THE IMPORTANCE OF FOREST BIODIVERSITY TO DEVELOPING COUNTRIES IN ASIA

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Received November 1992

APPANAH, S. & RATNAM, L. 1992. The importance of forest biodiversity to developing countries in Asia. Asia represents the cradle for about half of the forest biodiversity found in the tropics. Asia is also the most populous region in the world. As a consequence, its biodiversity is under great pressure from rapid conversion of forest land to other uses including agriculture. Uncontrolled logging too contributes to the eventual loss of biodiversity. Therefore, saving these forests poses a much greater challenge to mankind than that in any other biosphere on earth. The wealth of biodiversity, which has been the source of a high quality of life for a large population of rural people in the region, has not been accorded much economic value since most of it is consumed within a cashless economy. Instead, current forest usage practices are dominated by timber exploitation, accelerated by the strong demand in the international market for cheap tropical timber. This nullifies demands from the same consumer groups to conserve the rich biodiversity in the tropics. Neither have the profits from commercialization of some of the phytochemicals first sourced from tropical plants, preserved at a loss of opportunity, directly benefited the developing countries. Herein, lies a contradiction of values and interests. This should be resolved in order to conserve tropical forests. Additionally, there is a need to develop new valuation systems which take into consideration the true value of a forest, that include non-timber products as well as the environmental services. At the same time, multiple-use management systems should be given a higher priority.

Key words: Biodiversity - tropical forests - Asia - multiple use - timber - economics - values

APPANAH, S. & RATNAM, L. 1992. Kepentingan biodiversiti hutan bagi negara-negara membangun di Asia. Benua Asia mempunyai lebih kurang separuh daripada biodiversiti hutan dalam kawasan tropika. Asia juga merupakan rantau yang mempunyai paling ramai penduduk di dunia. Akibatnya, biodiversiti di rantau ini amat tertekan oleh kadar pembangunan pesat kawasan hutan kepada kegunaan lain, termasuk pertanian. Pembalakan yang tidak terkawal juga mengakibatkan kehilangan biodiversiti. Justeru itu, menyelamatkan hutan merupakan satu cabaran hebat kepada manusia sejagat berbanding dengan biosfera yang lain di bumi. Kekayaan biodiversiti merupakan sumber kualiti kehidupan yang tinggi pada sebahagian besar penduduk luar bandar di rantau ini. Aspek ini tidak pernah diberi perhatian dari segi ekonomi, kerana sejumlah besarnya digunakan didalam ekonomi tanpa wang. Penggunaan hutan pada masa kini di kuasai oleh exploitasi pembalakan yang di rangsang oleh permintaan yang kuat dari pasaran antarabangsa untuk mendapatkan kayu tropika yang murah. Keadaan ini menghadkan kehendak kumpulan pengguna yang sama untuk memelihara kekayaan biodiversiti di kawasan tropika. Begitu juga keuntungan yang diperolehi dari memperdagangkan sebahagian dari fitokimia daripada pokok-pokok tropika, tidak dapat dengan secara langsung menguntungkan negara-negara membangun. Di sini timbul pencanggahan dalam segi nilai dan kepentingan. Ini harus diputuskan demi untuk melindungi hutan tropika. Tambahan pula satu sistem penilaian baru perlu diujudkan, yang mana mengambil kira juga nilai sebenarnya sesuatu hutan, termasuk hasil pengeluaran bukan kayu dan juga faktor persekitaran.

Dalam masa yang sama keutamaan perlu dititik beratkan kepada sistem pengurusan pelbagai-guna.

Introduction

The Asian tropics is the cradle for a tremendous amount of biodiversity currently contained on earth. But their existence is being threatened by human beings. Mankind has been around in the Asian region for some 500,000 *y*, but only in the last 10,000 *y* or so did they begin to alter their environment irreversibly (Rambo 1979). This began with the discovery of agriculture. Some of the oldest civilizations arose in the monsoonal tropics of Asia. They waxed and waned in several sites, particularly along alluvial flatlands, and later along coasts and river mouths. Today tropical Asia is the most highly populated region in the world. Under such dense populations, the natural environment in tropical Asia has undergone much more modification compared to the tropical regions of Africa and South America. Irrigation, cultivation of wet rice, and the development of shifting agriculture affected most of the monsoonal sites in Asia.

The ever wet tropics were less healthy for people, and permanent agriculture was more difficult. These sites were relatively undisturbed up until the European colonization. They introduced plantation crops like cocoa (*Theobroma cacao*), coconut (*Cocos nucifera*), coffee (*Coffea* spp.), oil palm (*Elaeis guineensis*), rubber (*Hevea brasiliensis*), sugarcane (*Saccharum officinarum*), tea (*Camellia sinensis*), *et cetera*. This resulted in conversion of the moist forests so extensively that today they occur as scattered and isolated fragments.

The tropical Asian forests are also a rich source of timber, and they are now indiscriminately logged. Annually some 500 million m^3 of fuelwood and 100 million of industrial wood are produced, and the forest industries earn more than $5 billion m^3 in foreign-exchange (Spears 1988). The logging has gone on unsustainably, and reforestation programmes have not kept in pace with logging, and only about 13% of the forest area is being managed on a sustained yield basis (FAO/UNEP 1981).

Altogether, with the exploding populations and the need for additional land for cultivation, commercial agricultural operations and unsustainable logging have led to irreversible losses of tropical forests. Given the present rate of disturbance and deforestation (conversion, uncontrolled logging, excessive poaching, *et cetera*), the species-rich tropical forests will disappear or become degraded in a couple of decades. In this paper, we discuss the importance of the biodiversity (defined as the variety of life forms) for developing countries in Asia, and the contradictions between the values given to biodiversity by local inhabitants and the "outsiders", and how such opposing views can be resolved.

Extent of tropical forests in Asia

The data on tropical forest cover, original and remaining, are available from maps and FAO statistics (Table 1). It is clear that Asia's tropical forests have been reduced in extent by half. This includes some of the most majestic moist forests in the world.

Table 1. Extent of tropical forests (km^2) (closed canopy, open broadleaved, and tropical coniferous) in Asia, original and that remaining in the 1980s (modified from Sayer & Collins 1991)

Country	Original	Remaining	% Remaining
Bangladesh	130,000	9,270	7
Brunei	5,000	3,230	65
Burma	600,000	313,090	52
Cambodia	160,000	71,680	45
Southern China and Taiwan	340,000	25,860	8
India	910,000	228,330	25
Indonesia	1,700,000	1,138,950	67
Laos	225,000	78,100	35
Malaysia	320,000	209,960	66
Philippines	295,000	95,100	32
Singapore	500	20	4
Sri Lanka	26,000	16,590	64
Thailand	250,000	83,350	33
Vietnam	280,000	75,700	27
	5,241,500	2,349,230	45

Whatever that is remaining has been allocated into various land use categories, *viz.* totally protected forests, protection forests, production forests, and plantations. Only a very small percentage of the natural habitats is totally protected (Table 2). But in countries like Burma, Laos and Cambodia, these totally protected areas are not even gazetted. Even otherwise, such areas are still subject to poaching, logging and agricultural encroachment. Natural forests in Nepal and Bangladesh would most likely dissappear by the year 2000.

Table 2. Area of protected forest in Asia (km^2) (modified from Green *et al.* 1991)

Country	Land area	Area Protected (Existing + Proposed)	% Land
Bangladesh	134,000	744	0.5
Brunei	5,800	1,182	20.3
Burma	658,000	13,040	2.0
Cambodia	177,000	25,026	14.1
China and Taiwan	9,363,000	4,155	0.04
India	2,973,000	41,500	1.4
Indonesia	1,812,000	265,983	14.6
Laos	231,000	47,211	20.4
Malaysia	329,000	27,651	8.4
Philippines	298,000	2,395	0.8
Singapore	600	0.7	0.1
Sri Lanka	65,000	6,309	9.7
Thailand	512,000	56,645	11.1
Vietnam	325,000	6,252	1.9
	16,883,400	498,093.7	3.0

Protection forests, officially set aside for environmental protection, are equally insecure. Vast areas of such forests in India, Indonesia, Thailand, and elsewhere have been seriously degraded by shifting agriculture and fire.

Currently, the majority of the remaining forest is under production status, but mainly for timber extraction (here lies the greatest opportunity for preservation). Most countries have laws regulating timber harvesting. But rarely are the profits from logging benefitting the people. So except in countries where populations are small, or the forests are remote, shifting cultivation often accompanies logging. The forests become degraded and turn into scrub and grassland.

There is also an increasing trend to convert natural forests to plantations of fast growing tropical hardwoods (Appanah & Weinland 1993). Some of the species used are *Acacia, Paraserianthes* (*Albizia*) *falcataria, Anthocephalus, Araucaria, Eucalyptus, Gmelina, Leucaena* and *Pinus*, among others (Evans 1982). However, managing plantations of fast-growing species requires considerable amount of inputs and management effort. So usually the results are disappointing, and many expensive projects have been abandoned (Appanah & Weinland 1993). The original natural forest is lost too.

Biodiversity

The status of forests in Asia is indeed a gloomy one. But can the destruction and loss of forest and its biodiversity be halted or reversed. Solutions are needed, but they can only be based on information on what is the biodiversity, its whereabouts, and value, tangible and potential, to mankind.

Asia is an incredible source of animals and plants. This is the land of animals such as tigers (*Panthera tigris*), elephants (*Elephas maximus*), orang utans (*Pongo pygmaeus*), rhinoceroses (*Dicerorhinus, Rhinoceros*), pheasants, birds of paradise, pythons (*Python reticulatus*), cobras (*Naja* spp.), and crocodiles (*Crocodilo* spp.), and plants that include the massive dipterocarp trees, the largest flowers (*Rafflesia*), pitcher plants (*Nepenthes*), orchids, and stranglers (*Ficus*). In a review of this length, it is not possible to detail the biodiversity in the Asian region. The principle issues are outlined here, along with notable examples.

India on the western end of the region has a rich and diverse flora and fauna (Mani 1974). The tropical forests house a high concentration of the nation's total plant and animal diversity and include many species which are endemic. The flora is largely derived from Indo-Chinese and Southeast Asian origin. Of the estimated 45,000 species of plants (Lal 1989), 15,000 are higher plants, and over 4,000 are found in the evergreen forests in the Western Ghats, in just 5% of the land area.

Sri Lanka, despite its small size and long distance from the centres of biodiversity, is exceptionally unique in having high biodiversity; the perhumid forests are responsible for much of it (Andrews 1961). As a result of its disconnection with the mainland, endemism is very high too. Of the estimated 3,000 species of flowering plants, 830 are endemic. The endemics are mostly confined to the rain forests. Twelve out of 85 mammal species are endemic, and over half of the amphibians (total 101 species) and reptiles (total 90 snake species) are endemic as well.

Bangladesh is the transition zone between Indo-China, the Himalayas and the rest of the Indian subcontinent. As a result the region is extremely rich in biodiversity but few of them are endemic. Although the area is small compared to the Indian subcontinent, the tropical moist forests of Bangladesh are the richest in plants in the subcontinent, and they supported the greatest diversity of mammals (113 out of 500 species in the Indian subcontinent) and a high diversity of birds (574 out of 1200) (FAO/UNEP 1981, and others).

Burma straddles two zoogeographic zones, supporting Indian and Chinese elements in the north and Malesian elements in the south. About 7,000 flowering plant species are known in Burma, of which over 1,000 are endemic (Chatterjee 1939). There are about 300 mammal species, and some of the large mammals that roam the less disturbed forests include banteng (*Bos javanicus*), barking deer (*Muntiacus muntjak*), elephant (*Elephas maximus*), gaur (*Bos sundaicus*), leopard (*Panthera pardus*), tiger (*Panthera tigris*) and sambar (*Cervus unicolor*). About 1,000 bird species have been recorded. While the diversity is high, endemicity is low. For example the 1,000 bird species represent about 12% of the birds in the world (Smythies 1953). The Burmese forests can be described to contain Indian, Chinese and Malesian species.

Like Burma, Thailand is rich in flora and fauna, and likewise its wildlife comprises elements from the neighbouring countries. As a result its endemism is low. The flora of Thailand is estimated at between 10,000 and 15,000 species, including more than 500 tree species and 1,000 orchids (FAO 1981 and others). There are 265 species of mammals, over 900 bird species, and 100 amphibians. The birds and mammals of the Northern Highlands show affinities with those of western China, whereas the Southern Peninsula includes species from the Sunda Shelf countries.

Little is known of the flora and fauna of Laos and Cambodia. In Laos, plant species richness is considered to be high, with a moderate level of endemism (IUCN 1988a). About 600 tree and shrub species and 300 orchid species have been identified. Also known are 623 bird species (28 endemic to Indo-Chinese region) and 186 mammal species (20 endemic to Indo-Chinese region).

Unlike the former two Indo-Chinese countries, Vietnam's flora and fauna are better documented. They are very diverse, with a high level of endemism (Anonymous 1985). Some 7,000 of the predicted 12,000 plant species are known. There are over 160 mammal species, 723 birds, 180 reptiles and 80 amphibians.

China, in the northern and eastern end of the Asia region, is very rich biologically. It has about 30,000 species of higher plants, including 7,000 tree species. Almost half of them are from tropical and subtropical regions (Jiang 1986). Endemicity is very high. Of the 2,980 higher plant genera, 214 are endemic. The rain forests contain an exceptional number of species not found elsewhere in the country.

Below continental Asia, and connected to it is Peninsular Malaysia. As a result of the connection, the rich flora and fauna of P. Malaysia is overwhelmingly Laurasian (Asian), with a small Gondwanic (Australian) component (Symington 1943). There are about 8,000 species of plants, 200 species of mammals, including 81 bats, 110 species of snakes, and just over 600 species of birds (see Whitmore 1975). In

general endemism is not high.

The Malaysian states of Sabah and Sarawak are in the heart of the Sundaland, in the island of Borneo. Borneo has the greatest biodiversity in Asia, and it is one of the principle spots on earth that deserves exceptional attention from conservationists. The exact numbers of plant and animal species are not known yet, but individual families can illustrate the diversity. For example, the centre of diversity for the family Dipterocarpaceae is Borneo. Of the 390 species in Southeast Asia, 265 are found in the island, and 155 are endemic (Ashton 1982). The diversity of animals is high too, and so the endemism. Of the 196 mammal species, 40 are endemic.

Indonesia is perhaps most unique in terms of biodiversity worldwide. It is located in the heart of the Asia-Pacific humid tropics, but also spreads into areas with seasonal forests. The flora and fauna are influenced both by the Laurasian and Gondwanian sources. As a result, even though Indonesia occupies only 1.3% of the earth's land surface, it contains about 10% of all plant species, 12% of mammals, 16% reptiles and amphibians, and 17% of the birds. There are over 25,000 species of flowering plants, including about 10,000 trees (FAO 1982). About 40% are endemic at generic level. Of the 1,500 species of birds, 430 are endemic. Likewise are 200 of its 500 mammals, and a large proportion of the 1,000 reptiles and amphibians.

The Philippines has undergone much deforestation that it will never be possible to know what was the original flora and fauna. Nonetheless, it is still very rich, and high in endemism because of the numerous islands which constitute it. Some 12,000 species of plants and fungi have been recorded, and 3,500 are endemic (IUCN 1988b). Likewise, of the 96 species of non-flying mammals, about 70 are endemic.

Biodiversity and developing countries

Biodiversity may be regarded as a boon or bane to developing countries. The pressure for protecting biodiversity is viewed as coming from developed countries, who stand to gain most from discoveries that can be commercialized. As a consequence, those in the developing countries are being asked to give up the opportunity that would accrue if the lands are exploited for their timber, and converted to cash crop plantations or other forms of uses.

Biodiversity has also been regarded as a constraint for "development" (Panayatou 1989). Modern forestry and agriculture are based on the successful experience of monocultures in temperate countries (Evans 1982). The result has been a continuous replacement of high-diversity, "low-productivity" natural ecosystems with low-diversity, "high-productivity" man-made systems. What is even more enigmatic to the developing countries is that such "low-diversity" systems actually replaced their traditional mixed farming and other "high-diversity" systems.

If at all there is a group that needs no conviction about the value of biodiversity, it is the scientific community. But how can they translate this to the people who will save the biodversity, *viz.* the planner, the politician and the people in contact with the forests. If we cannot give biodiversity a tangible and realizable value, the battle

is almost lost. It can be done, though.

Biodiversity for agriculture

The tropical forests in Asia are an important source of food crops and animals (Hawkes 1989). Beverages, fibres, fruits, gums, oils, bamboos, rattans, spices, and vegetables have been derived from forests. Many are in cultivation too (Table 3).

Table 3. Cultivated plants originating from Asian forests (Burkhill 1935)

Fruits:	banana	(*Musa*)
	carambola	(*Averrhoa carambola*)
	citrus	(*Citrus* spp.)
	durian	(*Durio* spp.)
	illipe nut	(*Shorea macrophylla*)
	jackfruit	(*Artocarpus* spp.)
	longan	(*Dimorcarpus longan*)
	mango	(*Mangifera* spp.)
	mangosteen	(*Garcinia mangostana*)
	rambutan	(*Nephelium lappaceum*)
Spices:	betel nut	(*Areca catechu*)
	cardamom	(*Elettaria cardamomum*)
	cinnamon	(*Cinnamomum* spp.)
	clove	(*Syzygium aromaticum*)
	ginger	(*Zingiber officinale*)
	nutmeg	(*Myristica fragrans*)
	pepper	(*Piper nigrum*)
	turmeric	(*Curcuma longa*)
Fibres:	Manila hemp	(*Musa textilis*)
	jute	(*Corchorus capsularis*)
	sunn hemp	(*Crotalaria juncea*)
	ramie	(*Boehmeria nivea*)
Root crop:	taro	(*Colocasia esculenta*)

The biodiversity has indeed added to the richness of life in Asia. But these products are only a drop in the ocean of species still unexploited. Only a few plant crops (about 150) have been commercialized on a large scale world-wide (Plotkin 1988), and less than 20 species produce most of the world's food (Vietmeyer 1986). It is estimated that only 30% of wild relatives of cultivated fruit trees are now being planted (McNeely 1991). For example, there are 39 species of *Mangifera* occurring from India to the Solomons (Hou 1978), but only *M. indica* is cultivated widely, although a few other species are grown locally. It has been said that there are over 1000 varieties of *M. indica* in India alone (Swaminathan personal communication). Likewise, the humid tropics of Asia is the centre for Aurantioid, subfamily of the Rutaceae, with 33 genera and 204 species; and the genus *Citrus* has 16 species in the region (McNeely 1991).

Wild relatives of fruit trees and other plants proliferate the forests in the region. Therefore an incredible amount of genetic material is available for breeding purposes, for improvement of existing crops. Plant breeders have used it to double

yields of rice (*Oryza sativa*), soybean (*Glycine max*), sugarcane (*Saccharum officinarum*), triple the yield of tomato, and quadruple that of corn (*Zea mays*), sorghum (*Sorghum* spp.) and potato (*Solanum* spp.) (OTA 1987).

Biodiversity for animal husbandry

Like plants, Asia also has many wild relatives of domesticated animals like the cattle. They are gaur (*Bos gaurus*), banteng (*B. javanicus*), kouprey (*B. sauveli*), wild water buffalo (*Bubalus bubalis*) and tamaraw (*B. minorensis*). These animals are endangered due to habitat losses, but they are very important for breeding purposes.

Biodiversity in market terms

Today bamboo, rattan, and reeds are important sources of income for villagers and are important cottage industries in the region. Of the 151 species of rattans, 104 are found in P. Malaysia and Borneo (Jacobs 1982). Thousands of villagers are involved in their collection and processing. The export of rattan is worth $1,500 million per year from the region (Caldecott 1988a). In fact, exports of non-timber products can be shown to be increasing in value all the time. For example, in Indonesia non-timber exports comprised only 2.9% compared to timber exports in 1973, but the value reached 11% in 1983 (Table 4).

Table 4. Exports on non-timber products in Indonesia, 1973-1983 (Source: Repetto & Gillis 1988)

Year	Value of non-timber exports (US$)	as % of timber exports
1973	17.0	2.9
1974	24.9	3.4
1975	21.6	4.1
1976	34.7	3.9
1977	48.3	5.1
1978	58.6	5.2
1979	114.0	5.2
1980	125.6	7.5
1981	106.0	11.2
1982	120.0	13.3
1983	127.0	11.0

Valuable resins are produced by some 20 species of dipterocarps. In Lampung, southern Sumatra, villagers tap cultivated stands of *Shorea javanica* for damar, which is used as a varnish for fine art. Some of the tappers earn as much as US$1,000 per *ha* each year from tapping damar (Goldstein 1989). If the trees were harvested for timber, one cannot make more than four times the value of damar. Timber is a one-off affair. The resin from *Agathis* spp., known as copal, is used in the manufacture of paints and varnish. Annually about US$400,000 worth of copal is exported from the Philippines (Burgess 1991).

Before the advent of modern medicine, plants were a vital source of drugs and medicines for people in Asia. This tradition is still alive. In China and India, above 75% of the inhabitants rely on herbal remedies. For such cures, some 6,500 plants have been used in Asia, most of which are collected from the wild. In the tropical forests of Xishuangbanna, China, over 300 plant species are collected for medicinal value, another 200 are edible, over 100 are timber species, and another 100 are oil producers (Li & Zhao 1989, as in MacKinnon & Collins 1991). This represents nearly 20% of the higher plants in the forest, an incredibly high usage of the biodiversity. In monetary terms, their value in the Asian region could be billions of dollars.

Human beings have derived considerable benefits directly from the rich fauna in the region. For many people, wild animals provide most of their protein needs. A wide range of animals are hunted, chiefly pigs (*Sus*), and several deer like sambar (*Cervus unicolor*), barking deer (*Muntiacus* spp.), and mouse deer (*Tragulus* spp.). Caldecott (1988b) estimates that about 18,000 tonnes of wildmeat are harvested annually in Sarawak. Primates, pangolins, bats, crocodiles, pythons, frogs, hornbills, pheasants and pigeons are hunted. Birds of paradise and bowerbirds are taken for personal decoration as well, while cave swiftlets provide nests used by Chinese for soup.

The forest animals also form a flourishing trade internationally. For example, Moluccas exported 70,000 parrots in 1983, although only 42,000 were sent out legally (Smiet 1985). Each year thousands of crab-eating monkeys are exported from Indonesia for bio-medical research. Butterflies are traded both as deadstock or alive. Most of the specimens are collected from the wild but increasingly, smallholder butterfly farms are being developed (Collins & Morris 1985).

Finally, ecotourism has been a direct source of income for many villagers living besides nature parks. The examples are numerous. Annually some 400 million people visit nature reserves in Asia. The villagers neighbouring Khao Yai, Thailand's oldest protected park, act as guides and porters for tourists. The porters earn as much as US$200 per trek (Praween *et al.* 1988). In India, some 200,000 visitors to Periyar in the Western Ghats, paid US$40,000 as entrance fees and other revenue in one year (see Green *et al.* 1991).

Biodiversity a matter of impact and value

So far we have endeavoured to show how valuable biodiversity is to developing countries in Asia. In fact the rural folks in many parts of Asia are entirely dependant on the varied products for their existence. If this is indeed the case, why are tropical forests disappearing fast? This is a question of value. New generations who have lost contact with the forest make all the judgements on its future landuse. They introduce more exploitative technologies like the chainsaw and shotgun for marketable products like timber, rattan and bushmeat. Traditonal uses that are predominantly valued by cashless societies are ignored. The wealth of goods from tropical forests plummet in value, and forests lose their importance.

There has been an undue emphasis on timber from the Asian forests in the last three decades or so. As a consequence, tropical forest management often neglected other non-timber products and services. Sociologists and economists are beginning to argue that the many non-timber products in a forest may exceed the economic value obtained from a once in 30 to 40 *y* timber cutting. A case has been built for a Peruvian forest, where the economic value of many of the non-timber forest products sold in the village markets far outweigh the profits from timber (Peters *et al.* 1989). It was estimated that of the 842 individual trees belonging to 275 species in one hectare, 350 trees (72 spp.) yielded products with direct economic value with a net annual value of US$400 per hectare. No such case has been demonstrated in Asia; at least with dipterocarp forests, the timber values may in general be better than that for South American forests.

But the case to be borne in mind here is that timber harvesting very rarely enriches the forest inhabitants and the villagers in the area except for some short-term labour jobs. With current rent-captures, much of it is made by a few individuals who are remote from the forest (Panayatou & Ashton 1992). The concession fees do not take into account the loss of non-timber goods, forest services, wildlife, recreation services, *et cetera*. This gives a skewed view that only timber has much value. But neither do the states capture the full value of the timber, compared to the rents generated by it.

The case can be better exemplified by comparing the products from a natural forest and plantation. Plantations exceed natural forests any time in stumpage, the usual means of evaluting timber value. But natural forests produce a much wider range of goods beyond timber. They include rattan, bamboo, gums, resins, fibre, latex, fruits, mushrooms, game, flowers, fuel wood, fodder, condiments, spices, etc. There is the increasing search for bio-chemically active plants for the pharmaceutical industry, not discounting those used in traditional medicine. Beyond that the natural forest provides environmental services more effectively than plantations. The services include ecological stability, watershed protection, genetic resources conservation, recreation and tourism (Panayatou & Ashton 1992). None have been quantified and valued and compared with single-species plantations. One economist thinks the people in the tropics are giving away timber at a subsidy when the environmental costs resulting from logging (damage to residual stock, soil deterioration, nutrient loss, *et cetera*) are quantified (Panayatou personal communication). Economic analysis can prove the benefits from biodiversity.

Another reason these "minor" or non-wood products have not received their due recognition is because of their level and area of impact. They have little impact beyond the local communities (Table 5).

Table 5. Levels of significance for different tropical forest management schemes (adapted from Ashton & Panayatou, 1988)

Output Impact At	Local	National	Regional	International
Timber	+	+++	++	+++
Fuelwood	+++	++	+	-
Non-wood production	+++	++	+	+
Soil-water	++	+++	++	+
Genetic resources	-	+	++	+++

Key: - insignificant; + minor; ++ moderate; +++ major

From the Table it is easy to perceive why there are so many disparities in the values of the different products of tropical forests. For example, there is high demand for cheap tropical timber in the international markets. The pressure for conservation of biodiversity is also viewed as originating from the developed west. These under current management practices are mutually exclusive. The developing countries cannot understand the simultaneous demands for cheap tropical timber and conservation of biodiversity. The developing countries see both these demands benefitting the developed countries only. If logging practices are going to change so biodiversity is conserved, the price of timber will rise. In that event, many of the tropical timber producing countries fear the international markets will switch to cheaper sources elsewhere.

There is some justification in the accusation by developing countries that conserving biodiversity, at a loss of opportunity, is a commercial ploy by developed countries. Many of the commercial developments from chemical components resourced from tropical plants have not yielded a cent to the caretakers. An example is the development of environmentally safe insecticide from the neem tree (*Azadirachta indica*) from India. The plant is held sacred and has been planted by Hindus in their temples and elsewhere. In a sense they have conserved it, but obtained no benefits from the commercial development of the plant's chemicals. Until and unless the people in developing countries gain from such developments, conservation of biodiversity will be viewed as a lobby to safeguard commercial interests of developed countries. Todays patents compensate the final developers of a biological product, but not the conservers of its germplasm.

The hankering solely after timber seems to impoverish many people directly dependant on forest resources. The rural people depend heavily on forest products. A study in Laos found that villagers gathered or hunted 141 different types of forest products, which included 37 food items, 18 types of animals, and 68 medicinal plants (Ireson 1989). The villagers were affected seriously when the State enterprise began logging the forest. Streams and wetlands were dried up, forest paths were blocked by fallen timber, animals were scared away, and hunting due to loggers reduced game for the villagers. If such costs and ensuing rural poverty are recognized, planners will be in a better position to bargain for preserving forests.

The role of villagers in the maintenance of forests has not been recognized adequately. Outsiders usually decide the fate of forests, with little consideration on its implications to the people. A typical village in Asia is (was) usually modelled

around a few hundred people cultivating the flatter areas for rice. The neighbouring forest provided a variety of products and game. The seasonally flooded grasslands provided grazing grounds for livestock. The wetlands were also a source of fish. Such an order has been demolished. With that was lost the close contact people had with forests, and their interest in perpetuating it. Sustained management of the resources, much of which benefit the people directly is lost. Current forest management systems, mono-sectoral in fashion, ignore traditional management systems of biological resources. Modern systems do not cater for the social organization of the people even if the systems are based on sound ecological principles.

Biodiversity misunderstood

Developing countries too have often misunderstood the consequences of some of their actions by making direct comparisons with those in the temperate regions. The often cited argument against developed countries (in this sense, temperate regions) is that they have destroyed their forests to fund their development, are still cutting down their boreal forests, but meanwhile are trying to halt cutting of tropical forests which brings foreign exchange desperately needed by these countries. There is a lot of truth in the statement that most forests in temperate countries have been tampered heavily, and whatever is left of them resemble more of plantations. But the important issues are missed. While temperate forests have few species of plants, and almost little multiple-use, it is the converse in the tropics. Not only are tropical forests rich in biological diversity, a greater variety of products and services are available from tropical forests, timber being only a small part of it. Next, boreal forests with extremely low biomass buildup can hardly contribute to carbon dioxide sequestration compared to tropical forests. In a sense, the biological diversity in tropical forests appears a burden, and the inhabitants are thus forced to forego development of these lands so as to conserve biodiversity. Therefore, loss of tropical forests cannot be equated on par with temperate forests; more is lost in the former. A new and higher value should be given to biodiverse tropical forests.

Some solutions

Some important solutions to the conservation of biodiversity usually lie outside the framework of the forest. These include control of population growth, education, awareness, *et cetera*. Strong forest conservation policies are needed as well, and many countries in the region have them or subscribe to them. But usually the reservations are not clearly demarcated geographically. Such reservations may not be effective unless a permanent means of existence for the landless, marginal forest people is taken care of through equitable distribution of lands.

Forest industries should be tuned to use more intensively and efficiently a greater proportion of the timbers, and lesser known species as well as branchwood. For example, Wyatt-Smith (1952) had already pointed out the timber potential of over 200 species in Peninsular Malaysia, and the Pocket Checklist of Timber Species was produced for such a purpose. The list was drawn based on usage of some of these

species in some of the small mills. Now the bigger mills are beginning to use them, and often over 30% of the wood in plywood/veneer mills constitutes such lesser-known species. The industry itself should increase its recovery rates and reduce much wastage.

Management of natural forests has to be intensified sufficiently so their productivity is raised, and governments are less attracted to convert them to other land uses. Plantations may have to be created so they can relieve the pressure off natural forests. Heavily logged forests should be underplanted so that their forestry potential is never diminished. Panayatou and Ashton (1992) have put up an extensive case for multiple-use management of tropical forests. Under the system, an undisturbed forest could be managed to achieve maximum value through timber production, production of non-timber goods, provision of environmental and biological services, regulation of climate and carbon sequestration, recreation and aesthetic benefits, and conversion to agriculture and livestock production.

The decision for management to achieve maximum value of a forest should depend on a variety of factors, which include ascribing proper value to the variety of products (including services) obtained from the forest, the capacity of the soil for maintaining productivity, communities that are dependant on the resources, and the biodiversity in the area. Finally, while it is possible to ascertain the true value of the forests, these are useless entities if the international community does not respect such values and pay for them accordingly. Above all else, ways have to be sought to bring about development without compromising the biological wealth of the earth. Otherwise, mankind might lose its future options.

Acknowledgements

We wish to thank two anonymous reviewers whose critical remarks helped improve the content of this paper considerably.

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