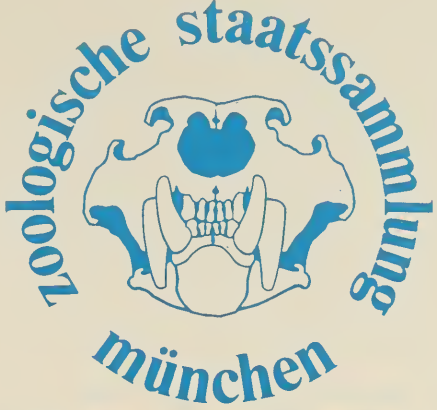

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Tropische Regenwälder
– eine globale Herausforderung –

Herausgegeben von
W. Engelhardt und E. J. Fittkau
Schriftleitung: L. Tiefenbacher

Generaldirektion der Naturwissenschaftlichen Sammlungen Bayerns
und
Zoologische Staatssammlung München, 1984

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The status of tropical forests in South East Asia

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Abstract

South East Asia is endowed with an environment rich in natural biological resources dominated by tropical forests. This biotic luxuriance is due to a stable tropical climate, to the centre of origin of several animal and plant groups in this region, and to a long historical period for evolution. The biotic richness has co-evolved with the environment. Very little of this biological resource is understood, and only a very small fraction of it is commercially utilised. In the wake of increasing pressures for land development, adequate samples of the natural environment (and its resource potential) has to be conserved, if only to afford posterity a resource potential for its own livelihood, recreation and development. There is a need for new approaches to development planning incorporating the interests of tropical forest conservation.

Introduction

South East Asia with an area of 4.5×10^6 km^2 is characterised by an environment rich in natural biological resources and dominated by tropical forests. These forests are among the oldest known to man, being more than 30×10^6 years old, due to their evolution in luxuriant and non-periodic environmental conditions. They are dominated by trees of the family Dipterocarpaceae.

The population of this region is about 250×10^6 with an annual growth rate of about 2.5%. This rapid population growth imposes socio-economic and developmental stresses on the natural environment and its rich biological resource base. These stresses are additional to the harsh socio-biological conditions for development, due to colonial history, namely JANZEN 1973):

(1) Already lower levels of potential and realised resources per capitum;
(2) Purchase of resource harvests at low prices unrelated to their worth;
(3) National borders based on resource partitioning for the more advanced nations;
(4) Interaction of opposing pressures on social structures, with radically differing goals in resource use;
(5) Social aspirations modelled on exploitative social systems of the more advanced nations; and
(6) Low levels of expenditure of usable productivity per unit of human effort.

Environment and resource base.

The tropical forest environment and its resource base may be examined from several dimensions:

(1) Climate and soil
(2) Vegetation types
(3) Ecosystem structure and function
(4) Material cycles
(5) Flora
(6) Fauna and
(7) Drainage system

1. Climate and soil

South East Asia enjoys a tropical equatorial climate characterised by a high rainfall (exceeding 2 000 mm per year) dominated by monsoons and thunderstorms, a high relative humidity (about 80–90%), a high average temperature (26° C) and a high solar radiation (500 cals/cm^2/day). The high insolation and rainfall over historical time in this region has accelerated weathering and senility resulting in oxisol and ultisol soil types with impoverished nutrients. Furthermore, the litter layer on the soil is thin due to rapid nutrient cycling caused by high rainfall and insolation. Rapid nutrient cycling is enhanced by mycorrhizal associations. The soils in the region are thus nutrient deficient especially in calcium and phosphorus; and nitrogen fixation by algae and legumes is important.

The soils are highly susceptible to erosion depending on the slope of the land, length of flood path, soil type, soil cover, and the nature and intensity of rainfall and insolation. Soil erosion increases by one to two orders of magnitude at steep slopes, under open canopy or during short fallow periods in shifting cultivation.

2. Vegetation types

Table 1: Tropical Moist Forest Climax Area of the World (SOMMER 1976) (millions of hectares)

Subcontinent	Total land area	Evergreen rain forest	Semi deciduous forest	Moist deciduous forest or forest Savanna mossic[+]	Total moist forest area	Percent of total land area	Percent of world total moist forest area
East Africa	236	13		12	25	10.6	1.6
Central Africa	408	197		72	269	65.9	16.8
West Africa	356	50		18	68	19.1	4.2
Total Africa	1000	260[++]		102	362	36.2	22.2
Latin America	1401	600		150	750	53.5	46.9
Central American/ Caribbean Region	166	27	26		53	31.9	3.3
Total Latin America	1567	627	26	150	803	51.2	50.2
Pacific Region	374	48			48	12.8	3.0
Southeast Asia	448	237	15	50	302	67.4	18.9
South Asia	348	12	15	58	85	24.4	5.3
Total Asia	1170	297	30	108	435	37.2	27.2
Total Humid Tropics	3737	1184	56	360	1600	42.8	100.0

[+]Refers only to Africa

[++]Evergreen and semi-deciduous types.

The vegetation in South East Asia is dominated by the tropical moist forests. Although this region has the next most extensive area of climax tropical moist forest after Central and South America (302×10^6 ha) (Table 1), it is only 18.9% of the climax tropical moist forest. However, it covers the most extensive area of land (67%) in comparison to Central Africa or Central and South America, because of its longer evolutionary history in the tropics. Nevertheless, about 38.1% of this tropical moist forest has been lost through conversion for agriculture and other uses, so that only 187×10^6 ha of this vegetation type actually occurs in the region.

This vegetation type is extremely rich in biological diversity. Grossly, it consists of the evergreen rain forest which is dominant, semi-deciduous forest, moist deciduous forest and of forest savanna. Each of these forest types may be further classified according to dominant species composition. The immense variety of vegetation types is demonstrated by the fact that no two patches of forest one to two kilometres apart, are exactly identical. This variety is due to intense competition for nutrients on the ground and light at the canopy, under high and relatively stable insolation and precipitation, resulting in a narrow niche space or a high degree of specialisation for each species.

3. Ecosystem structure and function

The ecosystem structure and funtion of the tropical moist forest is determined by the vegetation type. The vegetation is vertically stratified comprising an emergent discontinuous layer and a continuous canopy layer 30–40 m above ground, both dominated by trees of the family Dipterocarpaceae, essentially timber trees; a discontinuous understorey layer dominated by fruit trees; epiphytes, climbers and boles that link the canopy to the ground; and a ground layer of herbs, seedlings and litter. There are also horizontal discontinuities due to abiotic factors such as drainage channels, and biotic factors such as rotting tree trunks. This complex structure is enhanced by intense competition at the canopy and ground layers, resulting in a high degree of symbiotic associations of various sorts.

The regeneration time for such an ecosystem is estimated to be about 600–800 years (Webb 1977), depending on the availability of parental stocks which are seriously threatened by large-scale land clearance. The regeneration process is complicated by various groups of succession species that have different light and shade requirements for seedling and adult growth, different capacities of seed production and viability and different mechanisms of pollination and seed dispersal.

The tropical moist forest ecosystem has a high biomass averaging 450 m tons/ha, of which 60–85% is in the stems, hence their timber value. These stems are thus nutrient reservoirs, and their felling for timber results in gross nutrient deficiency and hence longer periods for forest regeneration. With selective felling the moist forests may regenerate somewhat in as short a period as more than 50 years.

The rich diversity of the ecosystem is demonstrated by the occurrence of more than 100 tree species/ha at a density of 1–2 trees/species/ha, of more than 600 trees/ha and of more than 16,000 plants/ha. Maintenance of sustainable populations of parental stocks thus demands the conservation of large areas, 1000 ha or more. This rich diversity contributes to the high biomass and to a high leaf area index of 8 tons/ha.

As a consequence, primary production is high being of the order of 70–100 m tons/ha/year, and community respiration is also high. The resultant net primary production is of the order of 22 m tons/ha/year which lower than that of temperate forests, and tropical perennial plantation crops. About half of this net production is diverted to growth, 80% of it to the trunk wood; and the other half is diverted to grazing (about 10%) and litter production and decomposition (about 90%). Although at climax phase the detritivore food chain predominates over the herbivore food chain, any perturbation to the ecosystem increases the energy and material flow through the grazing pathway up to 50%. At climax phase leaf litter production is about 10 m tons/ha/year while accumulation 3–4 m tons/ha/year, and wood litter production is about 11 m tons/ha/year while accumulation is 53 m tons/ha/year. Leaf litter production and decomposition are thus important pathways for the rapid recycling of nutrients, while wood litter production and decomposition are slow recycling pathways beffering and complementary to the first. Litter decomposition is generally rapid because of high insolation and rainfall.

Leaf flush in the tropical moist forest ecosystem is a continuous process, occurring at a rate of 2–20% with high peaks during the rainy season. At any one time, 70–90% of trees and 64–86% of species may exhibit leaf flush. Flowering and fruiting are somewhat aseasonal and irregular.

4. Material cycles

Material cycles in the tropical moist forest environment are variable according to the material, but are generally rapid. In the hydrological cycle, a rainfall of 2,400 mm results in a runoff in the drainage system. Usually 80% of stream flow is derived from interflows; however, perturbations of the canopy and ecosystem structure reduce the interflow contribution to 10% and increase surface flows to 50%.

Carbon constitutes 50% of minerals in the litter, amounting to 25-27 m tons/ha. About 40% of this material is in the living biological compartment of the tropical moist forest ecosystem. It is released to the atmosphere in large quantities when the vegetation is burnt as in shifting cultivation, to the extent of potentially affecting climate.

5. The flora

The flora is extremely rich in diversity with several groups having their centres of radiation in South East Asia. In Brunei and Sarawak each, there are about 2000–3000 tree species, with a large number being of economic importance. In Malaya, for example, there are more than 1000 species of economic importance of which about 680 species have timber value. Yet, only 40 species are exploited for timber, 12 species being intensively exploited. In terms of fruit trees, there are about 100 species that are cultivated in Malaya and, yet, another 100 species more are available for potential cultivation. About 10% of the plant species in the tropical moist forest contain secondary metabolites of economic importance such as insecticides, colours, oils, drugs, medicines, saponins and base compounds. All these are important natural resource potentials which should not be lost to posterity through neglect.

6. The fauna

The fauna in the tropical moist forest is also rich in diversity with several groups having their biogeographic centres in South East Asia, and with very few groups known. In Malaya, for example, there are more than 200 species of snakes, 800 species of birds and 200 species of mammals. The invertebrates especially the insects, however, are poorly known although much richer in species diversity. This rich diversity of the fauna is due to its symbiotic association in various ways with the vegetation. In Malaysia, for example, 70% of birds are forest dwellers. Because of the competition for matter and energy at the canopy and the ground layers, the fauna is also vertically stratified into arboreal and terrestrial forms especially mammals, birds and insects and terrestrial forms especially mammals, amphibians, reptiles and insects. In Malaya, for example, about 50% of mammals (excluding the bats) are arboreal while the remainder 50 % is terrestrial, whereas in the temperate regions only 15 % of mammals are arboreal while 77 % are terrestrial. The richness of the arboreal faune is related to the stratification of the canopy, and the richness of plant species with which they are associated.

7. The drainage system

The drainage system in the tropical moist forest ecosystems of South East Asia consists of streams, rivers and swamps. Lakes are few and relatively unimportant. This drainage system depends on material and energy inflows from the catchment basin. They are generally acidic, poorly oxygenated, low in nutrients, high in silicates, and clear or black in colour. They have a low capacity for primary production, and are dependent on the inflow of decomposing organic matter. They thus are heterotrophic and are dominated by a detritivore pathway especially of aquatic insects and fish. The nature of this drainage system changes when the forested land in transformed, resulting in the loss of valuable fish protein sources and of its potential capacity to process organic wastes.

Developmental impacts

Development with its cultural infusion and endogenous production of science and technology in the life-style of the people, is a difficult process in South East Asia because of prevailing complex social conditions:

(a) Large population size
(b) High population growth rates
(c) High population density
(d) Linguistic, cultural and religious diversity
(e) Substantial population of minorities
(f) Variety of colonial experiences
(g) Economic and spatial stratification of racial communities
(h) Low literacy rates
(i) Low levels of urbanisation and industrialisation

Sectoral development in the region raises numerous environmental impacts adversely affecting the quality of life:

1. Mining: Strip clearing of topsoil and forest cover; replacement of fertile lands by sterile tailings; siltation of rivers through effluent discharge; and release of toxic elements.
2. Forestry: Rapic deforestation ($0.3–2.7 \times 10^6$ ha/year in South East Asia) (Table 2); high extraction efficiency (51–62% timber); use of limited variety of species; vast areas damaged during timber harvesting (50–70%); high fuelwood consumption (50%); and poor and slow regeneration of forests.
3. Shifting cultivation: Decreasing fallow periods; and illegal practice by the untrained especially urban population are some environmental impacts of shifting cultivation.

Table 2: Total forest area affected by exploitation during the period 1964–73 (Sommer 1976)

Subcontinent	Roundwood production 1964 - 73 ($1000 m^3$)		Percent of total roundwood production	M^3 roundwood extracted by ha (estimate)	Area affected by exploitation (million ha)
	1964	1973			
East Africa	3,314	4,114	4.0 - 2.8	10	0.4
Central Africa	12,336	15,511	14.8 - 10.4	10	1.5
West Africa	8,542	11,755	10.2 - 7.9	10	1.2
Total Africa	24,192	31,380	29.0 - 21.1		3.3
South America	15,324	22,331	18.4 - 15.0	10 - 30	0.7 - 2.2
Central American/ Caribbean Region	2,111	3,120	2.5 - 2.1	10 - 30	0.1 - 0.3
Total Latin America	17,435	25,451	20.9 - 17.1		0.8 - 2.5
Pacific Region	444	1,227	0.5 - 0.8	30	0.03
Southeast Asia	33,006	80,638	39.5 - 54.2	30 - 80	1.0 - 2.7
South Asia	8,425	9,950	10.1 - 6.7	30	0.3
Total Asia	41,875	91,815	51.1 - 61.8		1.3 - 3.0
Total World	83,502	148,646	100		5.4 - 8.8

4. Agriculture: Extensive transformation of forest land for rural development for the predominantly rural (70%) population; intensive inputs of agro-chemicals in agriculture; and the generation of agro-industrial wastes.
5. Animal husbandry and fisheries: The non-intensive use of land and water resources; and the low level of integrated farming incorporating animal husbandry and aquaculture.
6. Wildlife exploitation: The intensive exploitation of wild animals for non-food uses.
7. Major engineering works: Extensive transformation of forest land for urbanisation and transportation infrastructure; and power generation and water supply.
8. Industrialisation: Extensive transformation of forest lands for ephemeral export-oriented industrialisation and point sources of industrial pollution.

Future prospects

The fragile tropical environment and its resources in South East Asia are threatened by impacts of sectoral development especially when they are not integrated. The quest for a sustainable environment, resource base and lifestyle are dependent on:

(1) Flexible and nationally unique strategies for surmounting the harsh sociobiological conditions for realising global inter-dependence, for inter-sectoral integration and incorporating conservation values into development planning.

(2) Research and education for technical inputs into development planning and strategies.

(3) An understanding of the complex interaction of factors governing resource conservation and transformation, spatial linkages and the distribution of income and privileges among the population in relation to skills, values and life-styles.

(4) A system of indicators sensitive to land and water use especially in the coastal zone.

There is hope for the conservation of tropical forests in South East Asia since the conservation ethic is implicit in the traditional cultures and life-styles of the region.

Zusammenfassung

Die Tropischen Regenwälder Asiens liegen im Südosten des Kontinents und erstrecken sich über eine Fläche von rund 450 Mio Hektar mit einer Bevölkerung von über 250 Mio Menschen und einem Bevölkerungswachstum von jährlich 2,5%. Sie gehören zu den ältesten und biogeographisch artenreichsten Wäldern der Erde.

Ihre Entwicklung vollzog sich unter intensiver nicht-periodischer Sonneneinstrahlung und hohen Monsun-Niederschlägen. Vorherrschend sind Bäume der Familie der Dipterocarpaceen. Die Böden sind alt, verwittert, im allgemeinen nährstoffarm und verstärkt der Erosion ausgesetzt. Aufgrund des harten Konkurrenzkampfes um Nährstoffe und Licht weisen diese Wälder eine ungemein große Artenvielfalt auf. Sie stehen in engster Verbindung mit ihren Entwässerungssystemen.

Rund 40% der tropischen Regenwälder sind durch Abbau von Rohstoffen, Holzgewinnung, Wander-Hackbau, Landwirtschaft, umfangreiche Baumaßnahmen und Industrialisierung zerstört worden. Sie sind ernsthaft bedroht durch Entwicklungsprojekte aufgrund der extremen soziologischen Bedingungen für die Bevölkerung dieser Region. Ihre Zukunft liegt in einem besseren Verständnis des Tropischen Regenwaldes und der Einbeziehung ökologischer Kenntnisse in die Entwicklung, ferner in der vielfältigen sozio-kulturellen Zusammensetzung dieser Region wie auch der verbesserten Abstimmung des Ressourcensystems mit den Bedürfnissen der jeweiligen Bevölkerung.

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This paper is an overview of a lengthy paper already published, in which data and references may be found:

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