6 Global economy as the new shifting cultivation

Transient use of resources, skimming off the cream that has slowly accumulated for some time, used to be the basis of agriculture, just as it remains the strategy of a pastoralist migrating with a herd. Shifting places is also a simple way to leave behind parasites and diseases. Culture and the rhythm of life get aligned with the dynamics of changing place. The transient use of resources is a common strategy in the global economy, as flexible outsourcing continuously searches for cheaper resources and labourand the absence of parasites and diseases.

A basic element in human psychology has prepared us for such a way of life, recognizing change as the antithesis of stagnation and death as the ultimate in stability. In condemning shifting cultivation as a primitive way of life, the modern transformation of life simply leads to new forms of shifting cultivation on a broader or even global scale, not to an inherently more stable relationship with our natural resources.

8.7 Dealing with the local dynamics of swiddens

Policies need to balance the need for intervention that follows from the environmental destruction and poverty arguments against interference in local affairs and disrespect for local culture embodied in swiddens.

Overall, the evidence in Indonesia and other parts of Asia suggests a high degree of adaptation in swidden systems to local circumstances, intimate local ecological knowledge, and local regulation of negative impacts and dynamic change. The actual track record in terms of forest and environmental protection of the agencies that try to stop shifting cultivation is not impressive. More modesty in their approach would be appropriate. Better site-specific diagnostics of issues is needed to avoid the standard responses that still characterize much land-use policy. It would help to quantify the local and external benefits from the goods and services derived from the various land-use systems in a mosaic context. Respect for local traditions and support for gradual change are still necessary first steps to improve local policies.

9. Conclusions and recommendations

9.1 Main Findings

Main questions and objectives	Key results
1. Assess trends in the extent of swiddening and changes in land cover over past years using readily available remote sensing and map data.	On a national scale, the Richards and Flint (1994) time series may still be the best basis for comparisons, as agroforests and less-managed fallows are still not consistently distinguished in maps broader than the case-study level.
2. Assess the number of people engaged in swiddening using demographic and economic data from the various countries and inputs from case studies.	In 1980, some 5% of the Indonesian population still engaged directly in swiddening, and for a further 20% swiddening was still part of their livelihood context. A quarter of a century later, swiddens remain relevant for 510 million people, out of the 220 million total, but proper statistical data is lacking.
3. Assess the impacts of swidden change on the social environment, notably on livelihoods, the economy and culture, using case studies and regional assessments.	The spontaneous intensification and market integration through agroforestry is well embedded in social systems, but current efforts to jumpstart intensive agriculture are not. Substantial differences exist among Sumatra, Kalimantan and Papua.
4. Assess the impacts of swidden change on the natural environment, notably on landscapes, biodiversity, agrobiodiversity, water resources and global climate, using case studies and regional assessments.	Tree-based intensification is, at least initially, compatible with maintaining biodiversity and significant C stocks, but further intensification leads to the loss of environmental services.
5. Assess the importance of policy as a driver of change, including a review of commoditization, changes in scale of production, economic policy, land tenure, infrastructure and conservation policies nationally and subregionally.	The primary policy interaction has been with efforts to establish an institutional framework for forest policies with centralized control. This has caused conflicts and intensification on the remaining land. The rural development paradigm has shifted somewhat from targeting intensive food crops to targeting intensive tree crops.
6. Provide a forum to share and compare the research that has been done on swidden agriculture in Southeast Asia.	The tree crop and agroforest transitions from swiddens in the humid tropics differ from the trajectories in the subhumid tropics, where intensified crop and vegetable production is more prominent.
7. Bring new ideas and new concepts regarding swidden agriculture management to policy makers in several Southeast Asian countries.	Current knowledge guiding ecological policy is challenged to appreciate the reality of dynamic land-use decisions and may be trapped in less-than-relevant classifications.

9.2 Policy-relevant conclusions

1. Definitions used in the policy arena and the institutional construction of a separate forest domain do not reflect local perceptions of rights, the actual dynamics of land use or the way swidden systems tend to evolve by adding value to the fallow and/or crop phase. A coherent system of land use is artificially split between separate forest and agricultural institutional frameworks. Claims to land by forestry institutions and the transfer of rights to logging and plantation companies trigger change in swiddening communities.

2. The contest for land affects relations between the state and local communities, and between members of the adat community and spontaneous and state-sponsored migrants, and plays a dominant role in decisions about clearing woody vegetation and its replacement with annual and perennial crops.

3. Remote communities' market integration in Indonesia has historically resulted mostly from modifying the fallow into an agroforest and the further intensification of agroforests into specialized tree crop production systems. It has not been led by changes in the crop phase of the swidden cycle.

4. The current focus on reducing the use of fire does not alleviate long-term ecological concerns over the conversion of natural forest into intensively managed plantations. The loss of diversity in crops and in the 'wild' components of agroforests continues, though it is less visible than smoke.

5. The rural development paradigm has switched from jumpstarting intensive permanent cropping to supporting intensive perennial crops, rather than supporting gradual change in accordance with local expectations.

9.3 Recommendations to the policy arena

1. Disentangle the debates about the functional roles of woody vegetation for society (the forest function) and rights to use and modify woody vegetation and use land (forest institutions and governance, the agrarian issue) to achieve more evidence-based public dialogue and improve the transparency of decision making. Create an integrated platform to deal with the forestagriculture continuum and its policies.

2. Substantially improve capacity to resolve land conflicts based on analyses of historical claims within the existing legal framework, which delegates the management of forests to the Forestry Law and regulates all issues of land rights in a single law.

3. Recognize that restricting the use of forest resources is a double-edged sword. Support the development of markets for forest commodities through basic certification that distinguish domesticated and semi-domesticated resources from the wild resources that require protection. Support the utilization of existing agrobiodiversity.

4. Improve data collection and analysis for more evidence-based policies in support of maintaining environmental services and turning the focus from symptoms like smoke to the underlying causes of the loss of natural capital.

5. Respect local ambitions and expectations in support of sustainable development and critically review current subsidies for monocultures and support for land grabs by external investors or state agencies.

Refereces

Agus F. 2007. Use of Leucaena leucocephala to intensify indigenous fallow rotation in Sulawesi, Indonesia. In: Cairns M, ed. Voices from the forest: integrating indigenous knowledge into sustainable upland farming. Washington: RFF Press. p 287294.

Agus F, Cassel DK, Garrity DP. 1997. Soil-water and soil physical properties under contour hedgerow systems in sloping Oxisols. Soil and Tillage Research 40:185199.

Agus F, Garrity DP, Cassel DK. 1999. Soil fertility in contour hedgerow systems on sloping Oxisols in Mindanao, Philippines. Soil and Tillage Research 50:159167.

Andriesse JP, Schelhaas RM. 1987. A monitoring study on nutrient cycles in soils used for shifting cultivation under various climatic conditions in tropical Asia. III. The effects of land clearing through burning on fertility level. Agriculture, Ecosystems & Environment 19:311332.

Anonymous. 2008. Habis kayu, terbitlah sawit. Kompas, 15 June.

Arif A. 2008a. Kalimantan di Ambang Batas. Kompas, 20 June.

Arif A. 2008b. Musim Semi Usaha Sawit. Kompas, 9 May.

Arif A, Saptowalyono CA. 2008. Konflik SDA: terpinggirkan di Tanah Sendiri. Kompas, 20 June.

Arif A, Syaifullah M. 2008. Infrastruktur diabaikan. Kompas, 20 June 20.

Belcher BM. 2007. The feasibility of rattan cultivation within shifting cultivation systems: the role of policy and market institutions. In: Cairns M, ed. Voices from the forest: integrating indigenous knowledge into sustainable upland farming. Washington: RFF Press. p 729742.

Bruijnzeel LA. 2004. Hydrological functions of tropical forests: not seeing the soil for the trees? Agriculture, Ecosystems & Environment 104:185228.

Bruun TB, Mertz O, Elberling B. 2006. Linking yields of upland rice in shifting cultivation to fallow length and soil properties. Agriculture, Ecosystems & Environment 113(14):139149.

Budidarsono S, Wulan YC, Budi, Joshi L, Hendratno S. 2007. Livelihoods and forest resources in Aceh and Nias for a sustainable forest resource management and economic progress: Report of the project identification study. ICRAF Working Paper 55. Bogor, Indonesia: World Agroforestry Centre (ICRAF) SEA Regional Office.

Cairns M, ed. 2007. Voices from the forest: integrating indigenous knowledge into sustainable upland farming. Washington: RFF Press.

Colchester M, Jiwan N, Andiko, Sirait MT, Firdaus AY, Surambo A, Pane H. 2006. Promised land: palm oil and land acquisition in Indonesia implications for local communities and indigenous peoples. Bogor, Indonesia: Forest People Programme, Sawit Watch, HUMA, World Agroforestry Centre (ICRAF) SEA Regional Office.

Colfer CJP, Dudley RG. 1997. Shifting cultivators of Indonesia: marauders or managers of the forest? Rice production and forest use among the Uma' Jalan of East Kalimantan. Samarinda: GTZ-SFMP report.

Contreras-Hermosilla A, Fay CC. 2005. Strengthening forest management in Indonesia through land tenure reform: issues and framework action. Washington: Forest Trends.

Cramb RA. 1993. Shifting cultivation and sustainable agriculture in East Malaysia: a longitudinal case-study. Agricultural Systems 42(3):209226.

Cramb RA. 2005. Farmers' strategies for managing acid upland soils in Southeast Asia: an evolutionary perspective. Agriculture, Ecosystems & Environment 106:6987.

Dechert G, Veldkamp E, Anas I. 2004. Is soil degradation unrelated to deforestation? Examining soil parameters of land use systems in upland Central Sulawesi, Indonesia. Plant and Soil 265:197209.

Dierolf T, Fairhurst T, Mutert E. 2001. Soil fertility kit: a toolkit for acid upland soil fertility management in Southeast Asia. Singapore: Potash and Phosphate Institute, East and Southeast Asia Program.

Directorate General of Forest Production. 2007. Development of forest people plantation. Jakarta: Department of Forestry.

Direktorat Jenderal Perkebunan. 2007. Road map kelapa sawit (Elaeis guineensis). Jakarta: Direktorat Jenderal Perkebunan.

Elmhirst RJ. 1997. Gender, environment and culture: a political ecology of transmigration in Indonesia. London: Wye College.

Fay C, Michon G. 2005. Readdressing forestry hegemony when a forest regulatory framework is best replaced by an agrarian one. Forest Trees and Livelihoods 15:193209.

Fluyt PCM. 1936. Report on the condition of the Forest Service for the Outer Islands at the end of the tenure of Dr. R. Wind as chief inspector, head of the Forest Service, June 1936. Internal report. Buitenzorg: Forest Service.

Friday KS, Drilling EM, Garrity DP. 1999. Imperata grassland rehabilitation using agroforestry and assisted natural regeneration. Bogor, Indonesia: International Centre for Research in Agroforestry (ICRAF) SEA Regional Office.

Galudra G. 2003a. Conservation policies versus reality: case study of flora, fauna, and land utilization by local communities in Gunung Halimun, Salak National Park. Southeast Asia Working Paper 2003_2. Bogor, Indonesia: World Agroforestry Centre.

Galudra G. 2003b. Kasepuhan and their socioculture interaction to the forest. Southeast Asia Working Paper, No. 2003_3. Bogor, Indonesia: World Agroforestry Centre.

Galudra G. 2006a. Memahami Konflik Tenurial Melalui Pendekatan Sejarah: Studi kasus di Lebak Banten, Bogor, Indonesia. Working Group on Forest Land Tenure (WG Tenure) http://www.worldagroforestry.org/sea/Publications/files/paper/PP0201-06.PDF

Galudra G, Sirait MT. 2006. The unfinished debate: socio-legal and science discourses on forest land-use and tenure policy in 20th century Indonesia. Bogor, Indonesia: World Agroforestry Centre (ICRAF) SEA Regional Office. (Available from http://www.iascp.org/bali/papers/Galudra_Gamma.pdf, http://dlc.dlib.indiana.edu/cpr/full-record.php?r_no=272203)

Gauthier RC. 1998. Policies, livelihood and environmental change at the forest margin in North Lampung, Indonesia: a coevolutionary analysis. London: University of London.

Giardina CP, Sanford Jr. RL, Døckersmith IC, Jaramillo VJ. 2000a. The effects of slash burning on ecosystem nutrients during the land preparation phase of shifting cultivation. Plant and Soil 220:247260.

Giardina CP, Sanford Jr. RL, Døckersmith IC. 2000b. Changes in soil phosphorus and nitrogen during slash burning of a dry tropical forest. Soil Science Society of America Journal 64:399405.

Hairiah K, van Noordwijk M, Setijono S. 1993. Tolerance to acid soil conditions of the velvet beans Mucuna pruriens var. utilis and M. deeringiana. Plant Soil 152:187199.

Hartemink AE. 2001. Biomass and nutrient accumulation of Piper aduncum and Imperata cylindrica fallows in the humid lowlands of Papua New Guinea. Forest Ecology and Management 144:1932.

Hartemink AE. 2007. Piper aduncum fallows in the lowlands of Papua New Guinea. In: Cairns M, ed. Voices from the forest: integrating indigenous knowledge into sustainable upland farming. Washington: RFF Press. p 185189.

Hartiningsih M, Harto A, Arif A. 2008. Lenyapnya 'syurga' kami. Kompas, 15 June.

IPOC, 2006. Indonesian oil palm statistics 2006. Indonesian Oil Palm Commission. Jakarta: Department of Agriculture.

Jepsen MR. 2006. Above-ground carbon stocks in tropical fallows, Sarawak, Malaysia. Forest Ecology and Management 225:287295.

Juo ASR, Manu A. 1996. Chemical dynamics in slash-and-burn agriculture. Agriculture, Ecosystem and Environment 58:4960.

Kauffman JB, Sanford Jr. R, Cummings D, Salcedo I, Sampaio E. 1993. Biomass and nutrient dynamics associated with slash fires in neotropical dry forests. Ecology 74:140151.

Ketterings QM, Wibowo TT, van Noordwijk M, Penot E. 1999. Slash-and-burn as a land clearing method for small-scale rubber producers in Sepunggur, Jambi province, Sumatra, Indonesia. Forest Ecology and Management 120:157169.

Ketterings QM, 1999. Fire as a land management tool in sepunggur Sumatra, Indonesia, can farmers do without it?. PhD Thesis. Ohio State University. 285 p.

Ketterings QM, van Noordwijk M, Bigham JM. 2002. Soil phosphorus availability after slash-and-burn fires of different intensities in rubber agroforests in Sumatra, Indonesia. Agriculture, Ecosystems and Environment 92:3748.

Kools, JF. 1935. Hoema's, hoemablokken en boschreserven in de Residentie Bantam. Doctoral dissertation. Wageningen: Wageningen University.

Kyuma K, Tulaphitak T, Pairintra C. 1985. Changes in soil fertility and tilth under shifting cultivation. Soil Science & Plant Nutrition 31:227238.

Lal R. 1991. Myths and scientific realities of agroforestry as a strategy for sustainable management for soils in the tropics. Advances. in Soil Science 15:91137.

Lawrence D, Astiani D, Syhazaman-Kawur M, Fiorentino I. 2007. Does tree diversity affect soil fertility: findings from fallow system in West Kalimantan. In: Cairns M, ed. Voices from the forest: integrating indigenous knowledge into sustainable upland farming. Washington: RFF Press. p 502514.

Levang P, Sitorus S, Dounias E. 2007. City life in the midst of the forest: a Punan hunter-gatherer's vision of conservation and development. Ecology and Society 12(1):18.

MacDicken K. 2007. Upland rice response to Leucaena leucocephala: fallows on Mindoro, the Philippines. In: Cairns M, ed. Voices from the forest: integrating indigenous knowledge into sustainable upland farming. Washington: RFF Press. p 295300.

Mackensen J, Hölscher D, Klinge R, Fölster H. 1996. Nutrient transfer to the atmosphere by burning of debris in eastern Amazonia. Forest and Ecology Management 86:121128.

Marsden WH. 1811. The history of Sumatra. Reprinted from 3rd edition, Oxford: Oxford University Press.

Mulyoutami E, Rismawan R, Joshi L. 2008. Local knowledge and management of simpukng or forest gardens among the Dayak people in East Kalimantan. Submitted to Forest and Ecology Management.

Murdiyarso D, van Noordwijk M, Puntodewo A, Widayati A, Lusiana B. 2008. District-scale prioritization for A/R CDM project activities in Indonesia in line with sustainable development objectives. Agriculture, Ecosystems and Environment 126:5966

Murniati. 2002. From Imperata cylindrica grasslands to productive agroforestry. Ph.D. thesis. Wageningen: Wageningen University.

Myers RJK, de Pauw E. 1995. Strategies for the management of soil acidity. In: Date RA, Grundon NJ, Rayment GE, Probert ME, eds. Plant-soil interactions at low pH: principles and management. Kluwer, Dordrecht. p 729741.

Nugraha A. 2005. Rindu ladang, perspektif perubahan masyarakat desa hutan. Tangerang, Indonesia: Wana Aksara.

Nye P, Greenland D. 1960. The soil under shifting cultivation. Technical Communication No. 51. England: Commonwealth Agricultural Bureau.

Onghokham. 2003. The thugs, the curtains and the sugarlord: power, politics and culture in colonial Java. Jakarta: Metafor Publishing.

Palm CA, Tomich T, van Noordwijk M, Vosti S, Gockowski J, Alegre J, Verchot L. 2004. Mitigating GHG emissions in the humid tropics: case studies from the Alternatives to Slash and Burn Program (ASB). Environment, Development and Sustainability 6:145162.

Palm CA, van Noordwijk M, Woomer PL, Alegre J, Arevalo L, Castilla C, Cordeiro DG, Hairiah K, Kotto-Same J, Moukam A, Parton WJ, Ricse A, Rodrigues V, Sitompul SM. 2005. Carbon losses and sequestration following land use change in the humid tropics. In: Palm CA et at., eds. Alternatives to slash and burn: the search for alternatives. New York: Columbia University Press.

Penot E. 2007. From shifting cultivation to sustainable jungle rubber: a history of innovation in Indonesia. In: Cairns, M, ed. Voices from the forest: integrating indigenous knowledge into sustainable upland farming. Washington: RFF Press. p 577599.

Piggin C, 2007. The role of Leucaena in swidden cropping and livestock production in Nusa Tenggara Timur, Indonesia. In: Cairns M, ed. Voices from the forest: integrating indigenous knowledge into sustainable upland farming. Washington: RFF Press. p 272286.

Potter L. 2008. Oil palm vs swidden agriculture. Paper presented at the international workshop on the Demise of Swidden Agriculture in South East Asia. Hanoi Agricultural University, March.

Purnomosidhi P, Hairiah K, Rahayu S, van Noordwijk M. 2005. Smallholder options for reclaiming and using Imperata cylindrical L. (alang-alang) grasslands in Indonesia. In: Palm CA, Vosti SA, Sanchez PA, Ericksen PJ, Juo ASR, eds. Slash and burn: the search for alternatives. New York: Columbia University Press. p 248262.

Richards JF, Flint E. 1994. A century of land-use change in South and Southeast Asia. In: Lange OL, Mooney HA, Remmert H, eds. Effects of land-use change on atmospheric CO2 concentrations. Ecological studies 101. New York: Springer-Verlag. p 1557.

Riyanto B. 2007. Konstruksi hutan adat menurut undang-undang kehutanan. In: Safitri M, ed. Konstruksi kutan adat: pilihan hukum pengakuan masyarakat adat atas sumberdaya hutan. Bogor: Forum Komunikasi Kehutanan Masyarakat. p 5498.

Riyanto B. 2008. Hutan adat dan hutan desa. Warta Tenure 5 (April), p 68 and 19. (Available at www.wg_tenure.org)

Rodenburg J, Stein A, van Noordwijk M, Ketterings QM. 2003. Spatial variability of soil pH and phosphorus in relation to soil runoff following slash and burn land clearing in Sumatra, Indonesia. Soil Tillage Research 71:114.

Roder W, Maniphone S, Keoboualapha B, Fahrney K. 2007. Fallow improvement with Chromolaena odorata in upland rice systems of northern Laos. In: Cairns M, ed. Voices from the forest: integrating indigenous knowledge into sustainable upland farming. Washington: RFF Press. p 142152 .

Roshetko JM, Snelder DJ, Lasco RD, van Noordwijk M. 2008. Future challenge: a paradigm shift in the forestry sector. In: Snelder DJ, Lasco RD, eds. Smallholder tree growing for rural development and environmental services: lessons from Asia (Advances in Agroforestry, Volume 5). Berlin: Springer. p 451483.

Ruthenberg H. 1976. Farming systems in the tropics. Oxford: Oxford University press.

Saleh HH. 1997. Slash and burn practices in North Lampung: land use and socioeconomic aspects. In: van Noordwijk M, Tomich TP, Garrity DP, Fagi AM, eds. Alternatives to slash-and-burn research in Indonesia. ASB-Indonesia Report Number 6. Bogor, Indonesia: Agency for Agricultural Research and Development.

Sanchez P. 1976. Properties and management of soils in the tropics. New York: John Wiley and Sons.

Sasaki H. 2007. Innovation in swidden-based rattan cultivation by Benuaq-Dayak farmers in East Kalimantan, Indonesia. In: Cairns M, ed. Voices from the forest: integrating indigenous knowledge into sustainable upland farming. Washington: RFF Press.

Savitri LA. 2007. Uncover the concealed link: gender and ethnicity-divided local knowledge on the agro-ecosystem of a forest margin. A case study of Kulawi and Palolo local knowledge in Central Sulawesi, Indonesia. Dissertation for Kassel University, Germany.

Simarmata R. 2007. Pilihan hukum pengakuan masyarakat adat atas sumber daya hutan. In: Safitri M, ed. Konstruksi hutan adat: pilihan hukum pengakuan masyarakat adat atas sumberdaya hutan. Bogor: Forum Komunikasi Kehutanan Masyarakat. p 154.

Steininger MK, Tucker CJ, Townshend JRG, Killeen TJ, Desch A, Bell V, Ersts P. 2001. Tropical deforestation in the Bolivian Amazon. Environmental Conservation 28:127134.

Sulistyawati E, Noble IR, Roderick ML. 2005. A simulation model to study land use strategies in swidden agriculture systems. Agricultural Systems 85(3):271288.

Suyanto. 1999. Evolution of indigenous land tenure institutions and tree resource management in Sumatra. Dissertation for Tokyo Metropolitan University.

Tomich TP, Fagi AM, de Foresta H, Michon G, Murdiyarso D, Stolle F, van Noordwijk M. 1998. Indonesia's fires: smoke as a problem, smoke as a symptom. Agroforestry Today 10(1):47.

Trenbath BR. 1989. The use of mathematical models in the development of shifting cultivation systems. In: Proctor J, ed. Mineral nutrients in tropical forest and savanna ecosystems. Oxford: Blackwell Scientific Publications. p 353371.

Uhl C, Jordan CF. 1984. Succession and nutrient dynamics following forest cutting and burning in the Amazon. Ecology 65:14761490.

van Noordwijk M. 2002. Scaling trade-offs between crop productivity, carbon stocks and biodiversity in shifting cultivation landscape mosaics: the FALLOW model. Ecological Modelling 149: 113-126

van Noordwijk M, Tomich TP, Winahyu R, Murdiyarso D, Suyanto S, Partoharjono S, Fagi A. 1995. Alternatives to slash and burn: summary report of phase I. Bogor: ASB-Indonesia, International Centre for Research in Agroforestry (ICRAF) SEA Regional Office.

van Noordwijk M, Hairiah K, Guritno B, Sugito Y, Ismunandar S. 1996. Biological management of soil fertility for sustainable agriculture on acid upland soils in Lampung (Sumatra). Agrivita 19:131136.

van Noordwijk M, Tomich TP, Garrity DP, Fagi AM, eds. 1997. Alternatives to slash-and-burn research in Indonesia. ASB-Indonesia report 6. Bogor, Indonesia: Agency for Agricultural Research and Development.

van Noordwijk M, Verbist B, Vincent G, Tomich TP. 2001. Simulations models that help us to understand local action and its consequences for global concerns in a forest margin landscape. ASB lecture note 11A. Bogor, Indonesia: International Centre for Research in Agroforestry (ICRAF) SEA Regional Office.

van Noordwijk M, Suyamto DA, Lusiana B, Ekadinata A, Hairiah K. 2008a. Facilitating agroforestation of landscapes for sustainable benefits: tradeoffs between carbon stocks and local development benefits in Indonesia according to the FALLOW model. Agriculture Ecosystems and Environment 126: 98-112.

van Noordwijk, Khasanah M, Hairiah N, Suprayogo K, Macandog D, Lusiana B, Cadisch G. 2008b. Agroforestation of grasslands in Southeast Asia: WaNuLCAS model scenarios for shade-based Imperata control during tree establishment. In: Snelder DJ, Lasco RD, eds. Smallholder tree growing for rural development and environmental services: lessons from Asia. Advances in Agroforestry 5:139159

van Noordwijk M, Roshetko JM, Murniati, Angeles MD, Suyanto, Fay C, Tomich TP. 2008c. Farmer tree planting barriers to sustainable forest management. In: Snelder DJ, Lasco RD, eds. Smallholder tree growing for rural development and environmental services: lessons from Asia (Advances in Agroforestry, Volume 5). Berlin: Springer. p 427449.

Wadley R. 2007. The complex agroforestry of the Iban in West Kalimantan and their possible role in fallow management and forest regeneration. In: Cairns M, ed. Voices from the forest: integrating indigenous knowledge into sustainable upland farming. Washington: RFF Press. p 490501.

Widyastuti CA. 2000. Knowledge of women on sweet potato and its contribution to sustainability of sweet potato biodiversity in the Baliem valley: a case study in Waga-Waga village, Kurulu district, Jayawijaya regency, Irian Jaya. Ms. thesis. Bogor, Indonesia: Bogor Agriculture University.

Wilk J, Andersson L. 2001. Modelling of hydrological impacts of forest removal in a river basin in northeast Thailand. Hydrological Processes 15:27292748.

Zhu Y, Chen H, Fan JH, Wang Y, Li Y, Chen J, Fan JX, Yang S, Hu L, Leung H, Mew TW, Teng PS, Wang Z, Mundt CC. 2000. Cultivating biodiversity for disease control: a case study in China. Nature 406:718722

Ziegler AD, Giambelluca TW, Sutherland RA, Nullet MA, Vien TD. 2007. Soil translocation by weeding on steep-slope swidden fields in northern Vietnam. Soil and Tillage Research 96:219233.

Zinke P, Sabhasri S, Kunstadter P. 1978. Soil fertility aspects of the Lua' forest fallow system of shifting cultivation. In: Kunstadter P, Chapman E C, Sabhasri S. Farmers in the forest. Honolulu: The University Press of Hawaii. p 134159.

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