

Deforestation in the Asian Tropics – Causes and Consequences

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Introduction

In view of the growing international concern about the problem of deforestation in the tropics, the Environmental Co-ordination Unit (ECU) of the United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP) has organized an Expert Group Meeting on the "Environmental and Socio-Economic Aspects of Tropical Deforestation" held in Bangkok, January 28 – February 3, 1986. Under this project the author had been appointed by ESCAP as a scientific adviser in order to prepare an analytical overview on this problem over the entire ESCAP region. The present study is an abstract of this overview.

The tropical parts of Asia can be roughly divided into the following three subregions:

1. South Asia: Bangladesh, Bhutan, India, Nepal, Pakistan, Sri Lanka;
2. Continental Southeast Asia: Burma, Kampuchea, Laos, Thailand, Vietnam;
3. Insular Southeast Asia: Brunei, Indonesia, Malaysia, Papua New Guinea, Philippines.

In addition the tropical parts of China are included.

According to a recent study of "Forest Resources of Tropical Asia" by FAO-UNEP(1) two major types of modification to the forest cover are to be distinguished:

- (a) Deforestation (in the strict definition) means a complete alienation of forest areas to agriculture or to other uses;
- (b) Forest degradation means a gradual reduction of bio-mass resulting from overexploitation, overgrazing, fire, etc.

Although this study is focused on deforestation, degradation is often the step to deforestation and is therefore included.

The present extent of tropical forests and deforestation

Until very recently, the knowledge about the extent of deforestation in the tropical countries of the world was quite limited.

It was not until the early 1970s that, with the use of satellite imagery and remote sensing techniques, more precise data on the real extent of the remaining forest resources and of deforested areas were estimated.

Subsequently, FAO has undertaken steps towards systematic collection and evaluation of data on a global scale. (2) The FAO findings for tropical Asia are summarized in Table 1 and 2.

The present total area of closed forests in the 16 major countries of tropical Asia account for about 306 million ha, which equals 34% of the total land area. By far the largest forest reserves can still be found in the humid parts of tropical Asia, i.e. in Insular South-East Asia, with 62% of the land area still under forests, whereas in the drier sections, i.e. in South Asia, the rate is down to 15%. In the semi-humid countries of continental South-East Asia, the share of land under closed forests accounts for 35% of the total land area.

These regional disparities become even more pronounced if one relates the areas of the remaining forests to the population figures of the various countries. On an average, there still exist 0.25ha of closed forest per person in the whole region. In Insular South-East Asia, the respective figure is 0.85 ha (with the extreme case of Papua New Guinea of 11.41 ha/person) in Continental South-East Asia, 0.46 ha; in South Asia, the figure is only 0.07 ha per inhabitant (with the extreme cases of Bangladesh: 0.01 ha and Pakistan: 0.03 ha/person).

The average rate of deforestation per annum has been calculated to be 1.8 million ha of closed forest for the whole region, i.e. an annual rate of 0.6%, which reflects more or less the world-wide trend of tropical deforestation. (3) To this figure one can add about 0.2 million ha of open woodlands being deforested each year. If this trend continues, the closed forests of tropical Asia will decrease from 306 million ha in 1980 to 270 million in the year 2000.

In absolute figures, most of the deforestation does, quite naturally, occur in areas with large forest areas still in existence, i.e. in Insular South-East Asia (with more than 0.9 million ha deforested each year). In relative terms, however, compared with the size of the remaining forest cover, the rate of deforestation is at present much higher in Continental South-East Asia: 0.9% per year (as compared with 0.6% for all tropical Asia). Thailand, exhibiting an annual rate of 3.2%, seems to be an area of particular concern. In South Asia, the process of deforestation has been slowing down to 0.3% in countries like India and Pakistan, probably because there are not many accessible forests left in these countries. On the other hand, in Nepal, the present rate of deforestation is relatively high and is estimated to be 4.3%.

Other interesting conclusions can be drawn if one relates the absolute figures of deforestation to population figures. The average size of deforested area per person is about 15 sqm per year for the whole region. It is highest in Insular South-East

Asia (45 sqm), closely followed by Continental South-East Asia (41 sqm). As, however, Insular South-East Asia still provides comparatively large forest reserves, the situation seems to be less serious there than it does in Continental South-East Asia, where forest reserves are relatively limited. In South Asia, the annual rate of deforestation is only about 3 sqm per person which, however, must be seen in the light of the immense population figures and very limited forest resources (South Asia contains 71% of the total population of tropical Asia, but has only 20% of the remaining closed forests). Extreme cases of deforestation per person are in Laos with 289 sqm/year (where the bulk of the population consists of hill-tribes performing shifting cultivation) and in Malaysia, with 176 sqm/person/year (obviously due to the country's aggressive land settlement policy and logging activities), followed by Thailand with 63 sqm/person/year, and Nepal with 60 sqm/person/year (mainly due to the present trend of farmland expansion by spontaneous settlers at the cost of the forest areas).

Causes of Degradation and Deforestation

A. Logging

The role of logging in tropical deforestation is very much disputed. Some critics regard it as the major cause of deforestation, (4) others do not consider it as a serious source if it is carried out with sufficient care. (5) Using scientific and selective logging practices which allow sufficient time for regeneration, commercial logging can indeed take place with minimal damage. However, many countries, for example, the Philippines, did not have much success for years in introducing or enforcing such controlled plans. (6)

Supporters of logging usually argue that the volume of timber extracted per hectare is only about 10 cbm in most tropical forests, for example, in Latin America and Africa. The rain forests of South-East Asia can, however, be logged much more intensively because of their relatively homogeneous composition with predominantly dipterocarp species, which makes them particularly attractive for logging. Thus, the volumes extracted in South-East Asia vary generally from 40 cbm to 100 cbm, which contributes about 15 to 35% of the gross volume of growing stock of an undisturbed rain forest. In addition to the extracted logs, a big share of the remaining growing stock is destroyed by the logging operations. Felling one big tree usually causes damage to several other non-target trees. Tracks and roads for the use of tractors and log haulers open up additional

spaces. Studies in Sarawak have shown that the temporarily uncovered space could represent up to 40% of the total logged area.(7) Even then, it has been argued, the depletion of growing stock is only temporary if the forest is left over and not encroached upon for other non-forest uses.

In reality, this argument remains but wishful thinking. In fact logging operations provide ideal paths for shifting cultivators and other farmers who follow on the heels of the loggers to complete the destruction of the forest cover for agricultural purposes. It thus seems obvious that logging, not only clear-felling but also selective felling, constitutes a major cause of tropical deforestation.

The rate at which forests are logged differs remarkably from subregion to subregion.

In South Asia with its very limited forest reserves the total industrial wood removal is comparatively low. Log production accounts for only 11% (1977-1979) of tropical Asia and is almost exclusively consumed within the region.

However, as domestic needs are expected to increase continuously, the stress on the remaining forests will increase as well. It is hoped that wood plantations might contribute about 50% to the wood removals in the year 2000. The rest is expected to be provided either by hitherto inaccessible forests, mainly from north-eastern India, Nepal and Bhutan, or from "secondary" wood species which are regarded as non-utilizable at present, but which may find market opportunities as forest resources continue to decrease.

In Continental South-East Asia, population density is moderate (75 inhabitants/sqkm, 1980), but forest reserves have been dwindling rapidly in the past; its share of the total log output of tropical Asia decreased from 12% (1968-70) to 7% (1977-1979), mostly attributable to gradually depleting stocks in Thailand, conservative logging in Burma and unstable conditions in the centrally planned countries. Exports declined at a rate of 22% from 1969-1978. A remarkable feature is the growing dependence of Thailand on imports, mainly from Malaysia, to keep the country's sawmilling industry running. From a net exporter, Thailand has emerged a net importer.(8)

Insular South-East Asia provides some 59% of the total closed forests of tropical Asia (but only 17% of the population). The relatively uniform dipterocarp forests and the comparatively easily accessible forest areas make commercial logging particularly attractive (except in Papua New Guinea) and have made this region one of the world's major exporters of valuable hardwood. Between 1969-70 and 1977-1979, the annual log production of Insular South-East Asia rose from 36 million cbm to 64 million cbm, and its share of the total log production of tropi-

cal Asia increased from 74 to 81% during the same period.

In Indonesia, log production tripled from 8 to 26 million cbm and exports grew from 4 to 19 million cbm during the 1970s. Logging operations are concentrated in Kalimantan, where more than 100 concessionaires achieve about 50% of the country's total log production.

Malaysia continued to be one of the leading log suppliers, rising from 17 million to 30 million cbm during the 1970s, mainly attributable to log harvesting in Sabah and Sarawak.

The Philippines exhibited serious problems of overlogging during the 1960s. Meanwhile, growing awareness of the need for conservation in this predominantly mountainous country led to a marked decline in log production during the 1970s, from 11 million to 7 million cbm. Exports even dropped from 9 to 2 million cbm, aided by export restrictions and a comparatively well developed domestic processing industry.

Papua New Guinea provides a special situation, as its rain forests exhibit a much wider variety of wood species which reduces the commercially valuable yields per hectare to about half of those commonly found in the more uniform dipterocarp forests of Insular South-East Asia. In addition most forest areas are relatively inaccessible and the costs of harvesting are high. (9) The forest resources are thus relatively unattractive for exploitation, and up to now logging operations resulted in rather modest outputs (1.4 million cbm in 1979).

It is expected that logging in Insular South-East Asia is now passing its peak and will level off or even slightly decrease in the coming years. The policy of Indonesia, Malaysia and the Philippines is now to cut down log exports and to promote domestic processing of logs.

B. Fuelwood

The collection of fuelwood by rural people for domestic energy needs is generally regarded as the most important cause of forest degradation, and not deforestation, but excessively practised it might also result in deforestation and desertification.

For large parts of tropical Asia, fuelwood has always been the dominant and traditionally free fuel, the only cost involved being the effort of gathering it. Whereas firewood is preferred in rural areas, charcoal is preferred in urban areas owing to its greater efficiency in regard to transportation and use (greater heat intensity and less smoke). Although consumed in towns, charcoal production has become a very important commercial enterprise for rural people, particularly for those

landless poor who have no other job opportunities.

The average per capita consumption of fuelwood varies from about 0.4 cbm per year in the arid parts of tropical Asia with limited wood resources, and about 1.0 cbm in lowland areas with sufficient forest reserves, to about 1.5 cbm per year in the cooler mountain zones. (10)

Most parts of South Asia are already today suffering from acute scarcity of fuelwood supply. In India, for example, the current demand for fuel amounted to 250 million cbm in 1979. However, the recorded production was only 16 million cbm. (11) The immense gap between demand and supply from forests had to be filled with unrecorded felling from forests and removal of fallen dried branch wood. It is further estimated that about 35% of the consumed firewood was collected from the people on their own land (including home gardens, etc.). Besides, about 386,000 ha of fuelwood plantations had been established by 1980, a figure which is expected to increase to some 615,000 ha by 1985.

However, the largest portion of the fuelwood gap in India has to be filled by dried livestock dung and agricultural residues which are used for cooking and heating instead of applying them as fertilizer to improve the soil fertility and stabilize the agricultural crop yields. It has been estimated that the dung used as fuel in the mid-1970s was equivalent to the total amount of mineral fertilizer consumed in India at the same time. (12) And for Nepal, it has been estimated that every ton of dung which is burnt deprives the country of 50 kg of grain. (13)

Another matter of concern is the growing distances between the villages and the dwindling wood resources. Many rural people of India, particularly the women and children, have to walk miles to the nearest woods, and are often forced to devote more time to fuelwood gathering and transportation than to other agricultural activities. (14)

In the other South Asian countries, except Bhutan, the situation is as serious as in India. Nepal seems to be of particular concern, where excessive fuelwood collection at the hillslopes has contributed to severe soil erosion and denudation. In Bangladesh, the per capita consumption of fuelwood fell by about 50% between 1960 and 1975 owing to acute shortage of supply and prices which increased beyond the reach of the lower income groups. The situation is further compounded by problems of transportation. For example, the charcoal used in the city of Dhaka is produced more than 300 km away.

In Continental South-East Asia, there is also heavy reliance on fuelwood, but the supply is considered satisfactory in most parts of the subregion at present, except in some parts of central and north-east Thailand and central Burma, where there

are deficit situations. Particularly in Thailand, the situation may become rather grave owing to the ongoing deforestation. As in Dhaka, the immense charcoal supplies for many of the 5 million people of Bangkok have to be carried over long distances. Vietnam has succeeded in reducing the scarcity of fuelwood through a systematic programme of tree-planting in several areas. Similar conditions are reported from the tropical parts of China.

About 40% to 50% of the population in Insular South-East Asia depend on fuelwood, but the situation is expected to remain satisfactory even beyond the year 2000. Only in some parts, like Java and parts of Luzon, the situation is approaching critical levels.

In Malaysia, the dependence on fuelwood is the least among all countries. Besides the availability of sufficient natural wood reserves and use of alternative energy resources, the country now promotes charcoal production from the old stands of its vast rubber plantations.

C. Grazing and fire

Overgrazing by cattle and other livestock is another important factor in the degradation of forests, mainly of open forests. Forest grazing is a traditional habit, particularly in the drier parts of the region. The gradual extension of farmland at the cost of pastures has been resulting in heavy reliance on grazing in forests. The problem is particularly acute in large parts of India, where forests are often the only places where livestock can find some fodder. With 15% of the world's cattle, 46% of its buffaloes and 17% of its goats, (15) but only 2% of the world's land area, India's forest is heavily overgrazed.

What is worsening the situation is the repeated lopping of trees for additional fodder supply by the herdsman, without leaving sufficient time to allow for regeneration. This practice seems to be especially common in Nepal where about 40 per cent of the buffalo feed and some 25 per cent of the cattle feed is made up of leaves and twigs.

In Continental South-East Asia, forest grazing is also common in some relatively dry areas like central Burma and north-east Thailand. In the humid tropics, i.e. the major parts of Insular South-East Asia, it is, however, not very widespread.

Another agent of forest degradation is fire. Spontaneous fires are rare, the vast majority being caused by man. (16) In South Asia, most forest fires are started by herdsman in order to burn the tough old grass and induce the growth of fresh shoots at the beginning of the rainy season. (17)

Fire is also used by shifting cultivators to clear land. In drier areas, this can cause considerable damage to the surrounding forests beyond the target plot. In addition, repeated burning promotes the growth of grass vegetation and is responsible for the spread of "alang-alang" savannas in large parts of Insular South-East Asia.

D. Agricultural expansion

There seems to be no doubt that deforestation in its strict sense (which excludes all forms of degradation) takes place, above all, in order to clear land for agricultural purposes.

There is general agreement that, in view of the rapid population growth in the developing countries, enlargement of the arable land area (apart from intensification on the existing farmland) is inevitable and is even necessary. But it makes an enormous difference in many aspects, as to where this expansion occurs (e.g. mountain ridges or plains), in what way the land is used after deforestation (i.e. which farming system is applied), for what purposes it takes place (e.g. subsistence or agrobusiness), and, perhaps most important of all, who (i.e. which persons or groups) the initiators are.

Forest-clearing for agricultural purposes is usually taking place in one of the following forms:

- (1) Traditional shifting cultivation;
- (2) Spontaneous pioneer settlement;
- (3) State-directed land settlement.

1. Traditional shifting cultivation

Shifting (or "swidden" or "slash-and-burn") cultivation is probably the oldest and at the same time the most controversially disputed type of agricultural production in the tropics. In its traditional form, it includes the following features:

- (a) Clearing and burning of a forest plot: Burning is necessary to kill weeds and insects and to provide ash-fertilizer.
- (b) The cultivation period which is limited owing to rapid soil exhaustion and, often more important, rapid invasion of weeds. This forces the farmer to abandon the plot and clear a new one. The length of the cultivation period tends to increase from only 1-2 years in the humid tropics of Insular South-East Asia to about 3-4 years in the semi-humid and semi-arid tropics of Continental South-East Asia and South Asia.

- (c) A fallow period which should be long enough to allow recovery of the soil and re-growth of sufficient secondary vegetation as potential ash-fertilizer for the following cultivation. Usually it exceeds the cultivation period by several times.

An important feature of traditional shifting cultivation is the use of a dibble (and not hoe or plough) for planting which leaves the fragile top soil rather untouched. Thus it does not necessarily disrupt the balance of the forest ecosystem. In fact, even environment specialists admit that under the given ecological and demographic conditions in large parts of the tropics shifting cultivation is the most rational type of land use, provided sufficient land reserves still exist. (18)

The problem starts with population growth. Decreasing forest reserves may force the shifting cultivators to extend the cultivation period and to shorten the fallow one beyond tolerable levels, usually accompanied by repeated burning. The result is a gradual "savannization" of tropical forest areas. The extended "alang-alang" grasslands (*imperata cylindrica*) in Indonesia and in other countries of South-East Asia, are indeed a result of too intensive shifting cultivation practices.

Shifting cultivation, in its traditional form, is nowadays mostly practised by scattered tribal groups, often ethnic minorities in the peripheral mountainous parts or hill tracts.

The socio-cultural and economic life-style of these tribes usually differs markedly from that of the lowland settlers, mostly sedentary wet rice farmers in the densely populated central parts. The remote and rather inaccessible location of the shifting cultivators makes the task of estimating their number and the area they occupy extremely difficult, and there is indeed a general dearth of any precise data. Nevertheless, it is generally stated that shifting cultivation is considered the main factor in tropical deforestation. According to FAO/UNEP, (19) it is responsible for almost 50% of the total deforestation in tropical Asia. The estimated number of people dependent on shifting cultivation is, however, relatively small: about 28 million, i.e. only 2.3% of the total population.

In South Asia, there is comparatively little shifting cultivation left: In Bangladesh, it is practised by some 13 hill-tribes living in the Chittagong Hill Tracts. Together, they constitute only about 0.3% of the total population.

Similarly, in India, shifting cultivation ("jum") is more or less restricted to the north-eastern states and to parts of Orissa. In all other parts of the country, acute population pressure forced the people to adopt more intensive farming systems long ago.

Also in Nepal, shifting cultivation in its original form seems to have been nearly abandoned.

Comparatively considerable shifting cultivation ("chena") has been practised in Sri Lanka until recently, particularly in the central and northern parts. Since the implementation of a chena-stabilization programme, it is anticipated that shifting cultivation has been decreasing in recent years.

In Continental South-East Asia, traditional shifting cultivation is still widespread. The vast terrain of hill tracts which encompasses the eastern half of Burma, northern Thailand, the western section of tropical China (Xishuangbanna), almost the whole of Laos and large parts of Vietnam is inhabited by various different hill tribes whose common feature is shifting cultivation. The total number may amount to only 11-12 million people, i.e. 8% of the total population, but the area they occupy is about as large as that inhabited by the rest of the population.

In Insular South-East Asia, the absolute number of people dependent on shifting cultivation (some 16 to 17 million persons) is even larger than in Continental South-East Asia. Nevertheless, shifting cultivation seemingly does not yet show such grave political, social and environmental problems as it does in Continental South-East Asia (with the possible exception of the Philippines). A major reason is probably the fact that relatively large forest reserves still do exist and these have, up to now, ensured the sustentation of traditional shifting cultivation. This is apparently true for the islands of Borneo (including Sabah, Sarawak, Brunei and Kalimantan) and New Guinea (including Irian Jaya and Papua New Guinea), where shifting cultivation is still the major enterprise for a great part of the population. On the island of Sumatra, often quoted as a major place for shifting cultivation, traditional swiddening ("ladang") has largely been replaced by the cultivation of perennial crops, mainly rubber and coffee. (20)

2. Spontaneous pioneer settlement

Large parts of tropical Asia are presently confronted with a rather new and rapidly accelerating dimension of forest encroachment and deforestation: a massive movement of people from overpopulated central regions towards the scattered settled peripheral "outer" areas. The movement is often directed from lowland areas to the surrounding mountain zones; but movements from densely populated highlands to sparsely populated lowlands also occur. Some of them are planned and state-directed, but most of the present land reclamation results from

spontaneous activities of various types of people with widely different motives and changing interests.

Despite the apparent magnitude of this problem, our knowledge about it is, up to now, more than limited. A possible explanation is the adverse conditions for empirical research, as the areas affected are usually difficult to access, and the people involved are, for various reasons, not very interested in being interviewed. Thus, the process of spontaneous land clearance is poorly documented. A positive exception is a recent study on land settlement in South-East Asia edited by Uhlig. (21)

While much more research and study are needed in this particular field, preliminary findings indicate that in India, the most serious encroachments of pioneer settlers on the forests took place under the "Grow More Food" programme during the late 1950s and early 1960s. Today, the process continues, albeit on a reduced scale. Altogether, some 2 to 6 million ha of forests (mostly open forests) were diverted to agricultural activities between 1951 and 1980, as opposed to some 5.2 million ha of closed forest still in existence.

Nepal seems to be the most critical case. Vast numbers of spontaneous settlers are reported to have moved from the crowded hills into the Terai lowlands, where the present annual rate of deforestation is estimated to be around 5%. Between 1964 and 1972, the area lost some 340,000 ha of forests, of which it is presumed that more than 75% was attributable to encroachment of squatters. (22)

Among the countries in Continental South-East Asia, Thailand offers certainly the most impressive example of spontaneous settlements. A great deal of the movements are directed into the highland-lowland-transition zone between the crowded plains and the hill areas inhabited by tribal shifting cultivators. The country's forest (including open forests) dwindled from 53% of the total land area in 1961 to an estimated 29% in 1985. At the same time, the area under agriculture tripled from 7.8 million to 23.5 million ha, whereas the population did not even double (from some 58 persons/sqkm to about 100 persons/sqkm). Most of the newly cleared areas are now cultivated with dryland crops like cassava, maize, sugar-cane and rubber.

The most serious case in Insular South-East Asia (and perhaps of tropical Asia altogether) seems to be the Philippines where, according to Cadelina, (23) "frontier swiddening" by lowland peasants resulted in an even more dramatic loss of forest lands than in Thailand: from 60% of the total land area in 1960 down to 27% in 1985. The disorganized spontaneous encroachment of these "modern kaingineros" (shifting cultiva-

tors) included tenants, farm labourers, and other land speculators from the lowlands, but hardly ever real kaingineros from the hill tracts. Usually, these lowland people occupy areas just cleared by logging, thus circumventing the law against illegal cutting of trees.

In Indonesia, the southern sections of Sumatra are now facing heavy immigration of rural poor from the neighbouring crowded island of Java. Apart from the remarkable state-directed "transmigrasi" programme, a growing number of spontaneous migrants are participating in the process, especially since the traffic linkages between Java and Sumatra have been greatly improved in recent years. It is estimated that the number of spontaneous migrants exceeds the number of those officially resettled by about four times. Many of them start as seasonal wage labourers for the local farmers before they decide to settle and carve their own piece of land out of the mountain forests, particularly for coffee cultivation.

In the central sections of Sumatra, a great number of the local farmers have been expanding their agricultural activities into the forests in order to grow rubber. Most of them had formerly been shifting cultivators and have now been turning to settled farming.

The eastern swamps of Sumatra offer another, quite interesting example of spontaneous land settlement: Buginese migrants from the island of Sulawesi have been settling in the lowland forests along both sides of the rivers in order to log and sell the timber to Java as a first step, then to open the cleared land for wet rice cultivation by applying the unique form of tidal irrigation ("pasang surut"), and to end up with the cultivation of coconut trees. (24)

Another target region for the inter-island movements of spontaneous settlers within Indonesia is the oil-rich province of East Kalimantan, where heavy logging spurs the way for immediate encroachment of squatters. (25)

From the cases of spontaneous pioneer settlement cited above some general conclusions can be drawn: Virtually all countries of tropical Asia are involved in this process, but Nepal, the Philippines, Thailand, and Sumatra seem to be the most affected at present.

Population growth which is inevitably responsible for the encroachment of the forests is, indeed, one important factor. But the example of Thailand (where the size of farmland tripled while the population only doubled) indicates that there must be other factors behind the scenes which exercise the same or an even greater influence on deforestation and agricultural colonization. Most of the crops cultivated in the newly cleared areas are apparently cash crops, often for export, rather than

food crops for the rural poor. Even so-called "food crops" are primarily grown for marketing. Thailand is a classical example. Within the last two decades, the country has emerged as the world's leading exporter of tapioca (dried and processed cassava tubers), and an important maize, sugar-cane and rubber producer. Admittedly, this did not happen at the cost of the traditional subsistence crop, rice (which is grown on flat alluvial plains, whereas cash crops are grown on uplands), but it accounted for the depletion of a large share of Thailand's forest reserves. (26)

The case of Thailand also casts some light on the important role of market prices. As soon as the price of a certain commodity reaches promising levels, its production is vigorously promoted, no matter how significant the environmental threats are.

The people involved in the spontaneous settlement process are by no means only landless and/or unemployed rural poor, as is frequently stated. The landless rural poor can hardly afford the means to participate in this process, but are generally welcome as wage labourers, contract farmers, tenants or sharecroppers. It frequently happens that traders provide the newcomers at the start with credits for food, seeds, fertilizer and other production means which the newcomers have to pay back in terms of their crop yield. In the hinterland of Chon Buri (south-east Thailand), local sugar-cane landlords hire landless squatters to open the forests along the pioneer front and encourage them to grow subsistence crops. Thus, the landlords avoid the risk of being blamed for forest clearing. After a fixed period, mostly 3 to 5 years of cultivation, when the tree-stumps and roots are rotten and tractors can move in, the squatter is bound to leave the spot and move on further into the forest where the procedure then starts all over again. Thus, the landlord is able to expand his sugar-cane holding without any risk, and if the squatter is convicted of illegal timber felling, the landlord can easily bail him out. (27)

In some countries of tropical Asia, the rapid increase in mechanization has undoubtedly been a major component in the process of deforestation and agricultural colonization. One example is the chainsaw which is spreading everywhere, putting one man in the position to clear within a day, a plot of forest which would have taken the traditional shifting cultivator several weeks. Another example is the tractor, which also plays an active role in the land-clearing operation. Again, Thailand provides an impressive illustration: between 1963 and 1982 the number of tractors in the country increased from some 2,500 to 107,528 units, (28) most of them employed for the work on newly cleared lands. In general, the tractors are

owned by entrepreneurs who rent them to the farmers. Many wet rice farmers in the central parts of Thailand, stimulated by the bright prospects for maize cultivation, have been expanding their farmland into the forests of the adjoining highland-lowland-transition zone, thus enlarging their traditional 2 to 4 ha wet rice holdings by another 5 to 10 ha under maize. Such large holdings can no longer be managed with family labour alone but require soil preparation by a tractor, as well as hired seasonal wage labourers for harvesting.

A further important role is played by all kinds of communication facilities, especially roads. As most of the crops grown are cash crops which need to be marketed, transportation gains importance. It has repeatedly been observed that, if there is a new road under construction, the forests along both sides of the road are cleared within a few years and turned into farmland by spontaneous pioneer settlers.

Probably one of the most crucial issues in the process of uncontrolled deforestation and land settlement is the institutional and legislative framework. In most countries this activity is illegal and many of the squatters involved are not registered. The governments are now faced with the delicate question of whether to sanction such action and to deliver title-deeds, or to prosecute the squatters. If they start to deliver title-deeds, the process of land reclamation would almost automatically escalate to uncontrollable levels, as evidently happened in the case of the "Land for the Landless" campaign in the 1950s in the Philippines, or the "Grow More Food" programme during the late 1950s and early 1960s in India. If no title-deeds are delivered the squatters will constantly remain a factor of potential social unrest and conflict. Besides, it has been observed that the uncertain legal status of squatters has very adverse effects on their methods of land cultivation. As long as the land does not belong to them, so that they have the inherent fear that one day they can be driven away, the squatters will exploit their plots as rigorously as they can. Only if they had a title-deed might they be willing to turn from soil-mining to soil-conserving measures.

3. State-directed land settlement

Since the beginning of the twentieth century, governments of many countries in tropical Asia have been clearing forest areas for new settlement projects. The motives of the government differ from country to country and have been changing over time. Official statements usually mention (a) balancing of regional and demographic disparities between densely populated cen-

tral areas and thinly populated "outer" areas, and (b) economic development and exploitation of uninhabited areas. More unofficial explanations include strategic and security reasons.

The most ambitious land settlement project is being implemented in Indonesia. Under the national "transmigrasi" programme, about 750,000 families from the overpopulated island of Java (including Madura and Bali) had been resettled to the country's "outer" islands up to 1984.

Yet, in all countries involved the area occupied by these resettlement projects does hardly exceed 1% of the respective total land area. Their contribution to deforestation is generally less than 10% and, as such, much less significant than that of spontaneous pioneer settlement.

E. Other causes

Other causes of forest degradation and deforestation include construction of roads, dams, factories, mining activities or war damage, as well as natural disasters like heavy storms, floods, earthquakes or insect pests.

Road construction deserves special attention. The amount of forest destroyed by the construction itself can be considered quite negligible compared with the massive indirect impacts caused by roads. As already mentioned, new roads generally serve as a guiding line for spontaneous pioneer settlers. Interestingly enough, the reverse effect might also occur. In Sumatra, it was observed that former shifting cultivators scattered over vast parts of the island found it more attractive to leave their isolated places and to settle along roads in order to become settled rubber farmers (often associated with intensive wet rice cropping). In this way, much former swidden land has been turned into forest land again. (29) However, such positive side-effects of road construction are certainly exceptional.

Similarly, vast tracts of forests are depleted by dam construction. The problem of resettling thousands of people from dam sites to new, mostly forested areas has been causing considerable concern, particularly in India and Thailand. In India, some 401,000 ha of forest land were lost to dam projects between 1951 and 1972. (30)

Forest destruction through mining has been reported from many parts of the region. Some tracts are destroyed by opencast working tin mines in Malaysia, Thailand and on Bangka Island (Indonesia), bauxite mining (Bintan/Indonesia), two giant copper mines on Bougainville Island (Papua New Guinea) etc.

Indian paper factories have been responsible for the destruction of considerable amounts of the country's extremely stressed forest reserves. Paper companies in Karnataka, after having destroyed all the bamboo forests in the area, are now encroaching upon the north-eastern states which constitute India's largest remaining forest area. (31)

The same complaint applies to Indian manufacturers of wooden packing boxes. These are needed in huge numbers to pack fruit (particularly apples in the western Himalayas) and tea in the eastern Himalayas. At present, about 10 million plywood chests are needed per year to pack the country's tea production.

Governments occasionally invoke security reasons for deforestation of so-called "sensitive" areas often in connection with the construction of strategic roads along the borders to neighbouring countries.

Damage caused by defoliants, tanks and bombs were a peculiar feature in Vietnam. According to FAO/UNEP (32) the country suffered the following losses of forests in the period between 1961 and 1974:

- (a) 1.47 million ha were degraded or destroyed by spraying of defoliants ("agent orange", etc.), including some 0.5 million ha of mangrove forests in the Mekong delta.
- (b) 0.30 million ha were seriously damaged by tanks and other heavy machinery used on the battle fields.
- (c) 0.12 million ha were completely destroyed by bomb explosions.

Taking these figures together, it turned out that about 22% of the country's forests (put in relation to the present area of closed forests) were destroyed during that period.

Impact of forest degradation and deforestation

A. The environmental impact

The natural tropical forests are highly complicated ecosystems the total functions of which even up to now are not fully understood by the scientific community.

Destruction of the forest cover, even if only temporarily (as in the case of shifting cultivation, or logging), results inevitably in the disappearance of many plant and animal species, but in an increase of other, often undesired species, like weeds, insects, rats, certain birds, etc. It further results in a loss of valuable genetic resources for many important agricultural crops and medical plants.

Deforestation decreases the water-holding capacity of the soil, reduces the water infiltration, and speeds up the surface run-off, which, combined with erosion, results in an increase of siltation, frequency of floods, and deterioration of the water quality.

Perhaps even more alarming is the adverse impact on the soils. Tropical forests, especially those in the humid tropics, often grow on rather nutrient-poor soils (e.g. oxisoils). Through their long evolutionary process, these forests have become adapted to the poor soil conditions by developing complex nutrient-conserving mechanisms. As a result, the majority of the nutrients are usually not in the soil but rather held in the bio-mass. Once this very close nutrient cycle is broken by removing the bio-mass through deforestation, the bulk of the nutrients are lost as well. (33) The exposure of the bare soil to sunlight, heat, and rain showers accelerates leaching and decomposition of the organic matter, and erosion of the valuable topsoil layer. Altogether, tropical soils tend to impoverish very quickly if the forest cover is removed.

The possible linkages between tropical forests and climate, especially global climate, are very much disputed. What has been proved is the addition to the atmospheric carbon dioxide (CO₂) budget through deforestation, which, according to the Global 2000 Report (34) might increase by some 25% up by the year 2000. This again may cause a rise in the earth's surface temperature ("greenhouse effect") and could, perhaps, have a far-reaching impact on the global weather. Another possible effect of tropical forests on global climate might be through evapotranspiration. (35) Besides, deforestation can lead to atmospheric pollution by dust, and some meteorologists believe that this may prohibit the ascent of moist air and reduce precipitation. (36)

If one discusses the ecological consequences of deforestation, the environmental impacts of the different kinds of land-use being applied on the deforested areas have also to be taken into consideration and to be weighed against the ecological values of the original forest.

From an ecological view-point the safest and most stable form of land-use is undoubtedly irrigated wet land cultivation which, in tropical Asia, is more or less identical to wet rice cropping. In some parts of the area it has been practised for more than 2000 years without any visible damage to the environment. The construction of terraces impedes erosion, and the steady depositing of silts by the irrigation water stabilizes and even improves the quality of the soils. Thus, generally no negative ecological consequences do occur if forest areas are replaced by wet land cultivation.

Similarly, the cultivation of perennial crops, like rubber, coffee, etc., can be judged as a sustainable kind of land-use with little adverse impacts on the environment. This is especially true for the plantations of smallholders who usually take little care with weeding and cleaning. Large mono-plantations, like the big rubber and oil-palm estates in Malaysia, may be less favourable, but up to now no substantial ecological damage has been reported. The same holds true for all kinds of plantations, reforestation, and agro-forestry.

The ecological effects of shifting cultivations have already been discussed. Immediate impacts on the environment include a considerable loss of bio-mass and genetic resources, an increase of atmospheric CO₂-concentration, and air pollution by slash-and-burn practices. Other adverse consequences like soil impoverishment and land erosion can be kept to a minimum provided the fallow period is sufficiently long, and as long as only the dibble (and not hoe or plough) is used. Thus, shifting cultivation can generally be regarded as ecologically serious, but not disastrous.

This seemingly tolerable situation changes dramatically with the application of permanent cultivation of annual crops on dryland (or "upland"). Probably the worst environmental impact of this farming system results from the methods of soil preparation. In order to suppress weeds, the soil has to be tilled by either hoe or plough (today increasingly with the help of tractors) and is fully exposed to sun and rain and subjected to heavy leaching, impoverishment, and erosion. What is worsening the situation still further is the fact that this farming system is usually practised in hilly or mountainous terrain. Thus the whole process will eventually result in a significant increase of barren wastelands, as is already apparent in great parts of India (in combination with overgrazing) and in the Philippines. Thailand will probably face similar consequences in the near future. Altogether, the permanent cultivation of annual dryland crops is, from an environmental view-point, certainly the most negative but at present the most rapidly expanding agricultural production system in the tropical areas of Asia. However, as it is a relatively new problem, only very limited research work has so far been conducted in this field.

A well known ecological problem is almost all kinds of livestock husbandry. The disastrous effects of overgrazing, especially in the drier parts of South Asia, have already been mentioned.

The examples show that different types of land-use may exercise rather different impacts on the environment. Therefore, deforestation does not necessarily lead to ecological disa-

sters, provided an appropriate follow-up land-use system is applied.

B. The economic impact

The economic impacts of forest degradation and deforestation cannot only be seen in the light of short-term costs and benefits but also the long-term implications of these processes have to be taken into account.

Under the aspect of short-term direct benefits, the logging business is usually considered first. Particularly, for the countries in Insular South-East Asia, the sale of logs and log products indeed constitutes an important component of their national income and a most welcome source of foreign exchange. Indonesia, Malaysia and the Philippines have earned about US \$2,300 million through export of logs in 1979 only.

However, such earnings are easily overestimated. In fact, the real benefit to the producer is substantially less. As most logging companies belong to foreign-based corporations using modern machinery, such items as expenses for equipment, high salaries for employed expatriates, and profit repatriation have to be deducted from the gross revenues. According to an estimate of Gillis, (37) the final net foreign exchange earnings in the logging business may hardly be more than 30% of the gross returns. Supporters of the timber business often stress the beneficial effects on the employment situation. This may be valid in the cases of South Asia and Continental South-East Asia, where logging operations are still quite labour-intensive. The use of axes and saws for felling, as well as bullock-carts and elephants for hauling and transportation, has been common practice in these areas up to now. In Insular South-East Asia, however, where the great bulk of logs are produced, the argument of employment is losing weight. Here, most of the logging operations are performed by modern, labour-saving machinery, although the countries suffer from surplus of labour and underemployment. In the Philippines, for example, only 0.42% of the country's total workforce were employed in forestry and logging, and an additional 1.15% in the timber-processing industries in 1975. (38) It has to be admitted, however, that in recent years the countries of Insular South-East Asia have been quite successfully undertaking measures to reduce or even stop log exports, in order to promote processing of timber, and thus creating job opportunities within the countries.

Another argument often put forward in favour of logging is

the improvement of infrastructure in terms of new roads, air strips, new townships, health centres, etc., which helps to develop the peripheral regions of the log-producing countries. However, in view of the fact that this infrastructure, particularly the roads, has generally served as a means of facilitating the recent massive forest encroachment by spontaneous pioneer settlers, this argument has also to be regarded with some caution. Many critics argue that the logging business has so far helped only a little, or not at all, to improve the economic situation of the big masses of the rural poor, but has rather been transferring wealth from the rural areas to the national elite in the cities and to some people abroad. According to them, logging has exchanged the permanent and broadly distributed benefits provided by forests to temporary and highly concentrated benefits. (39)

Forests not only produce timber but also provide a great variety of additional valuable products which are needed first of all by those people who live within the forests. There still exist a number of tribal communities whose economy depends to a great extent on the forest and its products. The many Papuan tribes in Irian Jaya and Papua New Guinea are perhaps the most prominent example of people for whom forests provide most of the basic needs, including food, materials for housing, tools, weapons, medicinal herbs, etc., as well as gathered or hunted items for sale. Another example are the Mantawaian people living on the islands off the west coast of Sumatra. For such communities the loss of forests means the loss of their economic basis. This, of course, applies similarly to the traditional shifting cultivators.

But also large communities residing outside the forests are profiting considerably from such secondary forest products as rattan, bamboo, resins, gums, yang oil, camphor, honey, mushrooms, animal skins, etc. It is further estimated that millions of women in rural areas earn additional income by producing handicraft items based on materials from forests.

As with the ecological aspects, the economic returns of forests and deforestation must be weighed against the possible returns of agricultural activities performed on the deforested areas.

The economic dimension of transforming forests into farmland is particularly apparent in the deforestation by pioneer settlers in order to produce cash crops. The depressing results in the case of India have been described by Droga. (40) Also in the Philippines, the times of windfall profits have in the mean time been replaced by a deeprooted economic depression. Malaysia, on the other hand, seems to be a comparatively positive example. The country's impressive performance in transfer-

ring forest lands into oil palm and rubber plantations have apparently resulted in quite sustainable economic returns, not only for some urban elite and foreign contractors but also for a large number of the rural people.

Thailand, by clearing more than half of the country's forest reserves, achieved a fundamental conversion of its once rather one-sided rice-based subsistence economy into a highly diversified agricultural market economy during the last 25 years. The remarkable returns on the production of cassava, maize, sugar-cane, kenaf (a fibre plant), rubber, pineapple, etc., most planted on deforested areas have without doubt been contributing significantly to the rise in the national income. In addition, considerable seasonal job opportunities have been created. Each year, probably more than 100,000 people from the poverty-stricken north-eastern area of Thailand migrate to the sugar-cane and maize-growing areas of the country to work as harvest labourers. Unlike Malaysia, however, the Thai boom is largely based on an ecologically highly vulnerable farming system - the permanent cultivation of annual crops on dryland, with rubber being the only exception. It might, therefore, happen that the present benefits will gradually be outweighed by the steady increase in environmental costs, in terms of lost topsoil, increasing flood damage, silted reservoirs, rivers and irrigation canals, polluted water, etc. There is some concern that this point is going to be reached very soon.

C. The social impact

Within the process of forest degradation and deforestation, it seems almost unavoidable that differing interests may interfere with each other, giving rise to social conflicts. This hits most of all those minorities who live within and are dependent on the forests. There exist many reports of tribal people who had to give up their traditional life-style after their economic basis was destroyed through logging operations. The Dayak in Kalimantan, the Papuan tribes in New Guinea, and the Mentawai people west of Sumatra, are some examples. Many logging companies use expatriate and outside workers, which adds to the inherent conflict potential, as, for example, in Kalimantan, where the local Dayak tribes are confronted with logging labourers from Java, Malaysia, the Philippines and other places. (41)

Large-scale local changes are taking place where deforestation is connected with land colonization and thus migration of people. The various processes of spontaneous pioneer settlement, mentioned above, provide numerous examples. Not all are

necessarily conflict-ridden. Some show interesting symbioses between different ethnic groups, as, for example, in the newly opened swamp areas in eastern Sumatra, where Buginese pioneer settlers open the area for tidal rice cultivation to employ Javanese immigrants as share-croppers, and Minangkabau from West Sumatra establish the service sector. Other land reclamation processes, however, have not proceeded as peacefully.

Totally new communities developed in the newly colonized areas. In China, new towns were established during the rubber promotion in the tropical south of the country. The reaction of the local hill-tribes when the rubber boom swept over their areas has, however, not been documented.

Certain potential factors for social unrest seem to be notorious in most of the newly settled deforested areas. These include:

- (a) Conflicts between government officials and "illegal" squatters;
- (b) Indebtedness of squatters towards landowners, traders, land speculators, etc.;
- (c) Unsettled land tenure problems;
- (d) Wavering positions of the governments.

Conclusions

The forests in the tropical parts of Asia are presently declining at a rate of 0.6% each year, amounting to about 5,000 ha each day. It is estimated that the combined impacts of increasing population pressure, economic growth, and rising demands for new farmlands and forests products will result in a more or less steady and continued degradation and deforestation up to around the year 2000. This rate might, thereafter, come to a virtual halt by the year 2020, leaving only the geographically inaccessible and therefore economically "nonproductive" forests untouched. (42)

Although measures to combat deforestation, e.g. improved forest management, sustainable land-use systems, etc., are well known, little has been achieved to reduce or even stop the rate of deforestation up to now. A major reason for this fact is certainly rooted in simple short-term economic considerations of the people involved. One has apparently to accept the fact that, based on the principle of comparative advantage, deforestation is not going to be reduced or stopped as long as alternative measures will not offer more profitable prospects immediately.

At the same time, there remains some hope for increased ef-

forts in the field of wood plantations. At present, the world-wide ratio between area planted and area cleared in the developing countries is still at a disappointing 1:10 level, but the respective figure for tropical Asia, where the population pressure is worse than in the other tropical countries, shows that the situation is not as bad and the ratio already stands at 1:4.5. (43) But this figure is still far from satisfactory.

The study attempted to identify and compare the various causes of forest degradation and deforestation. The following are its conclusions:

- (a) Logging is certainly an important cause of degradation, and often the first step to deforestation, even if selective logging is practised. In addition, it causes social and economic distress to the tribal communities who are dependent on the forest. However, the countries particularly involved in logging, i.e. the countries of Insular South-East Asia, have been quite successful in undertaking measures to reduce or even stop log exports and to increase timber processing within the countries, and this may result in a (at least temporary) decrease in logging operations and an increase in employment in the forestry sector.
- (b) Fuelwood-gathering and overgrazing is generally regarded as the most important cause of forest degradation. The problem is especially acute in the drier parts of tropical Asia, i.e. first of all in South Asia, where it has already turned vast tracts into barren wasteland and is accelerating the process of desertification. There is, however, some possibility of decreasing fuelwood-gathering through fuelwood plantations and the development of alternative energy resources, but there seems to be little hope of being able to reduce overgrazing.
- (c) Shifting cultivation is considered by many to be the main cause of deforestation. The present study indicates that this may be valid in quantitative terms (i.e. the size of area), but certainly not in qualitative terms (i.e. with regard to environmental and socio-economic impacts), and also not in terms of the number of people involved (only 2.3% of the total population). The areas most affected by shifting cultivation are the hill-tracts of Continental South-East Asia.
- (d) Agricultural expansion practised by pioneer settlers from densely populated areas has been emerging as most important cause of deforestation in many countries of tropical Asia. Largely based on environmental unsound farming methods, it threatens to cause serious environmental damage in the near future. Increasing need of food

crops for a growing population seems to be only a secondary motive: more emphasis is apparently put on cash crop production and land speculation. To a small degree, the process is government-directed, but most is performed by spontaneous pioneer settlers, giving rise to considerable social and economic implications. Up to now, the process seems to be less accentuated in the centrally planned countries. Despite its increasing acuteness in all other countries comparatively little information is available, leaving many questions relating to this problem open.

- (e) Other factors, such as construction of roads, dams and factories, and mining activities, also cause considerable depletion of forests but are usually restricted to certain localities.

Although "globalization" is always risky, the different situation in the three subregions of tropical Asia can be summarized as follows:

- (1) In South Asia the framework conditions consist of a semi-arid climate, high population density and very few remaining forests. Under these conditions the primary problem is undoubtedly the combination of fuelwood gathering and overgrazing, followed by the expansion of farmland by pioneer settlers. Owing to the heavy population pressure, shifting cultivation is restricted to a few isolated areas, and logging does no longer play an important role.
- (2) Continental Southeast Asia is characterized by a semi-humid climate, moderate population density and medium scale forest reserves. Here, the expansion of agricultural activities from the densely populated rice-growing areas in the alluvial lowlands towards the surrounding highland-lowland transition zone has been emerging as the primary cause of deforestation during the last 20 to 30 years. This is especially true for Thailand. In Laos, and probably also in Vietnam, traditional shifting cultivation by hill-tribes is still playing a crucial role in this process. Logging is no longer, and fuelwood-gathering is not yet, a major problem. In Thailand, grazing of cattle in the forests has been decreasing owing to the replacement of draught animals by tractors.
- (3) Insular Southeast Asia provides a humid climate, by and large little population pressure and still vast areas of valuable dipterocarp forests. Within this given framework logging is undoubtedly the primary cause of degradation and, indirectly, of deforestation too. Part of the region, particularly the Philippines, parts of Malaysia and the southern sections of Sumatra, are additionally

facing massive encroachment of pioneer settlers from overpopulated areas in the neighbourhood, both state-directed and spontaneous. Traditional shifting cultivation is still common in some parts, but is not felt as a major problem; in other areas, like Sumatra, it has largely been replaced by the cultivation of perennial crops. Fuel-wood-gathering and overgrazing are considered minor problems in most parts of the subregion.

Especially critical cases, so it seems to turn out, are large areas of the Philippines, parts of Nepal (particularly the Terai-lowlands), and the highland-lowland transition zones in Thailand. Various sections of India, especially the drier ones, are equally affected. Further, a problem of particular concern is the degradation and depletion of mangrove forests in several countries, especially in Bangladesh.

In view of all these seemingly disparate cases, the example of China deserves attention. The country undoubtedly belonged to those areas in the world which had been most severely affected by deforestation in the past. However, China has been making remarkable efforts in turning the wheel around from deforestation to reforestation, (44) some of which might well serve as a guide for other countries.

Country	Area (1000 ha)	Population (1000)	Deforestation (%)
Brunei	523	0.30	0.75
Indonesia	173 000	1 000	0.75
Malaysia	23 000	1 000	0.75
Philippines	2 810	0.30	0.30
Taiwan	34 500	17.91	0.98
Thailand	518 000	0.60	0.60
Tropical Asia	308 810	0.30	0.30

a) FAO/UNEP, Forest Resources of Tropical Asia (Rome 1981).
 of including broadleaved, coniferous and bamboo forests.
 n.a. indicates not available.

Table 1: Status of tropical forest in selected countries in tropical Asia.
Areas of natural woody vegetation (at end 1980) (a)

	Primary closed forest (b)				Secondary forest (1,000 ha)		
	Area 1,000 hectare	Share of total land area (%)	Area/ person ha	Open forests (1,000ha)	fallow forests (1,000ha)	shrubs (1,000) hectare)	total (1,000 hectare)
Bangladesh	927	7	0.01	n.a.	315	n.a.	315
Bhutan	2 100	45	1.64	40	205	25	270
India	51 841	17	0.08	5 393	9 407	5 378	20 241
Nepal	1 941	14	0.14	180	110	230	520
Pakistan	2 185	3	0.03	295	n.a.	1 105	1 400
Sri Lanka	1 659	26	0.11	n.a.	853	215	1 068
South Asia	60 653	15	0.07	5 908	10 953	6 953	23 814
Burma	31 941	49	0.95	n.a.	18 100	2 600	20 700
Thailand	9 235	18	0.20	6 440	800	500	7 740
Dem. Kampuchea	7 548	43	1.34	5 100	225	400	5 725
Laos	8 410	36	2.16	5 215	5 000	735	10 950
Vietnam	8 770	27	0.16	1 340	10 750	330	12 420
Continental SE-Asia	65 904	35	0.46	18 095	34 875	4 565	57 535
Brunei	323	55	1.75	n.a.	237	n.a.	237
Indonesia	113 895	63	0.78	3 000	17 360	23 900	44 260
Malaysia	20 995	64	1.52	n.a.	4 825	n.a.	4 825
Philippines	9 510	32	0.20	n.a.	3 520	n.a.	3 520
Papua New Guinea	34 230	76	11.41	3 945	1 445	85	5 475
Insular E-Asia	178 953	62	0.85	6 945	27 387	23 985	58 317
Tropical Asia	305 510	34	0.25	30 948	73 215	35 503	139 666

a) FAO/UNEP, Forest Resources of Tropical Asia (Rome 1981).

b) Including broadleaved, coniferous and bamboo forests.

n.a. indicates not available.

Table 2: Average deforestation in selected countries in tropical Asia (a)

	Primary closed forests (b)			Secondary open forests	
	Area (1,000 ha)	Average annual area deforested (1976-1985) (1,000 ha)	Share of total closed forest area (percentage)	Average annual area deforested per person (sqm)	Estimates average annual area deforested (1981-1985) (1,000 ha)
Bangladesh	927	8	0.9	1	n.a.
Bhutan	2 100	2	0.1	13	-
India	51 841	147	0.3	2	-
Nepal	1 941	84	4.3	60	-
Pakistan	2 185	7	0.3	1	2
Sri Lanka	1 659	41	2.5	28	n.a.
South Asia	60 653	289	0.5	3	2
Burma	31 941	100	0.3	30	n.a.
Thailand	9 235	292	3.2	63	127
Dem. Kampuchea	7 548	20	0.3	36	5
Lao People's Dem. Rep.	8 410	113	1.3	288	35
Vietnam	8 770	65	0.7	12	-
Continental SE-Asia	65 904	590	0.9	41	167
Brunei	323	6	1.9	324	n.a.
Indonesia	113 895	575	0.5	39	20
Malaysia	20 995	243	1.2	176	n.a.
Philippines	9 510	96	1.0	20	n.a.
Papua New Guinea	34 230	21	0.1	72	1
Insular SE-Asia	178 953	941	0.5	45	21
Tropical Asia	305 510	1 820	0.6	15	190

(a) FAO/UNEP, Forest Resources of Tropical Asia (FAO, Rome 1981).

(b) Including broadleaved, coniferous and bamboo forests.

n.a. indicates not available.

- indicates nil or negligible.

Notes

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