The search for a viable silviculture in Asia's natural tropical forests

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Natural forest silviculture could work in South and Southeast Asia – but only if pressures to overharvest and deforest ease.

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Sustainable forest management (SFM) is an evolving process; it always has been and always will be. It has changed as society's views and needs have changed and as knowledge of forest ecosystems has improved. It has also been influenced strongly by ownership. In many parts of the world, most recently in the tropics, forest ownership shifted from local people and customary systems to the state, and now there are societal pressures – and considerable impetus – to revert to local ownership or use rights, with often profound implications for forest management. As several authors in this edition of *Unasylva* point out, therefore, SFM is about much more than a silvicultural system: it encompasses a wide range of environmental and socio-economic issues as well. A scientifically perfect silvicultural system may not be implemented if the social settings – such as a lack of involvement of local people in management – do not support its implementation, there is a sudden change in environmental

Profuse regeneration in a tropical lowland rainforest, Sabah, Malaysia

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conditions, or the practices applied are economically unviable.

The notion of forest conservation has existed in the Asian tropics for thousands of years, and modern silvicultural systems have been in place in some areas for more than 100 years. Yet SFM is still relatively rare. This article reviews historical approaches to forest management in the moist tropics of Asia and the silvicultural systems in use in the region. And it discusses what is needed for their widespread success.

A future-harvest tree marked for retention in a lowland tropical rainforest managed for timber

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MANAGEMENT SYSTEMS

Indigenous management systems

While people have lived in tropical forests for tens of thousands of years, their traditional activities barely made a dent on forest area – perhaps unsurprisingly, given the generally low population pressures – and may have even promoted forest diversity (Baker, Wilson and Gara, 1999). Forest-dependent indigenous people practised shifting agriculture (rotational farming) – usually sustainably, thanks to long fallows (about 40 years, compared with current practices of often less than eight years), and they also harvested forest products and game. Early cultures developed low-intensity practices such as the cultivation and protection of fruit trees like mango and durian (in South and Southeast Asia), and avocado and Brazil nut (in South and Central America). Traditional forest-dwellers in Asia rarely cut the largest trees, preferring to use small poles, vines and bamboo for their houses and most other construction needs.[1] Some cultures developed more intensive forest management practices, such as the "firestick farming" employed by Australian Aborigines, to manage their food resources (Jones, 1969), which sometimes had major influences on forests, landscapes and biodiversity.

When forest management was taken over by the state, however, indigenous peoples were often blamed for forest destruction, their needs were ignored, they were evicted from forest reserves and they usually missed out on the benefits of forest development.

Ancient civilizations

As human populations grew and agriculture expanded, forests became overexploited. The Roman Empire is often cited as an example of how, with its expansion, forests went into decline. The Romans failed to institute conservation measures and, when timber became scarce locally, they simply met their needs by importing from foreign territories. Several authors (e.g. Diamond, 2005) have suggested that the historical decline of some civilizations was closely linked to the destruction of forests and the subsequent shortage of wood and decrease in ecosystem services, and to the failure to adapt to such changes.

Some societies, however, were able to address overexploitation in time. They instituted rules and regulations to control tree harvesting, grazing and the collection of non-wood forest products. In Asia, India stands out as a well-researched case

[1] Heavy hardwoods such as iron wood (*Eusideroxylon zwageri*) and teak (*Tectona grandis*) were sometimes cut for special purposes like the building of temples, palaces, long houses and dugout boats.


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This natural regeneration will form a future tree crop in a harvested lowland tropical rainforest

(e.g. Kumar, 2008). The concepts of sustainable management and conservation were embedded in the religious ethos of the region as far back as the Vedic period (4 500–1 800 Before the Common Era). Religious texts (*aranyakas*, or forest works) contain descriptions of uses and management of forests, the need to maintain forests for the "wholeness" of villages, participatory forest management and the creation of sacred forests and groves as part of cultural landscapes. Another well-recorded case in Asia is Japan, and there were many other examples in ancient Asia. Nevertheless, with the growth of populations and increases in commerce and industrial development in the seventeenth century, forest resources declined rapidly.

Advent of scientific forest management

India also provides an excellent example of the origins of scientific forest management in the tropics, so much so that the system there is referred to as "classical tropical forest management". During the early British occupation, forests appeared inexhaustible and were harvested with little control to meet demand for materials for ship-building in Britain, India's railroad expansion and other requirements. By the early 1800s, the teak forests of Malabar (South India) had been destroyed, and similar reports of forest devastation were filtering in from Tenasserim province in Burma (now Myanmar).

Such widespread forest damage provided the impetus for forestry pioneers such as Dietrich Brandis to introduce to India approaches that had been developed in Europe (Schmithüsen, 2013). While the approaches were imported, these pioneers recognized the complexity of tropical forests and, through analysis and research, progressively developed methods to suit local geographical and social settings (Leslie, 1989). The basic management elements of this scientific and iterative approach were: taking over the authority to manage forest areas; formalizing ownership and rights, including customary rights; determining the extent of the forest estate; investigating the silviculture of the main timber species; determining growth rates and investigating how to generate more precise inventory measurements; and developing sustained-yield management regimes that included yield control and the replenishment of harvested areas.

FOREST MANAGEMENT SYSTEMS FOR TROPICAL FORESTS

The early experiences in India resulted in several new forest management regimes, developed to accommodate variations in climatic, edaphic and physiographic features and human–forest interactions. The main components of these management systems were silvicultural and addressed the harvesting of trees, the regeneration of harvested areas, and the tending of regeneration to maturity. Two of the most well-developed silvicultural systems, the selection and shelterwood systems, are described below.

Heavily logged-over dipterocarp forest: the often high level of logging damage has made it difficult to determine the success of silvicultural approaches

Selection systems

Selection systems are the most prevalent form of silviculture in natural moist tropical forests in Southeast Asia. When the proportion of valuable species is low, trees of these species are felled selectively over a large area at periodic intervals. Areas that come under the system are called the selection working circle. Under this polycyclic selection system, exploitable trees of a specific girth are harvested and the next cutting cycle is determined by the time taken for the pre-exploitable class to reach harvestable size. The length of the felling cycle varies from 15 to 45 years, depending on the region and species. The system assumes that the selective removal of harvestable trees and the presence of pre-exploitable trees will provide the right environment for the establishment and growth of new regeneration. Some gap-planting may be undertaken where natural regeneration is poor.

Shelterwood systems

Shelterwood systems were introduced when the demand for wood increased and regeneration was not assured. The system involves the removal of the old stand through a series of cuttings so that regeneration produces a new, even-aged stand. Two variants of the shelterwood system have been broadly employed in India: the irregular shelterwood system and the uniform system. The irregular shelterwood system is used when regeneration is uncertain. Trees above the minimum exploitable diameter are removed, although mother trees are kept if there is a lack of regeneration. Additional regeneration improvement cuts are undertaken until regeneration is established, over a rotation of about 120 years.

The uniform system has been tried in high-value sal (*Shorea robusta*) and teak (*Tectona grandis*) forests. All exploitable timber is removed in one felling and regeneration is allowed to grow up. Where regeneration is poor, artificial regeneration techniques are employed. The rotations should be between 120 and 180 years, although they have become shorter as timber demand has increased.

Spread of Indian systems

The experiences in India were subsequently transferred and adapted to other British colonies in the tropics. The development of forest management systems in Peninsular Malaysia in the early 1900s demonstrates clearly the paths taken to deal with the issue of sustainability. Prior to introducing forest management, logging in Peninsular Malaysia was selective and focused on the heavy hardwoods, and silvicultural operations were limited to enrichment planting. But with the increase in timber demand, improvement fellings were carried out to release immature trees of valuable species. The approach did not bring about the intended result, but young regeneration became profuse. This led to the development of regeneration improvement fellings, in which commercially inferior species were removed in a series of fellings. Once the regeneration was verified as meeting requirements, a final felling of exploitable trees was carried out.

A serendipitous discovery led to the development of the Malayan uniform system (Wyatt-Smith, 1963). During the Japanese Occupation (1942 to 1945), many forests in Malaya (now Peninsular Malaysia) were clearfelled without applying systematic regeneration fellings. Later surveys revealed that these forests contained profuse regeneration, thus giving rise to the Malayan uniform system. Under this system, if adequate regeneration is present, a single felling is used to release the fast-growing dipterocarp seedlings and saplings to form a high stocking of a uniform future commercial crop. This approach was the basis for managing lowland dipterocarp forests from the late 1940s.

In the mid-1970s when the lowland dipterocarp forests in Malaysia were mainly alienated for extensive agricultural programmes, forestry was relegated to hillier sites, where natural regeneration was not uniformly present. A simplified version of the Philippines selective logging system was adopted (Appanah and Weinland, 1990), under which all commercial species of specific girth were harvested, with a sufficient number of pre-exploitable trees retained to form the next cut in around 30 years. An adequate stock of seedlings is assumed to exist, or will be replenished by the residual trees retained for the next crop. Selective fellings used for mixed dipterocarp forests in Indonesia and the Philippines, which preceded the selective fellings employed in Peninsular Malaysia, relied on the same principle: cutting exploitable individuals and leaving behind an adequate number of residual trees, which then provided stems for the next cut, which was carried out in cycles of about 30 years.

HOW SUCCESSFUL HAVE THESE SILVICULTURAL SYSTEMS BEEN?

After almost a century and a half of modern management in tropical forests, are there lessons to be learned? While the "scientific" silvicultural systems described above originated in Western Europe, they were adapted to new climatic conditions and high tree diversity.

Despite the lengthy period of trials, revisions and change, however, the success of these systems remains tentative. There are inherent difficulties in all these systems and they have often been applied imperfectly. The selection system, which exploits mature timber in cycles of 30–40 years and relies on pre-exploitable trees to form the future harvest, appeals to most practitioners. It does not, however, take into account the severe logging damage often inflicted by a combination of heavy harvesting machinery and poor harvesting planning and techniques (Nicholson, 1979; Appanah and Weinland, 1990). Surveys have revealed a lack of pre-exploitable trees nearly two decades after the first logging, which will mean a reduction in the number of harvestable, valuable trees at the next cut. With technological developments, many previously undesirable or lesser known species have increased in commercial value, or may do so in the future (Freezailah, 1984). But the lack of attention to regeneration in selection systems means that a lack of continuity of timber production is likely, if not inevitable.

In contrast, shelterwood systems, which focus on regeneration, have greater potential to provide continuity for future crops. Forest departments seem unwilling, however, to wait for the maturation of harvestable trees in shelterwood rotations, which can take 60 years or more. In the last few decades, as the demand for timber increased in South and Southeast Asia, especially as export markets expanded,

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Silvicultural tending operations in dipterocarp forests: this is indispensable for sustainable production in tropical forests extraction clearly overwhelmed natural production capacity. As a consequence, overharvesting has placed extreme stress on the viability of these nascent forest management systems.

Selection systems provide timber in the short term, with no guarantee of sustainability. Shelterwood systems have a built-in mechanism for sustainability but so far have proved too demanding in terms of silvicultural interventions and are unpopular with practitioners with short-term goals.

THE POTENTIAL FOR SFM IN TROPICAL ASIAN FORESTS

Forest management is of course more than (and in some cases may not even involve) achieving a sustainable timber yield: it is a continuous pursuit to meet ever-changing and increasingly varied needs. While foresters argue over which silvicultural system is best, external factors may render such arguments academic. Forests in Southeast Asia face intense competition from agriculture, and there is much controversy over replacing timber-rich dipterocarp forests with oil-palm plantations. SFM is yet to demonstrate that it is financially competitive as a land use compared with cash-crop plantations.

In steeper terrain, SFM is arguably the best form of land use because forests provide important services related to the protection of water catchments and soil, biodiversity conservation and other environmental benefits that agriculture and urban settlements take for granted (and cannot match). But the provision of such services has not yet been factored into land-use planning in many countries, and land conversion for agriculture continues relentlessly. It has been argued, especially in Malaysia, that if the lowland dipterocarp forests had not been converted for agricultural development, SFM would have been achieved. This is a doubtful claim, considering the problems with overcutting and heavy logging damage, the uncertainty associated with the regeneration of preferred species in logged forests, and the low financial competitiveness of SFM compared with agriculture (when services provided by the forest are not adequately remunerated). Hence, if SFM is ever to be realized there is an urgent need to demonstrate to decision-makers that the ecological and protective values of the forests far exceed those of timber production alone.

An even more contentious issue for SFM is meeting the needs of local communities. Contrary to popular belief, this issue was recognized early and given high priority in India (Stebbing, 1926). Later, however, emphasis was placed on reserving and conserving forests, without due concern for the needs of local communities. These imbalances are now being redressed, slowly, through policy and regulatory measures and by decentralization and devolution processes to return tenurial rights to the people – admittedly only after much of the timber wealth has been exploited by those with or close to political power. But much more still needs to be done in this regard. There is also a need to assist local rights-holders to implement SFM.

Technically, there is little reason why SFM that includes commercial-scale timber harvesting cannot be achieved in closed moist natural tropical forests by improving silvicultural and harvesting practices to reduce logging damage and ensure that harvesting and regrowth are in balance (Putz, 1994). But without political will and in the face of sustained pressure for quick profits, purely technical solutions are impotent. Historically, the profits derived from commercial timber extraction have favoured a relatively narrow segment of society, and approaches that meet the needs of multiple stakeholders, and distribute benefits more equitably, have a better chance of ensuring forest permanence. Silvicultural approaches certainly need to evolve further, but until the holders of land rights and land-use rights are convinced that the best use of the land is the management and maintenance of the forest growing on it, silvicultural solutions are unlikely to achieve their expected goals. ◆

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