

TROPICAL SECONDARY FORESTS IN ASIA: INTRODUCTION AND SYNTHESIS

W. de Jong, U. Chokkalingam, J. Smith

Center for International Forestry Research (CIFOR), P.O. Box 6596 JKPWB, Jakarta 10065, Indonesia

&

C. Sabogal

Center for International Forestry Research (CIFOR), Caixa Postal 68,66.240, Belem, Para, Brazil

DE JONG, W., CHOKKALINGAM, U., SMITH, J., & SABOGAL, C. 2001. Tropical secondary forests in Asia: introduction and synthesis. This paper provides the general objectives of the Special Issue: Secondary forests in Asia: their diversity, importance and role in future environmental management. It provides a brief overview of the renewed attention to tropical secondary forests and sketches the history of research on this subject. The paper introduces two analytical tools that are used throughout this Special Issue to better understand the current situation and trends of secondary forests in Asia: a typology of tropical secondary forest in Asia, and a conceptual framework that explains the formation and dynamics of these forests. It then outlines some of the main messages that emerge from discussions in the various papers and ends with recommendations for actions and needs for future research.

Key words: Tropical secondary forests - Asia - typology - conceptual framework - research and development needs

CHOKKALINGAM, U., DE JONG, W., SMITH, J., & SABOGAL, C. 2001. Hutan sekunder tropika di Asia: pengenalan dan sintesis. Artikel ini menyediakan objektif umum Keluaran Khas ini: Hutan sekunder di Asia: kepelbagaian, kepentingan dan peranannya dalam pengurusan alam sekitar pada masa depan. Artikel ini menyediakan gambaran ringkas ke atas tumpuan baru terhadap hutan sekunder tropika dan melakarkan sejarah penyelidikan mengenai isu-isu ini. Artikel ini memperkenalkan dua alat analitis yang digunakan dalam keseluruhan Keluaran Khas ini untuk memahami dengan lebih baik situasi terkini dan trend hutan sekunder di Asia: tipologi hutan sekunder tropika di Asia dan rangka kerja konsepsi yang menerangkan tentang pembentukan dan dinamik hutan ini. Artikel ini juga memberikan beberapa contoh bagaimana alat analitis ini dapat meningkatkan pemahaman tentang hutan sekunder tropika di Asia dan untuk mengenal pasti peluang-peluang bagi menambah keluaran dan perkhidmatan yang dapat diperolehi daripada hutan ini. Artikel ini diakhiri dengan cadangan-cadangan untuk tindakan dan keperluan penyelidikan pada masa hadapan.

The status and potential of secondary forests in Asia

Secondary forests are becoming increasingly prominent in the landscape in tropical countries, mainly because the areas that are under such forest are increasing steadily. While tropical primary forest continues to be logged for its timber or slashed to supply wood for pulp mills and land for agricultural production, estate crops or forest plantations, this conversion is accompanied by an increase in the area of secondary forest in Asia, Africa and Latin America (UNESCO 1978, FAO 1996, TCA 1997; Smith *et al.* 1999, Emrich *et al.* 2000). Estimates of the increase in secondary forest cover worldwide are probably even less accurate than estimates of tropical primary forest conversion. However, the numbers are indicative. FAO (1996) estimated the area of secondary forest in 1990 in Asia to be 87.5 million ha. The figures for Latin America and Africa were 165 and 90 million ha respectively (FAO 1996). Brown and Lugo (1990) estimated an area worldwide under secondary forest of 600 million ha, while Emrich *et al.* (2000) provided an estimate of 532 million ha. The latter authors also point out that this constitutes over 30% of the tropical forest area.

These data, and the awareness of the accelerated changes in the forest situation in countries like the Philippines, Indonesia, China and Malaysia, strongly suggest that the future goods and services that society obtains from tropical forests will increasingly have to come from secondary forests, or from some other kind of anthropogenically-induced forest. These probably include timber, environmental services, biodiversity conservation, and forest products for the rural poor. However, the features of younger regrowing secondary forests are often very different from primary or more mature secondary forests. Early tropical moist secondary forest, for instance, often has fewer species, although this may depend on the exact age and other factors (Richards 1964), but usually more individuals per ha. Typical pioneer and early secondary forest species are of softer wood, and grow to smaller diameters than many primary forest species (e.g. Whitmore & Burnham 1984, Finegan 1992). Secondary forests may supply quite a different set of goods and services, and the management, silvicultural treatment, legislation and extension support that are required are often quite different from that needed in the case of primary forest.

This fact is not yet adequately realised, let alone reflected in policies, legislation, or forestry development and extension (e.g. TCA 1997, Emrich *et al.* 2000). There may be a number of reasons for this, but the main ones are: the forestry sector in tropical countries has a tradition of focussing on primary forests, secondary forests are often considered waste land, their property right status is often more ambiguous than that of primary forests, and there is little knowledge of how many of the goods and services that primary forests provide can be substituted by secondary forests.

This Special Issue of the Journal of Tropical Forest Science brings together 15 papers entirely dedicated to secondary forests in tropical Asia. The reasons for focusing only on tropical Asia are on the one hand pragmatic. There are a number

of agencies in this part of the world that deal with forestry issues exclusively. Any knowledge provided by a volume like this Special Issue will be of particular interest to them. However, a second reason is the particular nature of initial secondary forest formation and its subsequent dynamics in many Asian countries. Brown and Lugo (1990) suggested that logging operations are more important as a factor in the initial formation of secondary forest in Asia than they are in Latin America and Africa, although changes in logging practices in the last decade, especially in Amazonia, may have altered this situation. Swidden agriculture and the related swidden fallow secondary forests are important in the three continents. However, processes of intensification of swidden fallow agriculture appear to be more prominent in many Asian countries (e.g. de Jong *et al.* 2000a) than they are in the other continents. In addition, species composition is probably richer but less uniform in Asian tropical secondary forests than in the other continents (Richards 1964).

Research on tropical secondary forests is not new, but the nature of this research has changed over the years. A general pattern in the research focus on tropical secondary forest can be observed. Richards (1964), in his well-known volume on the tropical rain forests originally published in 1952, already pointed out the importance of secondary forests. In the next several decades much of the research that came out of forestry science circles mainly focussed on ecological and silvicultural aspects at the stand level, such as forest succession and the autecology of species (e.g. Budowski 1961, Gomez & Vasquez 1974, Ewel 1980), and later on topics like the nutrient cycle in secondary forests (Jordan 1987). This research trend has continued until today. During the 1980s a significant number of studies focused on the economics and management of swidden fallow secondary forests by agriculturists (e.g. Denevan & Padoch 1987, Balèe & Gely 1989, Irvine 1989), although, as Denevan and Padoch (1987) have pointed out, early ethnographic studies noticed the importance of swidden fallow secondary forests in tropical forest-dependent societies (e.g. Conklin 1957). Both trajectories of secondary forest related research have eventually resulted in specific propositions for the management of tropical secondary forests (e.g. Wadsworth 1987, 1997, Finegan 1992). Some of the more recent studies on tropical secondary forests have tried to identify patterns of land cover change and the role that secondary forest plays in those changes (Scatena *et al.* 1996, Walker & Homma 1996, Moran *et al.* 1994, Smith *et al.* 1999).

These general trends of research on secondary forests relate to the dominant perceptions held at a particular time of the importance and potential of secondary forests. Richards (1964) suggested the opportunity for timber production from secondary forests, an opinion shared by, for instance, Wadsworth (1984, 1987). The renewed attention to the role of secondary forests among swidden agriculturists coincided with a wider awareness of trees and forests as a potential productive resource, expected to contribute to improving economic welfare among the forest-dependent rural population in the tropics. The more recent trends in research on secondary forests are partly inspired by concerns for tropical deforestation, carbon emission and threats of global warming, and biodiversity conservation.

This Special Issue of the *Journal of Tropical Forest Science* on “Secondary forests in Asia: their diversity, importance and role in future environmental management” is dedicated to identifying the status and trends of secondary forests in tropical Asia, and the opportunities that secondary forests in tropical Asia may offer to society. The papers included in this special issue were prepared by participants at the workshop “Tropical secondary forests in Asia: Reality and perspectives” held in Samarinda, Indonesia, April 10–14, 2000. The workshop was organised by the Center for International Forestry Research (CIFOR), the German Agency for International Development (GTZ), and the Dutch National Reference Center for Agriculture, Nature and Fisheries (EC LNV). This workshop was a response to recent increased attention to secondary forests among several donor agencies and tropical forest scientists (e.g. TCA 1997, Emrich *et al.* 2000). For instance, at the XIth World Forestry Congress in Antalya, Turkey, a site meeting was dedicated specifically to tropical secondary forests.

There are a few critical issues that need to be addressed when considering enhancing the supply of goods and services from secondary forests. Possibly of primary importance is the need to clarify what is meant by secondary forests in the first place. As suggested by Emrich *et al.* (2000), there is some variation in how different researchers have broadened or narrowed the definition of secondary forests. Second, it is opportune to know in sufficient detail what the current status and condition is of secondary forest in the different countries in tropical Asia, and how and why this situation is changing.

This last point is the guiding principle in much of this Special Issue. One fundamental and critical feature of secondary forests is that they only appear as a result of a number of external forces, forces that have profoundly altered or totally destroyed the original forests, while in most cases they continue to influence the future dynamics of the secondary forest that appear subsequently. There are a number of conditions that may influence the goods and services that can be derived from secondary forests, including the availability of management practices, silvicultural techniques, and market opportunities for secondary forest products. These conditions have to be optimised in order to enhance the delivery of goods and services from secondary forests. However, in addition to this, there is a need to understand the “underlying causes” of secondary forest formation and their subsequent dynamics and how those underlying causes can be influenced. Without such knowledge there is little opportunity to influence the wider processes of secondary forest formation and their subsequent dynamics, which means that secondary forest management, application of silvicultural techniques, or opportunities to market secondary forests products will have little adoption or effect on the condition of secondary forests on a wider scale.

Trying to understand the underlying causes of secondary forest formation and their subsequent dynamics means that it is necessary to know why secondary forests appear in the first place, i.e. why the original primary or otherwise mature forests are being removed or intensively disturbed, and why eventually the land is then allowed to regenerate (Chokkalingam *et al.* 2000a). One also needs to know what are the major drivers that influence, positively or negatively, these processes of

forest recovery. The formation of secondary forests and their subsequent dynamics are a result of a broad number of forces, or underlying causes, that relate to both natural and social and economic processes. Understanding these broad forces allows identification of appropriate intervention points and mechanisms for altering current secondary forest dynamics and trends.

The main purpose of this Special Issue, therefore, can be summarised in the following objectives:

- (1) Describe the current status of secondary forests in tropical Asia
- (2) Know how the cover and condition of secondary forests are changing
- (3) Understand why these changes occur
- (4) Identify the potential and opportunities of secondary forests in tropical Asia.
- (5) Identify what needs to be done to realise these potentials and opportunities.

This paper provides a general introduction to this Special Issue. It first introduces the two analytical tools that have been used in the papers. The first tool is a typology of secondary forests (Chokkalingam & de Jong 2001)¹. The second analytical tool is a conceptual framework that tries to explain the broad trends of formation and subsequent dynamics of different types of secondary forests in tropical Asia and the driving forces responsible (Chokkalingam *et al.* 2000a). Both tools are introduced in the next section. The subsequent sections outline the main messages that emerge from the discussions in the various papers, and research and development needs with relation to secondary forests in tropical Asia.

The framework of analysis used in this Special Issue

A typology of secondary forests

Although considerable literature exists on Asian secondary forests, there appears to be a lack of common understanding regarding what distinguishes a secondary forest from a primary forest, and the different types of forest that would qualify as a secondary forest. In much of the current literature, the types of secondary forests being referred to and the relative importance of the different types across the region remains unclear. This suggested the need to make a subdivision of different types of secondary forests such that on the one hand the common features of this collective of forests could be captured, while at the same time the unique characteristics of secondary forests that are the result of different types of disturbances are also adequately reflected. Though intensive natural disturbances can also give rise to secondary forests (Chokkalingam & de Jong 2001), this Special Issue only considers human disturbances because of the possibility for directly influencing such activities. The common feature of secondary forests—that they are all the result of some major disturbance of existing forests and the subsequent process of

¹ The secondary forest typology and definitions presented here from Chokkalingam & de Jong (2001) were refined through the combined effort of participants at the workshop “Tropical secondary forests in Asia: Reality and perspectives” held in Samarinda, Indonesia, April 10–14, 2000.

regrowth—is reflected in the general definition of secondary forests used in this special issue:

Secondary forests are 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.

This definition, however, remains broad, and does not distinguish between different kinds of human disturbance, and how this may result in different types of secondary forest. Some of the main activities or disturbances leading to secondary forest formation in tropical Asia include logging or other intensive resource extraction, fires, swidden cultivation and fallowing, enrichment of fallows or less-intensively managed home gardens, and rehabilitation of degraded lands. A typology or classification of secondary forests based on these processes responsible for their formation is useful in that it defines to an important degree the characteristics of the secondary forest, and the set of forces that influence these forests subsequent to their formation. Such a typology focusing on processes underlying the formation and subsequent evolution of the secondary forests could be used to influence the underlying drivers, guide secondary forest development along desirable pathways, and optimise the goods and services they provide (Chokkalingam & de Jong 2001). Such a typology is presented in Box 1 along with definitions, and used throughout this special issue.

Box 1 Common secondary forest types

Post-extraction secondary forests - 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 - 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 - 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 - 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 - 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 - 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)

The evidence that the typology also relates to opportunities for management options becomes clear when considering different types. Logging of forests for timber results in different degrees of disturbance, ranging from very limited to total removal of tree cover, whereas swidden agriculture generally results in almost total removal of the trees. For instance, the forests that regenerated following logging in Indonesia (e.g., Kartawinata *et al.* 2000) do have some similarities in biophysical conditions, but possibly more so in their legal status and perceived future use because they were formed following a similar land use activity. The activity or process that led to their creation defines to a large extent what will happen next to those secondary forests. Post-extraction secondary forests may experience influences that may vary from fairly undisturbed recovery to mature forest until a new cutting cycle begins, to short-rotation logging, often resulting in progressive degradation and fire susceptibility (Dennis *et al.* 2000, Kartawinata *et al.* 2000, Lasco *et al.* 2000, Zaizhi 2000). On the other hand, swidden fallow secondary forest tends to experience influences that are within a regime of small farmer management. Similar general patterns can be identified for other types of secondary forests.

A conceptual framework for the assessment of secondary forest dynamics

As pointed out above, to understand the dynamics of secondary forests, which we believe is a prerequisite to be able to enhance the chance of success of secondary forest management, there is a need to understand the forces affecting their formation and subsequent dynamics at different scales. These forces are not simply reflected in a typology, and rather need a broader framework that relates the trends of the different types of secondary forests distinguished in Box 1 to a number of processes in the countries where secondary forests exist and are changing. An attempt at such a model is presented as the conceptual framework developed by Chokkalingam *et al.* (2000a) for tropical secondary forests in Asia.

This framework essentially tries to relate the changes over time and in space of forces that lead to forest disturbance, and where this disturbance fades, to the presence, importance and dynamics of different types of secondary forests. The forces that lead to forest disturbance are captured as a land use/forest use intensification continuum in which four stages have been recognised: *extensive use stage*; *intensive exploitation stage*; *forest depleted stage*, and *forest recovery stage* (Chokkalingam *et al.* 2000a). These stages reflect clearly recognisable phases in many forest landscapes that have been subject to expansion of economic activities and related features of development.

The framework as described in this Special Issue focuses on the first three of the four intensification stages, and considers a number of attributes for each stage. These attributes are *resource endowments and land use activities*, *forest and landscape characteristics*, *development characteristics of different secondary forest types*, and *distribution and extent of the particular intensification stage* (Chokkalingam *et al.* 2000a).

The framework provides several useful functions. On the one hand, it provides a useful tool for analysis of the conditions and trends of secondary forests at the national or regional scale. To some extent, this is reflected in several of the papers in this volume that discuss the dynamics of secondary forests in one particular country or in a particular region in a country. As an example, de Jong *et al.* (2000a) look at the changes in swidden fallow secondary forests with land use intensification. Some general trends can be observed, while a number of factors are identified that influence the particular trajectory. The same paper also tries to identify the changes in goods and services that swidden fallow secondary forests provide when they evolve into secondary forest gardens or agroforests as a result of land use pressure, increased participation in the wider market economy and resulting land use intensification.

Secondly, the framework provides some predictive capacity, even though much of the information that is the basis of the framework is of a qualitative nature, and it is often not possible to identify clearly the causal links between attributes that appear to coincide at different stages. It provides a strong suggestion as to how particular cases of primary and secondary forest transformation may evolve, and what are possible points of intervention to steer those processes. Because of this feature, the conceptual framework is a useful tool to identify viable secondary forest management and policy options. It allows one to single out the resource endowments, infrastructure, and institutional and policy environment present in each stage and compare it with the resource and institutional requirements of the different management/policy options. Major underlying forces that influence the secondary forest dynamics include policy interventions and economic development efforts. In principle, therefore, it is possible to alter those policy interventions and economic development efforts, and that way influence the trajectory of secondary forest dynamics.

Some of the main messages from this Special Issue

This paper started out with the assumption that secondary forests increasingly provide the goods and services that tropical primary forests used to provide. The papers in this Special Issue suggest that this is indeed the case, especially in countries further along the intensification process (Chokkalingam *et al.* 2000a). There is also evidence that forest cover begins to stabilise in such countries (Bhat *et al.* 2000, Kanel & Shrestha 2000). The driving forces for such stabilisation include concern for the limited forest cover left, loss of environmental functions, and product scarcity, among others. Secondary forests of various categories contribute to this stabilisation and there is increasing interest in natural regeneration for meeting environmental and local livelihood needs. A main conclusion from this trend is also that the role of secondary forests in rehabilitation efforts, which have in the past largely focused on plantations, could be increased (Chokkalingam *et al.* 2000b).

A similar conclusion can be drawn in the case of swidden fallow secondary forests. Although swidden agriculture has on many occasions been stigmatised as a destructive land use, several papers in this Special Issue (Ramakrishnan & Kushwaha 2000, Schmidt-Vogt 2000, de Jong *et al.* 2000a, b) reconfirm that swidden agriculture can be looked at as a stage in a progressive land use intensification process. Swidden fallow secondary forests become secondary forest gardens and agroforests under certain intensification scenarios. These secondary forests, while having a progressively larger planted component, still retain a significant proportion of natural vegetation. Swidden fallow agricultural landscapes therefore as a rule retain significant areas of forest-like systems. Under certain circumstances this may happen even when quite far advanced along the intensification continuum (de Jong *et al.* 2000a, b). Understanding of the evolution of swidden fallow secondary forests suggests an opportunity, if not a need, to also consider conservation of biodiversity, or other features of a diverse swidden agriculture/agroforestry landscape when intensification of swidden agricultural production is pursued.

In the case of post-extraction secondary forests, Chokkalingam *et al.* (2000a) suggest that in late intensification stages these forests could become community and household managed forests. A Global Environment Facility report (GEF 2001) suggests that investments in the “enabling environment”² for biodiversity conservation are likely to be most important at the beginning of the Intensive Exploitation stage³, also meaning that the investment at this stage would be highest. The report provides a list of key elements for this enabling environment, and assesses their relative importance for enhanced biodiversity conservation in post-extraction secondary forest along the land/forest use intensification continuum. The above examples suggest that, although many of the features of the conceptual framework still need to be refined, it does have its usefulness in understanding the dynamics of different types of secondary forests at different stages of land/forest use intensification.

The papers in this volume suggest that tropical forests are not as fragile as previously believed. They are capable of renewing themselves as functioning secondary forest ecosystems after heavy intervention, and can be used and regrown. However, the concept of secondary forest management and use, be it post-extraction, rehabilitated, swidden fallow, or any other kind of secondary forest, directly challenges the notion of being able to manage a biophysical resource in isolation. Secondary forests are largely a product of human intervention, and often an integrated part of land use or forest exploitation processes at the larger landscape level. Therefore their sustainable management calls for an integrated landscape level approach as well as a participatory approach (e.g., Ramakrishnan & Kushwaha 2000).

² The enabling environment includes the enabling conditions that neutralise forces in society that have a degrading effect on forests.

³ In fact, the report concludes that: “Investments in the enabling environment for biodiversity conservation are likely to be most important in the Frontier and Early Intensification stages of landscape change as the Intensive Exploitation Stage is subdivided into these two stages”.

Development and research needs

Despite the wealth of information and knowledge and an increasingly wide interest in considering the potential and opportunities of secondary forests in Asia, there is a clearly identifiable number of actions that are needed. These include generating awareness of the potential and opportunities of secondary forests. Other actions include initiating actual management of secondary forests, where there is clear opportunity to do so. Lastly, there is a quite clear need for generating new knowledge that will increase the options for progressive secondary forest management that will result in increased benefits from secondary forests at the local to national levels. This section will elaborate briefly on each of these items.

The importance of generating awareness of the potential and opportunities that secondary forests can provide has been claimed elsewhere (e.g. TCA 1997, Emrich *et al.* 2000). For this to happen, a fundamental change in thinking is required among those responsible for forest management. Up till now secondary forests have been simply looked upon by foresters, policy makers, and conservationists as degraded resources having limited value (e.g. Banerjee 1995, Wadsworth 1997). However, post-extraction secondary forests and even post-fire secondary forests are making significant contributions to the supply of forest products and/or environmental services. This contribution is often unrecognised because extraction is often illegal or for subsistence purposes, and therefore not reflected in economic statistics.

Once this awareness of the potential and opportunities of secondary forest management has been raised, a next step would be to install some kind of policy and institutional reform such that the agencies that would be responsible for implementing new secondary forest oriented policies would be adequately prepared to do so. Such reform involves generating a broad understanding of different types of secondary forests, their unique features and potential. It also involves finding adequate resources to deal with a new mandate of promoting secondary forest management, or learning to deal with the diverse groups of owners and users of secondary forests. It also involves direct policy and institutional reform⁴, such as adjusting existing legal instruments that deal with forests and facilitating legal recognition of property rights over secondary forest.

The analytical tools briefly described in this paper, and the overview papers for different countries or regions offer guidelines for research programmes focusing on management and enhancement of benefits from secondary forests. A few of the researchable items are mentioned below.

Status and trends of secondary forests

Work that could be conducted as part of an effort to increase the level of detail of the conceptual framework developed by Chokkalingam *et al.* (2000a) would be

⁴ By institutional reform we mean reforms in legislation, property rights status and the like, as opposed to reform that relates to the agencies that would have the mandate to implement new policies or institutional changes.

crucial for a better understanding of the nature of the trends of secondary forests in all tropical Asian countries. This would include reliable regional/country and landscape estimates of secondary forest extent and productivity, to be complemented with an assessment of the actual conditions of different types of secondary forests, and how this relates to the goods and services that they provide. This will, among other things, yield a better understanding of the potential for generating environmental benefits from different types of secondary forests.

Management and silviculture at the stand level

The research on status and trends will have to be complemented by research on management regimes and silvicultural techniques, which could partly be based on existing local knowledge and experiences among secondary forest owners. Research on management of secondary forests among smallholders can become the basis for participatory and applied research to increase benefits to those secondary forest owners. In addition there is a need to better understand the ecological and economic principles determining the response of secondary forests to various management regimes. This work also needs to be completed with research on the potential markets for products from secondary forests and viable marketing strategies adapted to the specific conditions offered by different types of secondary forests.

Decision making related to secondary forests

There is also the need for a better understanding of the decision making processes and the driving forces behind land use changes affecting the dynamics of formation and transformation of different types of secondary forests.

Acknowledgements

The authors of this introductory paper would like to acknowledge the direct and indirect contributions to this Special Issue of participants of the workshop “Tropical secondary forests in Asia: Reality and perspectives” held in Samarinda, Indonesia, April 10–14, 2000. We also thank Dietrich Schmidt-Vogt for a critical review of this paper.

References

- BALÉE, W. & GELY, A. 1989. Managed forest succession in Amazonia: The Ka'apor case. *Advances in Economic Botany* 7: 129–158.
- BANERJEE, A. K. 1995. *Rehabilitation of Degraded Forests in Asia*. World Bank Technical Paper No. 270, Washington D. C, 48 pp.

- BHAT, D. M., MURALI, K. S. & RAVINDRANATH, N. H. 2000. Formation and recovery of secondary forests in India: A particular reference to Western Ghats in south India. Tropical secondary forests in Asia: introduction and synthesis. Paper prepared for the “Tropical secondary forests in Asia: Reality and perspectives’ workshop”. 10–14 April 2000. Samarinda, Indonesia. Center for International Forestry Research, Bogor, Indonesia.
- BROWN, S. & LUGO, A. E. 1990. Tropical secondary forest. *Journal of Tropical Ecology* 6: 1–32.
- BUDOWSKI, G. 1961. *Studies on Forest Succession in Costa Rica and Panama*. Dissertation, Yale University, New Haven, 168 pp.
- CHOKKALINGAM, U. & DE JONG, W. 2001. Secondary forest: a working definition and typology. *International Forestry Review* 3:19–26.
- CHOKKALINGAM, U., SMITH, J., DE JONG, W. & SABOGAL, C. 2000a. A conceptual framework for the assessment of tropical secondary forest dynamics and sustainable development potential in Asia. Tropical secondary forests in Asia: introduction and synthesis. Paper prepared for the “Tropical secondary forests in Asia: Reality and perspectives’ workshop”. 10–14 April 2000. Samarinda, Indonesia. Center for International Forestry Research, Bogor, Indonesia.
- CHOKKALINGAM, U., BHAT, D. M., & VON GEMMINGEN, G. 2000b. Secondary forests associated with the rehabilitation of degraded lands in tropical Asia: a synthesis. Tropical secondary forests in Asia: introduction and synthesis. Paper prepared for the “Tropical secondary forests in Asia: Reality and perspectives’ workshop”. 10–14 April 2000. Samarinda, Indonesia. Center for International Forestry Research, Bogor, Indonesia.
- CONKLIN, H. C. 1957. *Hanunoo Agriculture*. FAO Forestry Development Paper No 12. FAO Rome 243 pp.
- DE JONG, W., VAN NOORDWIJK, M., SIRAIT, M., LISWANTI, N. & SUYANTO. 2000a. Farming secondary forests in Indonesia. Tropical secondary forests in Asia: introduction and synthesis. Paper prepared for the “Tropical secondary forests in Asia: Reality and perspectives’ workshop”. 10–14 April 2000. Samarinda, Indonesia. Center for International Forestry Research, Bogor, Indonesia.
- DE JONG, W., CHOKKALINGAM, U. & PERERA, G.A.D. 2000b. The evolution of swidden fallow secondary forests in Asia. Tropical secondary forests in Asia: introduction and synthesis. Paper prepared for the “Tropical secondary forests in Asia: Reality and perspectives’ workshop”. 10–14 April 2000. Samarinda, Indonesia. Center for International Forestry Research, Bogor, Indonesia.
- DENEVAN, W.M & PADOCH, C. 1987. Swidden-fallow agroforestry in the Peruvian Amazon. *Advances in Economic Botany* 5. New York Botanical Garden, New York, 96 pp.
- DENNIS, R., HOFFMANN, A., APPLGATE, G., VON GEMMINGEN, G. & KARTAWINATA, K. 2000. Large-scale fire: creator and destroyer of secondary forests in Indonesia. Tropical secondary forests in Asia: introduction and synthesis. Paper prepared for the “Tropical secondary forests in Asia: Reality and perspectives’ workshop”. 10–14 April 2000. Samarinda, Indonesia. Center for International Forestry Research, Bogor, Indonesia.
- EMRICH, A., POKORNY, B. & SEPP, C. 2000. *The Significance of Secondary Forest Management for Development Policy*. TOB Series No. FTWF-18e. GTZ, Eschborn, Germany, 180 pp.
- EWEL, J. 1980. Tropical Succession: Manifold routes to maturity. *Biotropica* 12 (Suppl. Trop. Succession): 2–7.
- FAO. 1996. *Forest Resources Assessment 1990. Survey of Tropical Forest Cover and Study of Change Processes*. FAO Forestry Paper 130. Rome, Italy. 152 pp.
- FINEGAN, B. 1992. The management potential of neotropical secondary lowland rain forest. *Forest Ecology and Management* 47: 295–321.
- GEF 2001. Workshop on “Actions to be Supported by GEF to Create an Enabling Environment for Achieving Sustained Biodiversity Conservation Across the Landscape, Using Forests as an Example”. Global Environment Facility. Washington, 29 pp.
- GOMEZ, P. A. & VASQUEZ, Y. C. 1974. Studies on secondary succession of tropical lowlands: the life cycle of secondary species. Pp. 336–342 in *Proceedings of the First International Congress of Ecology*. The Hague.

- GROSSMAN, C. 2000. Nichtholz-Waldprodukte in Ost-Kalimantan, Indonesien. Analyse der walswirtschaftlichen und sozio-ökonomischen Aspekte ihrer Bedeutung und ihres Entwicklungspotentials für die Lokalbevölkerung in einem Holzkonzessionsgebiet. *Mitteilungen der Bundesforschungsanstalt für Forst und Holzwirtschaft* No 199. Hamburg, 301 pp.
- IRVINE, D. 1989. Succession management and resource distribution in an Amazonian rain forest. Pp. 223–238 in Posey, D. A. & Balée, W. (Eds.) *Resource management in Amazonia: Indigenous and folk strategies. Advances in Economic Botany* 7.
- JESSUP, T. C. 1981. Why do Apo Kayan shifting cultivators move? *Borneo Research Bulletin* 12(1): 16–32.
- JORDAN, C.F. (Ed.) 1987. Amazonian Rain Forests. Ecosystem Disturbance and Recovery. Pp. 24–33 in *Ecological Studies*. Vol. 60. Springer Verlag. New York (etc.).
- KANEL, K. & SHRESTHA, K. 2000. Tropical secondary forests in Nepal and their importance to local people. Tropical secondary forests in Asia: introduction and synthesis. Paper prepared for the “Tropical secondary forests in Asia: Reality and perspectives’ workshop”. 10–14 April 2000. Samarinda, Indonesia. Center for International Forestry Research, Bogor, Indonesia.
- KARTAWINATA, K., GINTINGS, A. Ng., PUSPITOJATI, T. & RISWAN, S. 2000. An overview of post-extraction secondary forests in Indonesia. Tropical secondary forests in Asia: introduction and synthesis. Paper prepared for the “Tropical secondary forests in Asia: Reality and perspectives’ workshop”. 10–14 April 2000. Samarinda, Indonesia. Center for International Forestry Research, Bogor, Indonesia.
- LASCO, R. D., VISCO, R. G. & PULHIN, J. M. 2000. Secondary forests in the Philippines: formation and transformation in the 20th century. Tropical secondary forests in Asia: introduction and synthesis. Paper prepared for the “Tropical secondary forests in Asia: Reality and perspectives’ workshop”. 10–14 April 2000. Samarinda, Indonesia. Center for International Forestry Research, Bogor, Indonesia.
- MORÁN, E.F., BRONDIZIO, E., MANSEL, P. and WU, Y. 1994. Integrating Amazonian vegetation, land-use, and satellite data. *BioScience* 44(5): 329–338.
- RAMAKRISHNAN, P. S. & KUSHWAHA, S. P. S. 2000. Secondary forests of the Himalaya with emphasis on the north-eastern hill region of India. Tropical secondary forests in Asia: introduction and synthesis. Paper prepared for the “Tropical secondary forests in Asia: Reality and perspectives’ workshop”. 10–14 April 2000. Samarinda, Indonesia. Center for International Forestry Research, Bogor, Indonesia.
- RICHARDS, P. W. 1964. *The Tropical Rainforest: An Ecological Study*. Second Edition. Cambridge University Press, 575 pp.
- SCATENA, F.N., WALKER, R.T., HOMMA, A., DE CONTO, A., PALHETA, C., DE AMORIM, R., NEVES DA ROCHA, A., MOREIRA, A. & MOURATO, P. 1996. Cropping and fallow sequences of small farms in the “Terra Firme” landscape of the Brazilian Amazon: a case study from Santarem, Para. *Ecological Economics* 18: 29–40.
- SCHMIDT-VOGT, D. 2000. Secondary forests in swidden agriculture in the highlands of Thailand. Tropical secondary forests in Asia: introduction and synthesis. Paper prepared for the “Tropical secondary forests in Asia: Reality and perspectives’ workshop”. 10–14 April 2000. Samarinda, Indonesia. Center for International Forestry Research, Bogor, Indonesia.
- SMITH, J., VAN DE KOP, P., REATEGUI, K., LOMBARDI, I., SABOGAL, C. and DIAZ, A. 1999. Dynamics of secondary forests in slash-and-burn farming: interactions among land use types in the Peruvian Amazon. *Agriculture, Ecosystems and Environment* 76: 85–98.
- TCA. 1997. *Memorias del taller internacional sobre el estado actual y potencial de manejo y desarrollo del bosque secundario tropical en América Latina*. Tratado de Cooperación Amazónica, Secretaria Pro-Tempore. Caracas, Venezuela. 272 pp.
- UNESCO. 1978. *Tropical Forest Ecosystems*. A state of knowledge report prepared by UNESCO/UNEP/FAO. UNESCO-UNEP, Paris, 670 pp.
- WADSWORTH, F.H. 1984. *Secondary Forest Management and Plantation Forestry Technologies to Improve the Use of Converted Tropical Lands*. U. S. Congress, Office of Technology Assessment, Washington, D.C., 82 pp.

- WADSWORTH, F.H. 1987. A time for secondary forestry in tropical America. Pp. 189–197 in Figuero, J.C., Wadsworth, F. H., Branham, S. (Eds.) *Management of the forests of tropical America: Prospects and Technologies*. Institute of Tropical Forestry. U.S.D.A. Forest Service and University of Puerto Rico. Río Piedras, Puerto Rico.
- WADSWORTH, F. H. 1997. *Forest Production for Tropical America*. USDA Forest Service Agriculture Handbook 710, USA, 563 pp.
- WALKER R. & HOMMA, A.K.O. 1996. Land use and land cover dynamics in the Brazilian Amazon: an overview. *Ecological Economics* 18: 67–80.
- WHITMORE, T.C. & BURNHAM, C.P. 1984. *Tropical Rain Forests of the Far East*. Oxford University Press, UK. 352 pp.
- ZAIZHI, Z. 2000. Status and perspectives on secondary forests in tropical China. Tropical secondary forests in Asia: introduction and synthesis. Paper prepared for the “Tropical secondary forests in Asia: Reality and perspectives’ workshop”. 10–14 April 2000. Samarinda, Indonesia. Center for International Forestry Research, Bogor, Indonesia.