

A CONCEPTUAL FRAMEWORK FOR THE ASSESSMENT OF TROPICAL SECONDARY FOREST DYNAMICS AND SUSTAINABLE DEVELOPMENT POTENTIAL IN ASIA

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CHOKKALINGAM, U., SMITH, J., DE JONG, W. & SABOGAL, C. 2001. A conceptual framework for the assessment of tropical secondary forest dynamics and sustainable development potential in Asia. In this paper, we present an intensification model based on the intensity of exploitation and use of forests and forest lands as a relevant framework for analysing the appearance, dynamics, and evolution of different types of secondary forests. The systematic driving forces responsible for the disturbances and subsequent secondary forest re-growth tend to change and evolve along this continuum. This dynamic, process-oriented, long-term framework draws on existing theories and models of the underlying factors of forest change relevant for tropical Asia, and emphasises factors related to secondary forests. We identify and characterise four general stages along this intensification continuum—the extensive use stage, the intensive exploitation stage, the forest depleted stage, and the forest recovery stage. In the extensive use stage, secondary forests tend to be limited and largely arise from long-rotation swidden agriculture. In the intensive exploitation stage, secondary forests tend to increase in absolute and proportional area, and arise mainly out of industrial and local logging activities and fires. In the forest depleted stage, natural forest cover is low and there is increasing interest in forest conservation, reforestation and sustainable management for timber, environmental and local needs. In the forest recovery stage, there is increased forest cover as a result of reforestation measures or regeneration with land use abandonment. This framework can help guide management and policy options for secondary forests based on threats and relative resource endowments, infrastructure, and the policy and institutional environment present in each stage. It could also be used to identify effective intervention points and to anticipate and prevent problem situations beforehand.

Key words: Conceptual framework - land use intensification - tropical Asia - secondary forests - extensive use stage - intensive exploitation stage - forest degraded stage

CHOKKALINGAM, U., SMITH, J. De JONG, W. & SABOGAL, C. 2001. Konsepsi rangka kerja untuk penilaian dinamik dan potensi pembangunan mapan bagi hutan sekunder tropika di Asia. Dalam artikel ini, kami memberikan model pengintensifan berasaskan eksploitasi dan penggunaan hutan dan tanah hutan sebagai rangka kerja

yang berkaitan dalam menganalisis rupa bentuk, dinamik dan evolusi jenis-jenis hutan sekunder yang berbeza. Daya penggerak sistematik yang bertanggungjawab terhadap kerosakan dan seterusnya pertumbuhan semula hutan sekunder cenderung untuk berubah dan berkembang di sepanjang kontinum ini. Rangka kerja yang dinamik, berorientasikan proses dan digunakan untuk jangka panjang mengambil kira teori yang sedia ada serta model faktor-faktor tersembunyi bagi perubahan hutan yang berkaitan Asia tropika. Selain itu ia menekankan faktor-faktor yang berkaitan hutan sekunder. Kami mengenal pasti dan mencirikan empat peringkat umum di sepanjang kontinum pengintensifan: peringkat penggunaan ekstensif, peringkat eksploitasi intensif, peringkat penyusutan hutan, dan peringkat pemulihan hutan. Di peringkat penggunaan ekstensif, hutan sekunder agak terhad dan sebahagian besarnya muncul daripada pertanian ladang kitaran panjang. Di peringkat eksploitasi intensif, hutan sekunder cenderung meningkat di kawasan mutlak dan berkadar. Hutan ini tumbuh khususnya daripada aktiviti industri dan pembalakan tempatan serta kebakaran. Di peringkat penyusutan hutan, litupan hutan semula jadi adalah rendah dan terdapat minat yang meningkat dalam pemuliharaan hutan, penghutanan semula dan pengurusan mapan untuk balak serta keperluan alam sekitar dan tempatan. Di peringkat pemulihan hutan, litupan hutan meningkat kerana penghutanan semula atau pemulihan akibat penghentian penggunaan tanah. Rangka kerja ini dapat dijadikan panduan dalam pengurusan dan pemilihan polisi bagi hutan sekunder berasaskan ugutan dan pembiayaan sumber-sumber relatif, prasarana, dan keadaan polisi serta institusi yang wujud di setiap peringkat. Ia juga dapat digunakan untuk mengenal pasti masa campur tangan berkesan dan untuk menjangka serta mengelakkan masalah terlebih dahulu.

Introduction

As primary forests decline in the tropics, large and growing areas of secondary forest appear (Brown & Lugo 1990, Emrich *et al.* 2000). Secondary forests are defined as 'forests regenerating largely through natural processes after significant human disturbance of the original forest vegetation at a single point in time or over an extended period, and displaying a major difference in forest structure and/or canopy species composition with respect to nearby primary forests on similar sites' (Chokkalingam *et al.* 2000). Often considered degraded compared to the forests they replace (Banerjee 1995, Wadsworth 1997), their existence suggests that tropical forests are dynamic and resilient. They have the capacity to recover from intensive human intervention under certain conditions and be managed as a renewable resource for a wide range of socio-economic and environmental services. Chokkalingam *et al.* (2000) identify five major categories of secondary forests in tropical Asia: post-extraction secondary forests, post-fire secondary forests, swidden fallow secondary forests, secondary forest gardens, and rehabilitated secondary forests (see box for definitions).

To create conditions under which these different types of secondary forests can sustainably contribute to the well-being of local people and the environment, we need to understand the following:

- (1) Why are these lands allowed to regenerate into forests after intensive disturbance versus being degraded or converted to non-forest use?

Post-extraction secondary forests are defined here as 'forests regenerating largely through natural processes after significant reduction in the original forest vegetation through tree extraction at a single point in time or over an extended period, and displaying a major difference in forest structure and/or canopy species composition with respect to nearby primary forests on similar sites'.

Post-fire secondary forests are defined here as 'forests regenerating largely through natural processes after significant reduction in the original forest vegetation due to a catastrophic human-induced fire or succession of fires, and displaying a major difference in forest structure and/or canopy species composition with respect to nearby primary forests on similar sites'.

Swidden fallow secondary forests are defined here as 'forests regenerating largely through natural processes in woody fallows of swidden agriculture for the purposes of restoring the land for cultivation again'.

Secondary forest gardens are defined here as 'considerably enriched swidden fallows, or less-intensively-managed smallholder plantations or home gardens where substantial spontaneous regeneration is tolerated, maintained, or even encouraged'.

Rehabilitated secondary forests are defined here as 'forests regenerating largely through natural processes on degraded lands*, often aided by rehabilitation efforts, or the facilitation of natural regeneration through measures such as protection from chronic disturbance, site stabilisation, water management, and planting'.

*Degraded lands are defined as 'formerly forested lands severely impacted by intensive and/or repeated disturbance (such as mining, repeated fires, or overgrazing) with consequently inhibited or delayed forest re-growth. These include barren areas, *Imperata* grasslands, brushlands, and scrublands'.

Source: Chokkalingam and de Jong (2001)

- (2) What socio-economic and environmental services do secondary forests provide at the current time?
- (3) How can degradation and inappropriate conversion be prevented, and the current contribution of secondary forests enhanced and rendered part of a sustainable land use system?

Disturbance and vegetation re-growth dynamics are largely a result of social interactions with the 'natural environment, and the task of understanding and working with these dynamics calls for a holistic analysis of ecological, social, economic, technical, and policy aspects. A conceptual framework that brings together information from these different disciplines in a meaningful manner is required (Skole *et al.* 1999). Considerable site-specific information exists with

regard to the dynamics and importance of different types of secondary forests in tropical Asia, and the threats and opportunities they face. However, these show a high degree of variability in space and time, and the underlying causative factors are complex and interlinked. A dynamic conceptual framework can help organise the apparently random variability by identifying systematic processes/trends and their underlying driving forces.

A dynamic process-oriented long-term framework will be useful for the following purposes:

- (1) To identify the primary systematic driving forces underlying forest disturbance and re-growth at different stages of a longer-term process and seek to influence them, rather than the symptoms or effects/outcomes.
- (2) To analyse the options for secondary forest management and development at different stages and develop effective interventions.
- (3) To focus research on anticipating and preventing problem situations from occurring beforehand rather than documenting negative developments as they occur or trying to tackle them during the most difficult phase, when they are in full bloom.
- (4) To identify points in time and space to intervene effectively, i.e. where it may be easier to have a positive impact, and when attitudes are more favourable for sustainable forest and land management.
- (5) To extrapolate to other areas undergoing similar processes.

Theories on the dynamics of large-scale deforestation and their underlying causes (Palo 1987, Rudel & Horowitz 1993, Browder & Godfrey 1997, Richards 1997, Reis & Blanco 2000, Wunder 2000) do not adequately address forest re-growth as secondary forest or plantation after heavy human intervention. Studies on agricultural frontiers, mostly from Latin America (Moran *et al.* 1996, Smith *et al.* 1997), address forest change and re-growth. However, they only explain forest re-growth related to swidden agriculture, and not forest change driven by other interventions like logging (an important phenomenon in Asia). Besides, all of the above theories are largely limited to a particular temporal and spatial point in the developmental process, i.e. exploitation of resources and development at the forest frontier zone. They do not identify the role of the process explained in the forestry transition of the region, nor do they pay adequate attention to forest-related developments before and beyond the frontier zone.

The 'environmental Kuznet's curve' (Panayotou 1997) and analyses by Persson (1998) and Mather (2000) look at longer-term trends in forest cover and their underlying causes. They all suggest declining and then rising trends in forest cover in countries across the globe. However, these authors with the exception of Persson (1998), focus on forest re-growth as occurring only in later developmental stages, when forest cover is very low and re-growth is more visible in the statistics. But existing data indicate that many types of secondary forest regenerate even when considerable primary forest cover still exists, for example, swidden fallow secondary forests and

post-extraction secondary forests. As suggested in Persson's (1998) stylised depiction (Figure 1), reduction in old forest cover often coincides with a simultaneous increase in managed natural forest (of which secondary forests are a component (Persson, pers. comm.)) cover from early on. Although there is some understanding of these phenomena, there has virtually been no attempt so far to systematise it through a dynamic framework.

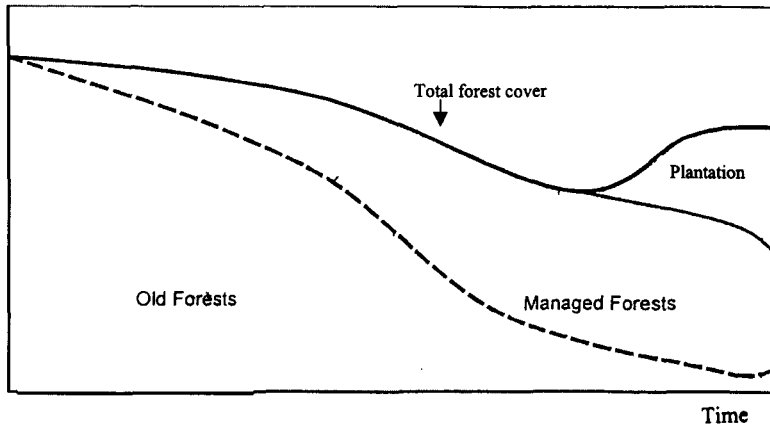


Figure 1 Stylised depiction of historical trends in trends in forest cover (adapted from Persson 1998)

The dynamic framework developed in this paper (see next section) conceptualises the evolution of the role and importance of different types of secondary forests and related land use based on the underlying systematic driving forces responsible for forest land disturbance and subsequent re-growth dynamics, over time and space in countries across tropical Asia. It draws from existing theories and models on the underlying factors of forest change relevant for tropical Asia and emphasises factors related to secondary forests. In the third section, the potential usefulness of this framework for guiding management and policy options at each stage of the intensification continuum is illustrated, along with its potential role in anticipating and preventing problem situations beforehand.

The intensification continuum

We propose an intensification continuum based on the intensity of exploitation and use of forests and forest lands as a relevant framework for assessing disturbance and secondary forest re-growth dynamics in tropical Asia. The systematic driving forces responsible for the disturbances and subsequent secondary forest regeneration tend to change and evolve along this continuum. We identify four general stages along this intensification continuum:

- (1) Extensive use stage
- (2) Intensive exploitation stage
- (3) Forest depleted stage
- (4) Forest recovery stage

The forest recovery stage has been noted elsewhere but is not really significant at the current time in tropical Asia in terms of natural forests or forestry plantations. Regions such as Java, the wet zone of Sri Lanka and Kerala can be said to have reached this stage but the increased vegetative cover is largely composed of home gardens and estate crop plantations. We deal primarily with the first three stages in this framework.

Extensive use stage

Resource endowments and land use activities (Table 1)

Extensive land use tends to occur where land is abundant; and population density, market access, infrastructure, and capital and technological inputs are low. Boserup (1965) relates extensive land use to high land availability and low population density, but the framework presented here further identifies other factors such as national development prerogatives; infrastructure, capital and technological availability as being important determinants of land use intensification in tropical Asia.

With limited labour and market access, households limit forest clearing to what can be managed for cultivation and is necessary for survival (Lahjie 1996). Also, given the poor infrastructure, most products extracted are for subsistence, while selected high value products are traded (Padoch & Peluso 1996, Kathirithamby-Wells 1998), making use of animal and river transport. With low capital and technological inputs both in agriculture and forest resource use as well as plentiful resource availability, there is not much investment in increasing yields (Persson 1996). In forested regions in the extensive use stage, indigenous groups tend to practice long-fallow swidden agriculture and extraction of forest products (Chandran 1998, Reid 1998). Forests and forest products play an integral role in local livelihoods (Colfer *et al.* 1997, Wiersum 1997, Chandran 1998, Reid 1998). Traditional local institutions regulate land use, and government intervention is very limited (Padel 1998). The forest is often a common property resource with claims to tracts or individual trees based on clearing or planting efforts.

Forest and landscape characteristics (Table 2)

In the extensive use stage, primary forest cover tends to undergo a slow decline with the general trends of rising population and expansion of agriculture (Persson 1998). Secondary forest re-growth occurs because it complements agriculture, but the area tends to be limited compared to subsequent stages. Swidden fallow secondary forests, along with some secondary forest gardens, are the principal

Table 1 Socio-economic, resource, institutional and policy-related characteristics of the three stages of the development/intensification continuum

Characteristics	Extensive use stage	Intensive exploitation stage	Forest depleted stage
1. Land use			
Main activities	Swidden (long-fallow) agriculture Local extraction of forest products	Intensive logging Industrial-scale plantation Mining activities Development activities-roads, dams Intensive local extract of forest products Swidden (short-fallow) or permanent agriculture Secondary forest garden & smallholder plantations Grazing	(Small-scale) local extraction of forest products Sedentary agriculture Grazing Protected forest areas Some agroforest and home gardens—more in wetter areas Some plantation forestry Some rehabilitation of degraded lands
Main actors	Indigenous groups/ forest-dwellers	Timer concessionaires Mills and processing industries Plantation companies Mining companies Government departments (forestry, mining, sponsored migration, plantation) Migrants Traditional forest-users/residents	Local communities (traditional forest-users and migrant settlers) NGOs Extension agencies Government
Objective	Subsistence & some cash income in areas of market access	Large-scale industrial activities: profits and economic growth Infrastructure: development and economic growth Migrant activities: cash income and subsistence Traditional forest-users: subsistence and cash income	Communities: subsistence and some cash income Private landholders: cash income, investments Forest protection and restoration measures: environmental services and/or forest products Plantation forestry: cash income, forest products and services

continued

Table 1 (continued)

Characteristics	Extensive use stage	Intensive exploitation stage	Forest depleted stage
II. Relative resource endowments			
Population density and labour availability	Low	Tends to increase—migrants (transient and permanent settlers) and natural increases in local population	High, medium, or low depending on whether people continue to reside in area, or move to better opportunities available elsewhere
Natural resource and forest land availability	Plenty	Less	Low
Capital and technology	Low	High—availability of private and government finance, improved harvesting and processing technologies, chemical inputs, improved biological stocks and extension support	High in private operations Medium in government-owned operations. Lower in open access and community-owned operations
III. Infrastructure			
Transport and access	Limited—mainly water and animal transport	Better—road networks developed and more powerful motorised road and water transport available	High—already established road networks, though they may become degraded in poorer areas More efficient transport systems available for those who can pay
Markets	Limited—mainly along waterways and coastal zones	Increased access to local, regional, national and global markets	Accessible

continued

Table 1 (continued)

Characteristics	Extensive use stage	Intensive exploitation stage	Forest depleted stage
IV. Institutional endowments			
Land tenure	Traditional claims operates. Opening up of forest for swidden confers nearly exclusive use rights on the individual.	Overlapping conflicting tenure relations with government ownership of forest lands, leases given to industry, traditional claims still held, and migrant squatting on opened up land.	Large areas still government-owned, either totally protected or open access. Move towards privatisation (to communities or households) or joint management of some forest lands.
Governance	Limited government intervention. Traditional local councils govern resource use.	Centralised conferment of resource use rights, monitoring and control of use. Influence of traditional local councils more limited.	The start of devolution of governance of some forest and land use to local levels, both governments and communities.
V. Policy environment			
	Forests away from urban and development centres not subject to many government policy initiatives.	Forests and forest lands viewed as national resources and wealth, and their exploitation and conversion promoted to further national development and economic growth through subsidies to industry, development projects, etc. Tendency to marginalise local resource needs, traditional management and use practices.	Higher environmental and social awareness. Concern for low forest cover, loss of environmental services, product scarcity, land degradation, and local livelihood needs begin to guide policy initiatives. Greater emphasis on reforestation, natural regeneration, community forestry, sustainable forest management, watershed protection, etc.

Table 2 Secondary forest characteristics of the three stages of the development/intensification continuum

Characteristics	Extensive use stage	Intensive exploitation stage	Forest depleted stage
Absolute and relative (vis-à-vis primary forest - PF) cover	Low absolute and relative cover	Higher absolute and relative cover	Stable or declining absolute cover, but very high relative cover
New SF formation	Some	Considerable	Insignificant
Main SF types	Mostly swidden fallow SF Some SF gardens Limited post—extraction SF	Most post-extraction SF Some swidden fallow SF More SF garden (on favourable sites) Some post-fire SF	Not much new SF formation, except for some rehabilitated SF Some post-fire SF
Importance to local livelihoods	The dominant type, swidden fallow SF (and SF gardens)—very important for soil rejuvenation, subsistence products, and some cash income in areas of market access	The dominant type (post-extraction SF) not very tightly linked to smallholder land use but still very important for subsistence and cash income. Illegal logging could be a major source of income to the local economy. In some areas, important to industry for timber.	SF of all types - important for local livelihoods when there are higher extraction pressures and resource scarcity. Even more so if they are involved in rehabilitation, management and benefit sharing.
Management practices	Low-intensity management of swidden fallow SF based on traditional technical knowledge	Most exploitative use of post-extraction and post-fire SF by different users. Swidden fallow SF give way to more intensively managed SF gardens favouring commercially desired species.	SF protection in reserves, low-intensity management in community-owned areas, intensive management in small private holdings, and unsustainable exploitation in open access areas.

continued

Table 2 (continued)

Characteristics	Extensive use stage	Intensive exploitation stage	Forest depleted stage
Environmental dimensions	Not much damage in formation of swidden fallow SF, keeps early successional forests and species on the landscape in a shifting mosaic	Lots of environmental damage in formation of post-extraction and post-fire SF due to large-scale and intensive nature of forest exploitation. Subsequent SF re-growth is important for environmental stability.	SF formation and management on degraded lands could contribute greatly to environmental stability.
Ecological characteristics	Rapid re-growth of swidden fallow SF and good forest conditions	Post-extraction and post-fire SF re-growth is difficult because of soil destruction, lack of seed sources in the vicinity, and repeated disturbance, with the forest getting more degraded as a result.	Existing SF degraded under conditions of open access and high extraction pressures, but can be in good condition when protected or otherwise managed. Establishment of rehabilitated SF is difficult because of highly degraded site conditions and chronic disturbance.
Landscape characteristics	Large sections of PF or mature SF; broken up by little pockets of settlements, fields, swidden fallow SF of various ages, and some SF gardens	Post-extraction and post-fire SF in different development stages, degraded lands, agriculture, smallholder and large-scale plantations and estate crops (more in moist areas), industries and development projects, mines, road networks, settlements, and PF patches on inaccessible sites.	Predominantly an agricultural landscape intermixed with urban developments, large areas of degraded lands, and some plantations. PF scarce and confined to inaccessible areas. SF also restricted to hilly terrain or less accessible areas.

PF: primary forest
 SF: secondary forest

types of secondary forests. Individual households may typically manage and use one or a few swidden fields as well as fallows of varying ages, and extract products from primary forests. This results in a heterogeneous landscape around settlements which may consist of a mosaic of swidden fields, fallows of varying ages all the way to mature secondary forest, and primary forests, some of which may be protected (Chandran 1998). The forested region as a whole would then have large sections of primary forest or mature secondary forest, broken up by pockets of settlements, fields, swidden fallow secondary forests of various ages, and patches of protected primary forest.

Development and characteristics of different secondary forest types (Table 2)

Swidden fallow secondary forests: Forest dwellers clear primary forest or mature secondary forest to make swidden agricultural fields with long forest fallows mainly for subsistence production. In this stage, swidden fallow secondary forests regenerate rapidly because they re-grow on small patches and are not subject to intensive use. In the continuously forested landscape seed sources are plentiful. Swidden fallow secondary forests provide rotating habitats for successional species in a primary forest matrix thus enhancing biodiversity. Due to limited forest destruction and rapid re-growth, the watershed and soil properties of this primary-secondary forest landscape are almost the same as land which is only under primary forest.

Swidden fallow secondary forests are critical components of local agriculture, but also provide a variety of products through the stages of succession that augment their subsistence and provide some cash income (de Jong *et al.* 2000b). Local dependence on these systems may be very high, particularly given their accessibility and the potential availability of greater numbers of desired species as a result of human manipulation. Secondary forests may be preferred by some groups for creating new swidden fields due to the ease of clearing such lands, whereas others may prefer to clear primary forests, citing the greater fertility of the soils. Management intensity of the swidden fallow secondary forests is usually low in this stage and based on traditional technical knowledge.

Secondary forest gardens: Home gardens and enriched fallows managed on a low-intensity basis (termed as 'secondary forest gardens' in this special issue) are already common in this stage, and may be an important source of cash income in places with higher population densities or greater market access. They are more prominent in the intensive exploitation stage.

Post-extraction secondary forests: Some logging and commercial extraction of other products may take place in the extensive use stage, but it is restricted and does not give rise to substantial areas of secondary forests.

Distribution and extent

The extensive use stage was common over much of forested pre-colonial and colonial Asia, and extended into the 1960s–70s in many regions (Richards 1996). It now persists in remote areas where forests are still plentiful and external pressures low, for example, in sections of Borneo, Sumatra, West Papua, Myanmar, Cambodia, and Lao PDR (Flint 1994, Bryant 1997, de Jong *et al.* 2000a). In the last three countries, war and civil strife inhibited development until recently (Bryant 1997).

Intensive exploitation stage

Resource endowments and land use activities

Intensive exploitation of natural resources tends to occur with emerging national development priorities aimed at industrial and infrastructure expansion and GDP growth. Large national and global markets for timber and plantation products create opportunities to earn foreign exchange (Persson 1996, Mather 2000, Wunder 2000). Forms of large-scale forest land perturbations include intensive logging, mining, conversion of forest lands to large-scale plantations and agriculture, as well as construction of dams, roads and other infrastructure (Mittelman 2000, Perera 2000, Zaizhi 2000). Logging activities tend to be largely exploitative with limited concern for longer-term sustainability. Underlying causes include high market demand, ample supply of richly stocked forests, short-term concession tenure, inappropriate logging regulations, limited government monitoring and control given the remoteness of the sites, enhanced local access to forests provided by logging roads, and elements of collusion and corruption (IFF 1999). Conversion of forest lands to other sectors such as plantations is facilitated by available global markets, pricing policies, and tax incentives and subsidies.

Migrants (spontaneous or sponsored) tend to follow in the wake of large-scale development activities and eke out livelihoods through logging, working on large-scale extraction or development projects, continuous or short-rotation cultivation at the forest frontier, and extraction of subsistence products from nearby forests (Kartawinata & Vayda 1984, Vayda & Sahur 1985). Unfamiliarity with the new biophysical conditions, cheap land availability, limited capital availability, or being forced to cultivate and use the most degraded areas abandoned by other groups may contribute to more degrading land use (Schmidt-Vogt 2000). Local long-term residents may remain at, move away from or towards the centres of exploitation, depending on resource conditions and the opportunities available. In the last case, they may adapt or alter their traditional practices in response to the new conditions and opportunities at the frontier. The presence of multiple actors and vast areas of highly degraded forest lands and plantations tend to increase the likelihood of uncontrolled burning and land degradation in drought periods (Dennis *et al.* 2000, Colfer *et al.* 2001).

Reallocation of forest land to large-scale exploitation or development activities, forest degradation, and/or rising population pressures may create resource and/

or land scarcities in the late intensive exploitation stage. Traditional long-rotation swidden agriculture tends to give way to shorter-rotation and permanent agriculture where land availability becomes a constraint. In some cases of scarcity of capital and tenure insecurity discouraging investments, shortened fallows without additional inputs to support the system could lead to progressive land degradation (Wiersum 1997, Schmidt-Vogt 1998). In other cases, modified management practices could include fallow enrichment with appropriate species or progressive intensification from swidden agriculture to secondary forest gardens to smallholder plantations (de Jong *et al.* 2000b, Ramakrishnan & Kushwaha 2000). These more positive trends could be related to favourable biophysical environments, increased commercialisation, road and market access, policy support, and technology and capital availability.

The intensive exploitation stage is usually characterised by a shift to active centralisation of ownership and governance of forest land by the State, with granting of industrial concessions on lands traditionally used by local people (IFF 1999). Both direct and indirect government interventions tend to be high in this stage, in terms of promoting logging, plantation, and other industrial development, determining property rights, regulating forest and forest land use, as well as encouraging migration. Often there are overlapping property rights claims, with governments, industries, migrants, and traditional users in conflict. Policies tend to focus on national development priorities with regard to forestry and forest lands, and local people could be marginalised and disempowered in the process. Traditional institutions and systems of land management may break down under the altered conditions.

Forest and landscape characteristics

In the intensive exploitation stage, primary forest cover tends to decline rapidly following widespread disturbance through extraction, fire, and conversion to alternative land use (Persson 1998). Secondary forests tend to increase in absolute and relative cover. The forest landscape in this stage could be very diverse, potentially comprising post-extraction and some post-fire secondary vegetation at various stages of development, degraded lands, development projects, road networks, smallholder and large-scale plantations, secondary forest gardens, some primary forest patches on sensitive or difficult-to-access sites, as well as short rotation swidden and permanent agriculture. The diverse landscape of intensive exploitation, deforestation and land degradation tends to eat into the primary forest frontier in this stage.

Development and characteristics of different secondary forest types

Post-extraction and post-fire secondary forests: Post-extraction secondary forests arising after commercial logging activities, both industrial and local, may be the principal type of secondary forest formed in this stage (Bhat *et al.* 2000, Kartawinata

et al. 2000, Lasco *et al.* 2000). Some post-fire secondary forest may regenerate following wildfires in areas that escape repeated burning (Dennis *et al.* 2000). Regeneration may occur following intensive extraction and/or fire instead of conversion to other uses because low capital and labour availability compared to land availability does not yet favour conversion. This is particularly so in remote areas where property rights enforcement is poor. In addition, unsuitable site conditions (swamps, steep slopes, dry areas) tend to limit conversion efforts.

Post-extraction and post-fire secondary forests formed in this stage tend to be less tightly linked to smallholder systems of use, or are used like open access resources and are thus more susceptible to degradation and conversion. However, they could be very important to local people for subsistence and cash income (Lasco *et al.* 2000). They can be a source of valuable timber in well-monitored industrial or state forest areas closer to market centres. Often post-extraction secondary forests have an established road infrastructure and market access, and are subject to rampant 're-entry' logging in the intensive exploitation stage.

Intensive logging and catastrophic fires over large tracts could cause considerable environmental damage in terms of soil erosion, and loss of watershed functions and biodiversity. Subsequent secondary forest re-growth may be important for environmental stability, but successional processes are often inhibited by the scale and intensity of destruction in this stage. Soil destruction, lack of seed sources in the vicinity, and repeated disturbance (extraction, grazing, fire) could hamper forest re-growth (Aiken & Leigh 1995).

Swidden fallow secondary forests and secondary forest gardens: The importance of swidden fallow secondary forests tends to diminish with land use intensification, and gives way to short-rotation fallows, permanent agriculture, or secondary forest gardens with a larger planted component (Whitmore & Burnham 1984, de Jong *et al.* 2000b). The exact intensification pathway depends on subsistence needs, capital availability, economic incentives, tenure, and site conditions.

Planted commercial species in secondary forest gardens potentially provide a major source of cash income, depending on market conditions, while also providing various products for subsistence. Secondary forest gardens tend to be managed to favour the commercially desired species, with varying intensity depending on capital and market availability.

Distribution and extent

Intensive and rapid exploitation of forests started during the mid-late colonial periods in some parts of tropical Asia, and in the post-colonial period in other parts. Intensive and rapid forest exploitation is currently encroaching into regions with remaining primary forest, namely, parts of Sumatra, Borneo, West Papua, Lao PDR, and Cambodia, and still continues in northern Thailand and the Philippines (Persson 1996, Sunderlin & Resosudarmo 1996, Lasco *et al.* 2000, Mittelman 2000). The availability of increased capital, global markets, and improved harvesting and processing technology, roads, transport, and other infrastructure in the industrial

era allows for even more intensive and rapid forest exploitation compared to that in the pre-industrial colonial era.

Forest depleted stage

Relative resource endowments and land use activities

Forests are depleted given prior intensive and rapid forest exploitation and intensification of land use, and people adapt and respond to the depleted conditions. Population density may be high, medium, or low depending on whether people continue to reside in the area, or move to better opportunities available elsewhere. Capital and technology tend to be relatively low in local community operations, but high in private operations. Transport and market access tend to be high in this stage because of already established road networks, but become degraded in poorer areas. More efficient transport systems are usually available to those who can pay.

In this stage, a denuded resource base raises concerns about future timber supplies, and meeting local livelihood needs for fuelwood and other forest products. Low forest cover and environmental deterioration raise concerns for watershed protection, biodiversity conservation, and soil protection, among other environmental values (Mather 2000). Most of the limited natural forest cover tends to be protected and held by state agencies to conserve the remaining resources and safeguard environmental functions (Persson 1996). Logging bans are placed on most natural forests. Industrial and development activities are reduced in and around forest areas. However, there may still be populations who live in these areas and depend on forest resources for their sustenance and livelihoods. Local use may include extraction of fuelwood and non-timber forest products, grazing, and short-rotation swiddening, resulting in highly degraded forest conditions in some areas (Schmidt-Vogt 1998, Kanel & Shrestha 2000, Perera 2000, Zaizhi 2000). Swidden agriculture is often banned because it is considered as a degrading practice in most countries in this stage but continues to be practised in the absence of alternative livelihoods in hilly or dry terrain.

Primary forest cover is very low and total forest cover may stabilise with reduced large-scale exploitation, as well as increased protection and better management in this stage (Persson 1998). Continued demand for forest and products arising from converting forest lands (agriculture, pasture) are often met by imports, product substitution, more intensive use of existing areas, plantation establishment, and rehabilitation of degraded lands. However, resource imports, substitute products and intensified agriculture are generally not available to the poorer sections of society.

In this stage, plantation forestry tends to be used increasingly as a means of meeting the fuelwood and fodder needs of local people, to provide fibre for industrial use, and to rehabilitate degraded lands. Large-scale plantations for timber, fibre, and fuelwood are mostly initiated by the state, and smallholder plantations (fruit trees, estate crops) are privately owned. The latter tend to occur

in wetter areas, and are encouraged and supported by the state (Persson 2000). In drier or less productive areas, continued pressures on the limited resources, unfavourable climate and site conditions to develop more intensive land use alternatives, and inadequate alternative livelihood options may result in further degradation in this stage. Degraded lands tend to be a widespread feature over the landscape, especially on forest lands which are not under direct state protection or private ownership. There is increasing interest in rehabilitating degraded lands for environmental purposes, and to make them productive both for industrial and local needs.

In this stage, policy initiatives begin to focus on concepts such as reforestation, natural regeneration, community forestry, sustainable forest management, and watershed protection (Wiersum 1997). Large areas of forest land are often still government-owned. However, there tend to be initiatives to devolve use and management rights to communities or individual households, or joint management of degraded forest lands for better management and conservation, and for meeting local needs (Bhat *et al.* 2000, Kanel & Shrestha 2000). Similarly, local governments and institutions tend to be given a larger share in the governance of forest and land use. Trends towards democratisation and equity are common, with policies beginning to shift to accommodate the different interest groups and requirements.

Changes in policy in this stage are often driven by the scarcity of forest products and environmental services attaining substantial proportions, and increased local and international NGO and community activism to fulfil environmental and local livelihood needs (Persson 1996). There tends to be greater recognition of the potential effectiveness of community participation in actually halting and reverting the trend of degradation, given secure tenure and benefit sharing options (Ramakrishnan *et al.* 1994, Lamb & Tomlinson 1994). In the short term, devolution to private control may encourage short-term exploitation, particularly given a history of frequent tenure changes (Zaizhi 2000).

Forest and landscape characteristics (Table 2)

The landscape is predominantly an agricultural one with intermixed urban developments, large areas of degraded land and some plantations. Primary forests are scarce and confined to inaccessible areas, and secondary forests are also restricted to hilly terrain or less accessible areas. Secondary (and primary) forest cover tends to stabilise because of protection from degradation and conservation of remaining natural forests in reserves for environmental amelioration and long-term security. There is not much new secondary forest formation because most available productive land has already been converted to alternative profitable use.

Development and characteristics of different secondary forest types

In this third stage, secondary forests may have greater value and recognition than before because they are natural forests in a forest-poor landscape. Local

people may be the most important users of secondary forests at this stage, mainly for subsistence, but also for some cash income and risk aversion in case of crop failure.

Post-extraction secondary forests: Post-extraction secondary forests resulting from re-growth following past extractive activities tend to be the dominant forest type. Existing secondary forests may be subject to degradation under conditions of open access and high extraction pressures on the resource, but can be in good condition when protected or otherwise managed such as in reserves or through community forestry (Zaizhi 2000).

Rehabilitated secondary forests: In this stage, sustainably managed rehabilitated secondary forests are a potential source of new secondary forest formation, especially in more arid, less productive regions, with protection and rehabilitation of degraded lands through community and state forestry projects. Increased interest in afforestation to enhance the productivity of degraded lands and in natural/mixed regeneration for environmental and local livelihood needs (Lamb & Tomlinson 1994, Wiersum 1997) facilitate this process, along with the lack of funds to plant and manage on a more intensive basis (Bhat *et al.* 2000).

New secondary forest formation and management on degraded lands may be vital for environmental stability and the conservation of biodiversity, but successional processes may be inhibited by highly degraded site conditions and chronic disturbance. Local involvement in the rehabilitation, management and use of these forests could help enhance their condition and people's participation is often sought in the form of community forestry or joint forest management, with more clearly defined tenure relations. Management may involve the introduction and maintenance of desired species for subsistence and/or cash income, along with protection from chronic disturbance.

Distribution and extent

The forest depleted condition exists today in Vietnam, Nepal, tropical China, Sri Lanka, Peninsular Malaysia and most of India (Flint 1994), and interest in conservation and reforestation to meet local needs and for environmental services has been high for some time now (Bhat *et al.* 2000, Kanel & Shrestha 2000, Zhang 2000). In the more productive wet areas of tropical Asia, e.g. Kerala, Java and the wet zone of Sri Lanka, the trend has been towards privately owned home gardens and simple agroforestry systems (Persson 2000). In other areas, reforestation projects involving greater community participation have been pursued to varying degrees, but natural or secondary forest regeneration is still limited. The Philippines and Thailand are also fast approaching the forest depleted stage, as are parts of Sumatra and Borneo.

Management and policy options

This conceptual framework based on the intensification continuum provides a dynamic perspective, and can be used to anticipate and avoid potential unfavourable developments via appropriate management and policy options. For example, recognition of the tendencies towards forest depletion, resource scarcity and environmental degradation in most countries following intensive exploitation of their forest resources calls for planning for sustainable use at the frontier zone or in the extensive use stage itself.

In addition, this conceptual framework can be used to evaluate on an extant basis whether certain management options are likely to work and the types of problems and policies we should be focusing on in each stage. We do not have sufficient information as yet to identify the priority management or policy options. What we are trying to do here is to set out a framework that can be used to guide management/policy options, as illustrated below.

To know what the 'best bet' management options for tropical secondary forests are, we need to know the following:

- (1) What are the likely threats to sustainable and equitable management and use in each of the intensification stages and what options could potentially alleviate these threats?
- (2) What are the requirements of these management/policy options in terms of management skills, resource endowments, infrastructure, as well as institutional and policy environment?

The requirements of these management and policy options could then be compared against the resource endowments, infrastructure, as well as institutional and policy environment present in each of the stages to identify the most viable options at that point.

Based on the preliminary information available, the framework suggests the following management and policy options for the different secondary forest types through the intensification continuum, but these suggestions need further validation.

- (1) The framework suggests that *post-extraction secondary forests* in the late intensive exploitation stage and in the forest depleted stage are perhaps not of much interest for industrial management, since the timber is not so valuable, and capital and resources may be available to establish and manage more productive plantations. These secondary forests could potentially be used more as community or household-managed forests for non-timber forest products and short-rotation wood products, both for subsistence and cash income. This may be particularly so in drier areas where further intensification and additional inputs may not prove quite as profitable, yet there is high pressure on the secondary forest resources and interest in management for

sustained longer-term benefits. However, tenure security and restricted access are required to ensure commitment to management and prevent resource degradation. Increased recognition of local livelihood needs, and management ability in the forest depleted stage, facilitate the development of community-based forestry.

- (2) Given the high land requirements, common property regimes, and predominantly subsistence basis of *swidden fallow secondary forests* with their low productivity, this management option may be sustainable primarily in the extensive use stage where land is plentiful and population density is low. In the intensive exploitation and forest depleted stages in moist areas, opportunities exist for intensification of traditional swidden systems into more intensively managed secondary forest gardens with higher productivity, while retaining a large natural vegetation component (de Jong *et al.* 2000b). These would be facilitated by the provision of private tenure security to support the higher longer-term investment. Infrastructural development and individual access to capital, markets, and technical knowledge also enhance this process. In dry, less productive areas, scope for such intensification may be more limited.
- (3) The establishment and sustainable management of *rehabilitated secondary forests* with community participation may become possible in the forest depleted stage since the policy environment is more favourable and incentives may be available. However, tenure security, closed access, and adequate benefit sharing are again required to ensure commitment to management and prevent repeated degradation. Attempts to rehabilitate degraded lands in the intensive exploitation stage because of international pressures or funding availability are often not viable because the underlying causes of degradation may continue to operate. However, new measures such as certification and carbon trading may be useful for forest regeneration and management in this stage (IFF 1999).

The intensification continuum presented in this paper for tropical Asia is not to be viewed as a steady, fixed, overly deterministic model. A substantial proportion of the processes may be driven by policy interventions and economic motivations that could vary, and also provide much scope for modification. This intensification continuum operates over both time and space, and at multiple scales, and can be used for planning and policy making at different levels. The region as a whole could be in the frontier zone in terms of development processes in the long term and at the regional scale. However, in the short term, local areas ahead of the frontier could be in the extensive use stage, areas at the frontier in the intensive exploitation stage, and areas behind the frontier in the forest depleted stage.

Conclusion

The conceptual framework based on forest land use intensification developments and the underlying complex of interrelated driving forces provides a broad setting to analyse the appearance, dynamics and evolution of different types of secondary forests. The underlying driving forces tend to change along the intensification continuum. In the intensive exploitation stage, large areas of secondary forests regenerate following industrial and local extraction and fire because they can still compete with other land uses, given plentiful land availability, tenure insecurity discouraging investment, and the difficulty of monitoring remote sites. But the scope for maintaining and enhancing the contribution of secondary forests may be higher in the early extensive use and forest depleted stages. This is because in the extensive use stage, swidden fallow secondary forests (the dominant type) form an integral part of smallholder production systems. In the forest depleted stage, the situation is more ripe for policy changes and implementation favouring tenure clarity, sustainable management, rehabilitation, local livelihoods and environmental services. However, in the intensive exploitation stage, there is scope for applying paradigms developing in areas further along the intensification continuum and trying to revert degradation trends in advance.

This framework can help in management and policy options based on threats and relative resource endowments, infrastructure, and the policy and institutional environment present in each stage. The framework suggests that interventions directed at sustainable secondary forest use and development need to be integrated into a long-term land management strategy based on a strong knowledge base, equitable participation of relevant stakeholders, clear tenure definition, and a long-term perspective in all stages. Management options and policy interventions suggested by the framework need to be verified with empirical data. The intensification model presented in this paper is not to be viewed as overly deterministic. The underlying driving forces include substantial policy interventions and economic developments that could be altered and managed.

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