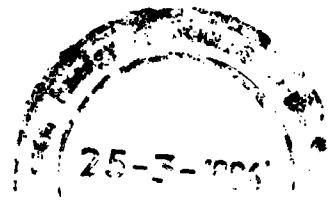
REGIONAL SEMINAR ON FORESTS OF THE HUMID TROPICS OF SOUTH AND SOUTH-EAST ASIA

19-22 March 1996

ABSTRACTS OF PAPERS



ORGANIZED BY
NATIONAL MAB COMMITTE
AND THE
NATURAL RESOURCES, ENERGY & SCIENCE AUTHORITY
(NARESA)

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REGIONAL SEMINAR ON FORESTS OF THE HUMID TROPICS OF SOUTH & SOUTH - EAST ASIA

INAUGURATION

P R O G R A M M E

09.00 - 09.15 a.m.	-	Welcome & Introduction Prof. Priyani E. Soysa Director General, NARESA
09.15 - 09.30 a.m.	-	Address by UNESCO Representative Dr. M. Hadley
09.30 - 09.45 a.m.	-	Address by Chief Guest Hon. Bernard Soysa Minister of Science, Technology and Human Resources Development

Addresses from Guests of Honour

09.45 - 9.55 a.m.	-	Hon. D.M. Jayaratne Minister of Agriculture, Lands and Forestry
09.55 - 10.05 a.m.	-	Hon. Richard Pathirana Minister of Education and Higher Education
10.05 - 10.15 a.m.	-	Hon. Ratnasiri Wickramanayake Minister of Public Administration, Home Affairs, Plantation Industries & Parliamentary Affairs
10.15 - 10.30 a.m.	-	Vote of Thanks Prof. R.N. de Fonseka Chairman, National MAB Committee
10.30 a.m.	-	T E A

REGIONAL SEMINAR ON FORESTS OF THE HUMID TROPICS OF SOUTH & SOUTH - EAST ASIA

PROGRAMME

Venue: Hotel Topaz, Kandy

19th March '96

INAUGURATION

09.00 - 10.30 a.m. : Inauguration

10.30 - 11.00 a.m. : T E A

TECHNICAL SESSIONS

I. Forest Biodiversity in Humid Tropics

Chairman : ***R.N.de Fonseka***

11.00 - 11.30 a.m. : ***J.A. McNeely***
"Forest Biodiversity in the humid tropics: Who cares ?"

11.30 - 12.00 noon : ***S. Gunatilleke***
"Understanding long term vegetation dynamics for management of biodiversity : A Sri Lankan perspective"

12.00 - 12.20 p.m. : ***A.H.M. Jayasuriya***
"The national conservation review of Sri Lanka"

12.20 - 12.40 p.m. : ***N. Gunatilleke et al.***
"Genetic Diversity and Mating Systems of Sri Lankan Dipterocarps in the Genera *Shorea* and *Stemonoporus*"

12.40 - 01.00 p.m. : ***R.H. Wickremasinghe***
"Wild orchids of Sri Lanka's humid forests with proposals for their conservation"

01.00 - 01.30 p.m. : Discussion

01.30 - 02.15 p.m. : L U N C H

II. Ecological Characteristics and Environmental Functions of Humid Forests

Chairman : ***M. Hadley***

02.15 - 02.45 p.m. : ***T.C. Whitmore***
"Ecological characteristics and environmental functions of tropical rain forests"

02.45 - 03.05 p.m. : ***U. Kutintara***
"Deciduous forests of Thailand"

03.05 - 03.25 p.m. : ***G.I. Seneviratne***
"Floral diversity of Kalatuwawa-Labugama Forest reserve"

03.25 - 03.45 p.m. : T E A

03.45 - 04.05 p.m. : ***B.M.P. Singhakumara & P.M.S. Ashton***
"Growth of four co-occurring canopy tree species in different light and moisture environments"

04.05 - 04.25 p.m. : ***H. Gamage et al.***
"Seedling leaf-structure of some late successional canopy tree species in simulated light & soil moisture environments of a Sri Lankan rain forest"

04.25 - 04.45 p.m. : ***C.J. Geldenhuys***
"Southern African Forests : Their biogeography, conservation & utilization"

04.45 - 05.05 p.m. : Discussion

20th March '96

III. Conservation of Tropical Humid Forests

Chairman : ***L. Wijesinghe***

08.30 - 09.00 a.m. : ***H.M. Bandaratilleke***
"Conservation of humid tropical forests in Sri Lanka"

09.00 - 09.20 a.m. : ***S.N. Rai***
"Long term research sites in tropical forests of India"

09.20 - 09.40 a.m. : ***R. Abdul Hadi***
"Tree population dynamics of a lowland forest block in G.Leuser national park Sumatra"

09.40 - 10.00 a.m. : ***R. Arrifin***
Links between sustainable development of forest resources and conservation of biodiversity in peninsular Malaysia

10.00 - 10.20 a.m. : ***D. Mueller-Dombois***
"Spatial dynamics of canopy breakdown recovery in forest ecosystems"

10.20 - 10.40 a.m. : Discussion

10.40 - 11.00 a.m. : T E A

IV. Sustainable Utilization of Tropical Humid Forest Resources

Chairman : ***H.M. Bandaratilleke***

11.00 - 11.30 a.m. : ***K.J. Dayananda***
"Effects of Economic Development on the Extraction of NTFP among the Communities of Sinharaja"

11.30 - 11.50 a.m. : ***S. Appanah***
"Between conservation and management : Together a future for tropical rainforests exists"

11.50 - 12.10 p.m. : ***A. Wickremasinghe***
"Management issues in the sustainable utilization of forest resources of the humid tropics"

12.10 - 12.30 p.m.	:	***R.S.J.P. Uduporuwa et al.*** "Floristics of soil seed banks in relation to light & topographic position in Sri Lankan rain forest"
12.30 - 01.15 p.m.	:	L U N C H
01.15 - 01.35 p.m.	:	***D. Tilakaratna*** "Conservation of Genetic Resources of Important Tree Species in Sri Lanka"
01.35 - 01.55 p.m.	:	***D.B. Sumithraarachchi*** "Conservation and importance of some medicinal plants of Sri Lanka"
01.55 - 02.15 p.m.	:	***H.B. Kotagama*** "Sustainable Development through sustainable use of biodiversity : Economic policy options"
02.15 - 02.45 p.m.	:	Discussion
02.45 p.m.	:	T E A

21st March '96

V. Links between Sustainable Development of Forest Resources and Conservation of Biodiversity

Chairman : ***B.A. Abeywickrama***

08.30 - 09.00 a.m. : ***M. Batisse***
"Conservation and Development in the Humid Tropics"

09.00 - 09.20 a.m. : ***A.S. Tamrakar***
"Sustainable development of forest resources & conservation of bio-diversity"

09.20 - 09.40 a.m. : ***S. Gunatilleke***
"Conversion of pine plantations in the buffer zone of Sinharaja Man & Biosphere reserve to mixed stands of multiple use primary rain forest species"

09.40 - 10.00 a.m. : ***C. Santiapillai***
"Deforestation and its implications for conservation of elephant in Sumatra and Sri Lanka"

10.00 - 10.20 a.m. : Discussion

10.20 - 10.50 a.m. : T E A

VI. International Cooperation on Issues relevant to Conservation and Development of Forests in Asian Humid Tropics

Chairman : ***S.N. Rai***

10.50 - 11.10 a.m. : ***M. Hadley & N. Ishwaran***
"Changing relationships between forestry research and landscape management in the humid tropics"

11.10 - 12.00 noon : Discussion

12.00 noon : L U N C H

02.00 p.m. : Leave for Field Excursion to Sinharaja World Heritage Site

REGIONAL SEMINAR ON FORESTS OF THE HUMID TROPICS OF SOUTH & SOUTH-EAST ASIA, Kandy, Sri Lanka: 19-22 March 1996

Field Excursion : Visit to Sinharaja World Heritage Site
Friday, 22 March 1996

Thursday 21 March

02.00 pm Leave Hotel Topaz, Kandy
06.00 pm Arrival in Hotel, Ratnapura

Friday 22 March

06.30 am Leave Ratnapura
09.30 am Arrival at Kudawa Range Forest Office. Briefing on Forest Department activities at Sinharaja. Refreshments.

10.30 am to 01.00 pm

i. Visit enrichment planting trial, using primary forest timber and non timber species as well as selected exotic and export agricultural crop species, in part of the buffer zone of Sinharaja.

ii. Visit a forest gap where a competition experiment has been set up to examine the performance of 6 congeneric *Shorea* species of the Section Doona, endemic to Sri Lanka.

iii. Arrive at field research station for a briefing of other research activities at Sinharaja.

   a. Performance of canopy dominant primary forest species under different light and nutrient conditions, in artificial shelters. At present *Syzygium* species are being tested. The experiment was only initiated in mid Jan. '96.
   b. Some preliminary results of the 25 ha long term forest dynamics plot set up in part of the undisturbed forest.

iv. Walk through a regenerating skid trail, a bandoned 20 years ago, and through part of the primary forest.

01.00 pm Visit the Sinharaja information center. Further discussions may be had over lunch.

02.00 pm Leave for Colombo

(Intermonsoonal rains are to be expected during the latter half of March. Temperature will be around 26°C. Terrestrial leeches are likely to greet visitors to the forest. Insect repellent, leech socks, rain gear and walking shoes will be useful for the visit.)

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FOREST BIODIVERSITY IN HUMID TROPICS

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CONSERVATION OF TROPICAL HUMID FORESTS

SUSTAINABLE UTTLIZATION OF TROPICAL HUMID FOREST RESOURCES

LINKS BETWEEN SUSTAINABLE DEVELOPMENT OF FOREST RESOURCES AND CONSEVATION OF BIODIVERSITY

INTERNATIONAL COOPERATION ON ISSUES RELEVANT TO CONSERVATION AND DEVELOPMENT OF FORESTS IN ASIAN HUMID TROPICS

FOREST BIODIVERSITY IN THE HUMID TROPICS: WHO CARES?

J.A. McNEELY

IUCN, Rue Mauverney Gland, Switzerland.

ABSTRACT

Forests in the tropics are often seen primarily, or even exclusively, in terms of their timber. But scientists have a very different perspective, recognizing numerous values of biodiversity in the humid tropics. This paper describes a number of the interest groups involved and the kinds of values that might motivate their behaviour toward conservation. The paper goes on to indicate how science can help contribute to improving both policy and management. Indeed, it often seems that a basic problem is the lack of communication between science and policy makers. A number of suggestions are provided on how this communication can be improved.

UNDERSTANDING LONG TERM VEGETATION DYNAMICS FOR MANAGEMENT OF BIODIVERSITY: A SRI LANKAN PERSPECTIVE

C.V.S. GUNATILLEKE

Department of Botany, University of Peradeniya, Sri Lanka.

ABSTRACT

Based on biological diversity, its distribution and hydrology a protected area network is currently being identified for Sri Lanka. Most of these protected areas, degraded by anthropogenic influences in the past, will be subject to participatory management in the near future. This paper highlights the need to understand long term dynamics of the vegetation both within the protected area and its buffer zone as a prerequisite to their effective management.

In lowland rain forests, some widely used non-timber forest species are gap colonizers, exhibiting better growth in degraded sites; a number of rain forest species are site specific even within small areas. Information on the growth rates and productivity of these species, vital for sustainable extraction, is lacking. In the montane ecosystems, forest die back continues; regeneration of canopy species appears to be suppressed by shrubs; the dwarf bamboo, once confined to stream banks, is now invading the natural wet patana grasslands; sites disturbed by, the potato project in the Horton Plains and cardomum cultivation in the Knuckles forest, are yet to be restored. In the intermediate and dry zones, invasion of exotic weeds subsequent to restriction of forest fires appear to be changing habitat diversity, particularly in wild life parks. These ecological changes may in turn affect animal populations and exacerbate the elephant-man conflicts in some of these areas.

In all these ecosystems, perennials with long life cycles dominate the vegetation. Consequently, while long-term studies are imperative to understand the changes in them, a holistic approach is required as mosaic diversity cannot be ignored.

It is proposed that the National Man and Biosphere Committee plays a pivotal role in fostering research related to long-term dynamics in these ecosystems. This will provide at least some of the necessary information for sustainable management of these ecosystems, while contributing to conservation of its biodiversity.

NATIONAL CONSERVATION REVIEW

A.H.M. JAYASURIYA

Department of Agriculture, Peradeniya, Sri Lanka.

ABSTRACT

In Sri Lanka, Investigatory research in biological systematics has so far been in terms of collection and recording of plants and animals to compile floras and faunas. The need for sustainable use and conservation of natural resources has brought in perspectives of biological diversity and the identification of an optimum conservation areas network into this important field of life sciences.

With this in view, the Environmental management in Forestry development Project of FAO/UNDP has launched the NCR with technical assistance from IUCN - The World Conservation Union in order to support the Forest Department to evaluate the conservation importance of all remaining natural forest areas. It is the first ever systematic and relatively comprehensive survey of such areas for biological diversity, soil conservation needs and hydrology. It is also an unique project, unparalleled elsewhere in tropics possibly, providing a useful model for application in other tropical countries. The Gradsect Sampling technique adopted to survey the biodiversity is essentially rapid and cost effective and has yielded an enormous volume of information on the occurrence and distribution of plant and animal species indicating their actual conservation standing. Furthermore, new species, new species records for Sri Lanka and some species hitherto presumed extinct were also discovered.

However, it should be noted that the NCR biodiversity survey was limited to woody flowering plants and vertebrate and selected invertebrate animals due to time and

resource constraints. Furthermore, sampling adequacy has not been achieved for a number of forest sites while some large and complex areas warrant more extensive sampling due to high habitat diversity.

Relative conservation values for various forest sites and the conservaiton areas network generated by the NCR database will necessarily influence a variety of conservation planning issues such as buffer zone management, revision of boundaries, reforestatin of degraded areas, controlled harvesting of non timber forest products, enhancement of research, educaiton and tourism and legislative revision. However, it is strongly emphasized that timber production in any degree and any other development activities leading to species and habitat degradation in natural areas should not be planned as the NCR data, at present, are not sufficient to support such activities.

GENETIC DIVERSITY AND MATING SYSTEMS OF SRI LANKAN DIPTEROCARPS IN THE GENERA *SHOREA* AND *STEMONOPORUS*

D.A. MURAWSKI[1], I.A.U.N. GUNATILLEKE[2], C.V.S. GUNATILLEKE[2], B. DAYANANDAN[3], K.S, BAWA[4] AND P.S. ASHTON[1]

[1] *Harvard University, USA.*

[2] *University of Peradeniya, Sri Lanka.*

[3] *Department of Biology, Boston University, USA.*

[4] *Department of biology, Harbour Campus, University of Massachusetts, USA.*

ABSTRACT

Using isozyme analyses of seed and leaf tissues of several Sri Lankan dipterocarps, we examined levels of inbreeding, patterns of genetic diversity and genetic structuring, and effects of selective logging on mating system patterns. Additionally, data on genotypic frequencies of progeny arrays allowed us to screen for apomixis. The species examined were primarily outbreeders with outcrossing rates ranging from 54-87%, supporting the results of earlier cross pollination experiments. Species of the endemic genus *Stemonoporus* typically occurring in small populations in the wet zone, contain surprisingly high levels of genetic diversity on average. Evidence for apomixis and hybridization in this genus suggest a clue to the maintenance of genetic diversity despite apparently small population sizes. In one species of *Shorea* section Doona selective logging was associated with an increase in inbreeding, presumably due to reduced population density. This has important implications for conservation management. Future studies need to examine causality and consequences of inbreeding.

WILD ORCHIDS OF SRI LANKA'S HUMID FORESTS WITH PROPOSALS FOR THEIR CONSERVATION

ROHAN H. WICKRAMASINGHE

Institute for Tropical Environmental Studies, 41, Flower Road, Colombo 7, Sri Lanka.

ABSTRACT

Of the 167 indigenous orchid species of Sri Lanka, 76 (i.e.45.5%) are endemic. Of the indigenous species a number are also rare or very rare. Some (e.g. Vanda Thwaitesii which was described in 1861 but has not been found since) **may now be extinct.**

A number of factors have contributed to the high level of endemicity of Sri Lanka's wild orchids and a number of causes are contributing to their gradual disappearance. The major factor leading to their disappearance is the growing human population pressure. This leads, in turn, to jungle clearing for agriculture and habitations, felling of trees which serve as phorophytes ("host" trees for epiphytes), more extensive use of pesticides which also eliminates pollinators, air pollution etc. Another factor which may make a significant contribution in the years ahead is climate change brought about by global warming.

Available data have been studied to determine the distribution in the island of a) wild orchid species in general, b) endemic orchid species and c) rare and very rare orchid species. This information helps to identify areas where survival of indigenous orchid species is most at risk and to which priority should be given in the implementation of conservation measures, as far as possible.

Proposals are presented for laboratory and field measures for the conservation of wild orchid species of Sri Lanka taking into account the various considerations described above. The proposals will supplement existing legislated provisions while some of them could be accompanied by or assist in the conservation of other rare and endangered plant species.

ECOLOGICAL CHARACTERISTICS AND ENVIRONMENTAL FUNCTIONS OF TROPICAL RAIN FORESTS

T.C. WHITMORE

Geography Department, Cambridge University, U.K.

ABSTRACT

A distinctive ecological characteristic of tropical rain forests that continues to excite biological interest is their extremely high species richness and diversity. It has many causes, one of which is structural complexity of the forest canopy. The canopy is in a continuous state of change by the development of canopy gaps and subsequent regrowth. Aspects of this dynamism also contribute to diversity. Small gaps are filled by climax species and create a shifting mosaic steady state that has been subject to much recent research. Large community-scale disturbance due to rare catastrophic destruction creates big gaps which become filled by pioneers and its signs persist for their lifetime. Other signs, e.g. charcoal and human artefacts, are long persistent. Increasingly more rain forests are being found with signs of large scale disturbance. Tropical rain forests impact on hydology and climate, and through the release of greenhouse gases, their destruction contributes to climatic change.

THE DECIDUOUS FORESTS OF THAILAND

UTIS KUTINTARA

Department of Forest Biology, Faculty of Forestry, Kasetsart University, Bangkok, Thailand.

ABSTRACT

The deciduous or seasonal forests of Thailand are characterized by their physiognomic function of the community by which nearly all trees shed their leaves during the dry period and most species have some adaptive characteristics to survive under forest fire pressure. This vegetation type covers more than 40 percent of the total forest land of the country especially in the northern half where the seasons are distictively pronounced. This plant formation is subdivided into 4 vegetation types, namely, mixed deciduous forest, deciduous dipterocarp forest, savanna and tropical grass-land.

The mixed deciduous forest occurs along the dry belt of the country where precipitation is less that 1,600 mm/yr, on deep soils and along dry season (more than 4 months). The dominant tree species is teak *(Tectona grandis)* intermixing with *Xylia xylocarpa, Terminalia alata, Pterocarpus macrocarpus et al.* but teak may be absent in some places and bamboo present in the middle layer. The deciduous dipterocarp forest occupies rather more dry sites and shallow soils. This forest is characterized by having deciduous dipterocarp species such as *Dipterocarpus tuberculatus, D. obtusifolius, D. intricatus, Shorea siamensis* and *S. obtusa* in the top layer. The savanna is associated with very dry sites which have grasses as the dominant plants and trees or shrubs are sparsely distributed. *Imperata cylindrica, Vetiveria zizanioides, Panicum notatum* and *Themeda triandra* are the dominant grass species while the common trees and shrubs are *Acacia harmandiana, A. catechu, A. tomentosa, Careya herbascea* and *Anitidesma montanum.* The tropical

grassland usually occurs on saline soils or very dry sites or strongly sandy soils. Annual fire is the important limiting factor preventing invasion of tree or shrub species into this forest type.

The deciduous forest communities usually have an unique ecosystem. A large amount of annual fresh biomass produced close to the ground provides high energy to herbivores which in turn supply food for capnivores. Decomposition rate is not so rapid as in the evergreen forests but annual forest fire destroys all dead and death materials on the forest floor.

FLORAL DIVERSITY OF KALATUWAWA - LABUGAMA FOREST RESERVE

G.I. SENEVIRATNE

Department of Botany, University of Colombo, Sri Lanka.

ABSTRACT (REVISED)

Kalatuwawa - Labugama Forest reserve is the catchment area associated with two important water reservoirs. It is a tropical rain forest patch of about 5300 ha. and it has not been researched upon before. The reserve at present includes some natural forest patches which were present at the time it was declared a reserve as well as recovering forests in previous village settlements. Vegetation sampling was carried out at different places to include all possible habitats and to find out the diversity in this forest. The species along two main streams were also inventorized. Although it is very much smaller that the Sinharaja forest, up to date 105 species belonging to 95 genera and 46 families have been identified. Out of the species collected 41 are endemic indicating a high percentage of endemism. In general the forest has a dense canopy layer with scattered emergents. The Dipterocarpaceae, Annonaceae, Anacardiaceae Clusiaceae are will represented. Data collected on the distribution of tree species at different sampling sites revealed among others the presence of Dipterocarpaceae species as true emergents in undisturbed areas and species like *Xylopia parvifolia* as emergents in disturbed areas. The forest shrub layer has most of the typical rain forest species. Woody climbers such as *Entada pusaetha* and *Coscinium fenestratum* are very common.

GROWTH OF FOUR CO-OCCURRING CANOPY TREE SPECIES IN DIFFERENT LIGH T AND SOIL MOISTURE ENVIRONMENTS

B.M.P. SINGHAKUMARA[1] and P.M.S ASHTON[2]

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[2] *School of Forestry and Environmental studies, Yale University, USA.*

ABSTRACT

Seeds of canopy trees *Mesua ferrea, M. nagassarium, Dipterocarpus hispidus,* and *D. zeylanicus* were gathered from the Sinharaja rain forest and grown in treatments that reflected a range of light and soil moisture environments for a two year period. The treatments reflected the range of environments that had been measured within the rain forest. *M. nagassarium* is a canopy tree of ridge sites; *M. ferrea* and *D. hispidus* are canopy trees of lower slopes and small valleys; and D. zeylanicus is a canopy tree of lowlands and large riverways. The two soil moisture treatments exposed seedlings to i) full sun; ii) direct light like that at the center of a 400 m^2 canopy opening; iii) direct light like that of a 200 m^2 canopy opening; iv) 50% shade with a quality similar to the outside edge on the shaded side of a 400 m^2 canopy opening; v) 20% shade with a quality similar to the inside edge on the shaded side of a 400 m^2 canopy opening; and vi) 99% shade with quality similar to the forest understorey. Greatest height growth and dry mass gain for all species were measured in the partial shade treatment that exposed seedlings to moist soil conditions and that were in the 50% shade treatment. *D. zeylanicus* exhibited the greatest growth among all species in these environments. The species that was most tolerant of conditions simulating the forest understorey, with highest survival and growth, was *M nagassarium. M. nagassarium* also had the highest survival as compared to the other species in the periodically dry soil moisture treatments. All species had different specific leaf areas among the light treatments. For a species, greatest specific leaf area and total leaf area of seedlings were

associated with the light treatments that promoted their greatest growth. Growth and growth allocation to roots, stem and leaves are discussed in relation to species phytosociology.

SEEDLING LEAF-STRUCTURE OF SOME LATE-SUCCESSIONAL CANOPY TREE SPECIES IN SIMULATED LIGHT AND SOIL MOISTURE ENVIRONMENTS OF A SRI LANKAN RAIN FOREST

H.K. GAMAGE[1],B.M.P. SINGHAKUMARA[1], and P.M.S. ASHTON[2]

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[2]*School of Forestry and Environmental Studies, Yale University, CT 06511, USA.*

ABSTRACT

Studies have shown differences in leaf anatomy and morphology among tree species categorized as pioneers and late-successionals, or those that are sun-loving and shade-tolerant. Few studies have examined changes in leaf structure among tree species belonging to the same ecological grouping (e.g.successional status, light tolerance)or within an ecological grouping grown under different soil moisture regimes. This study examined the variation in leaf structure among seedlings of four canopy tree species that have been characterized as late-successional and relatively shade-tolerant.

Seedlings of *Dipterocarpus zeylanicus* Thw., *D. hispidus* Thw., *Mesua ferrea* L. and *M. nagassarium* (Burm.f.) Kosterm. were grown for two years within replicated environmental shelters that had various light and soil moisture treatments. The light treatments reflected the range of microenvironments that have been observed within the mixed-dipterocarp forest of southwestern Sri Lanka. Three light treatments exposed seedlings to uniform diffuse light conditions that simulated amounts and qualities of radiation like that of the forest understorey and forest edge (photon photosynthetic fluxes of 50,350, and 800 $\mu mol\ m^{-2}\ s^{-1}$). Two treatments also exposed seedlings to amounts of direct radiation that were comparable to the centers of $100m^2$ and $400m^2$ canopy openings. A control treatment exposed seedlings to full open (1600 $\mu mol\ m^{-2}\ s^{-1}$) conditions. For each light treatment seedlings were grown

in either soil that was regularly watered to field capacity or soil that was consistently <30% of field capacity. At the end of two years leaf samples were taken from each species in each of the light-soil moisture combinations. Measures were made of leaf blade thickness, stomatal frequency, and thicknesses of upper epidermal, palisade mesophyll and lower epidermal cell layers. Significant differences in measures of leaf structure were shown among species and among the various treatments. In general, leaf dimensions and cell layer thickness of all species increased with increase in amount of light and decrease in availability of soil moisture. Largest dimensions were therefore recorded from leaves exposed to full sun but grown in relatively dry soils. *M. ferrea* exhibited the thickest leaf blades followed by *D. zeylanicus, D. hispidus* and lastly *M. nagassarium. D. zeylanicus* had greater thicknesses of epidermal and palisade mesophyll layers than *M. ferrea.* This suggests that *M. ferea* has a much thicker spongy mesophyll layer than the other species. Unlike *Mesua*, both Dipterocarpus species exhibited double rows of cells within the palisade mesophyll and lower epidermal layers in certain treatments. This increased in frequency with increase in light. Greatest densities of stomata were measured for *D. hispidus* followed in decreasing order by *M. ferrea, M. nagassarium* and *D. zeylanicus.* Differences in shade and drought tolerance among species in relation to site specialization are discussed.

SOUTHERN AFRICAN FORESTS: THEIR BIOGEOGRAPHY, CONSERVATION AND UTILIZATION

C. J. GELDENHUYS

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ABSTRACT

Mixed evergreen forests form the smallest, most widely distributed and most fragmented biome in Southern Africa and cover <3000 km². The paper reviews information relating to the distribution, phytogeography and composition of the forests, the impacts of past and present landuse practices on them and the measures currently taken for their conservation and sustainable utilization.

Forests occur along the eastern coast and escarpment. The few large forest complexes are widely separated. The large ratio of forest margin to forest area accentuates the importance of forest margins in forest survival. Hot, desiccating winds during winter cause physiological drought in exposed sites and fragment the forests when associated with fire. The natural fragmentation had been aggravated by current landuse practices. Development of commercial forestry of pines and eucalypts in the grasslands and shrublands surrounding the forests contributed to conservation of the forests. They also act as nurse stands for the establishment of forest species and the process is manipulated in selected areas to restore the forest.

Two main forest types occur whose floras have strong affinities to the tropical forest flora: forests of the Afromontane Region along the escarpment; and forests of the coastal dunes and lowlands. Scrub forest occur in the drier areas between the coast and escarpment. The forests cover only 0.08% of the area and 5.35% of the species, but are relatively rich, 0514 species/km². Species richness remains relatively

constant along the tropical-temperate gradient of southern Africa except for the south-western extreme. Undisturbed forest is somewhat richer in species than disturbed forest, and mature forest is richer than regrowth of seral forest. Conservation of the forests have two major components: maintenance of the components and critical processes within a forest ecosystem in forest reserves, and maintenance of gene flow between the different forests through management of forest corridors. National and Provincial Governments and statutory bodies manage and control a very large proportion of the forests and the largest forests. Only a small portion is privately owned.

Many studies of forest composition and dynamics of forest recruitment, growth and mortality and of disturbance, recovery and restoration processes, have provided a basis for sustainable resource utilization. Management of the forests range from a sophisticated multiple-use system (timber, minor forest products, ecotourism) applied in the State Forests, to a low income subsistence utilization of headmen's forests applied in rural areas for building material, fuelwood and household goods. Two systems for the removal of marketable timber are in use, optimal productivity harvesting of trees selected from a stand on the basis of species growth and mortality rates, and harvesting of dead and dying trees of commercially valuable species. Large utilizable trees are topped before felling to reduce canopy damage. Special extraction equipment is used to minimize soil compaction and drainage disturbances.

CONSERVATION OF HUMID TROPICAL FORESTS IN SRI LANKA

H.M. BANDARATILLAKE

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ABSTRACT

Sri Lanka's natural forest cover has dwindled rapidly during this century due to increased population pressure on forest lands. The dense natural forest cover in 1992 has been estimated as 23.9% of the land area of the country. According to historical records, forest management in Sri Lanka began in the latter part of the 19th century. The first forest policy was formulated in the year 1929 and this emphasized the need for protection and self sufficiency in timber. At this time, the natural forests in the country were managed primarily for production of timber. Establishment of forest plantations were also started around this period. Identification and declaration of protected areas (Wildlife reserves) were began around 1930's and expanded during last 2 decades. As a result of the continuous depletion of forest cover, the need for long term planing was recognized and the first Forestry Master Plan was formulated in 1986. However, due to inadequate attention paid to conservation issues this plan was implemented with some major modifications. Conservation and environmental aspects of forestry was identified as one of the major components in the implementation programme.

The National Forest Policy which was formulated in 1994 highlights the need for conservation of forests, increasing the tree cover and productivity of forests and enhancing the contribution of forestry to the welfare of the rural population. The Forestry Sector Master Plan, prepared in 1995, identifies the partnership with local people and the private sector as a major strategy for forestry conservation and development in Sri Lanka. Conservation of forests for biodiversity and protection of soil and water, multiple management of forests for forest products and services,

establishment of forest plantations, development of non-forest tree resources and improvements to forest products utilization are the key programmes identified for the conservation and sustainable management of forest resources in Sri Lanka.

LONG TERM RESEARCH SITES IN TROPICAL FORESTS OF INDIA

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ABSTRACT

Some of the oldest Long Term Research Sites (LTRS) in the tropical forests of the world, perhaps, exist in India. The earliest increment plot which was established in India is in the west coast region for *Hopea parviflora*. Subsequent to this, during 30s, there were concerted efforts for establishing Long Term Research Sites (variously called as Linear Tree Increment plot (LTI), Linear Sample Plot and Linear Increment Plot). During this period plots were established in 2 main regions; in northern India in *Shorea robusta* forests of Uttar Pradesh, Bihar and West Bengal States and in southern India in tropical rain Forests of Western Ghats in Karanataka, Tamil Nadu and Kerala states. Subsequently during early 50s, in parts of Karanataka and in early 80s, in parts of Maharashtra there were renewed efforts for creation of LTI plots in moist deciduous and dry deciduous teak bearing forests, respectively. At present nearly 100 such LTRS exist in India and majority of them are well maintained, with the exception of Sandalwood plots which have been practically destroyed beyond recognition, in the three southern states of Andhra Pradesh, Karanataka and Tamilnadu, due to anthropogenic factors.

During the past 20 years, the author has studied the rate of diameter growth, basal area increment and pattern of mortality in the LTRS of Karanataka state which are situated in the tropical rain forests and moist deciduous teak and non-teak forests. The author has also studied the rate of diameter increment of Sandalwood from the existing old records. The average increment of basal area in the tropical rain forests is around 2%. The average rate of diameter increment for species in the Western

Ghats has been between 0.3 to 0.35 cm per year. The pattern of mortality as expected is very high for pioneer species and very low for the typical climax species of the rain forests.

TREE POPULATION DYNAMICS OF A RIVERINE MIXED FOREST IN KETAMBE RESEARCH STATION, G. LEUSER NATIONAL PARK SUMATRA, INDONESIA

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ABSTRACT

A 1.6 hectare permanent plot of a lowland forest near Ketambe Research Station in G.Leuser National Park, Sumatra was established in 1980. All trees with DBH greater than 10 cm were initially enumerated and marked. This forest was described as a Riverine Mixed forest. A total of 736 trees, belong to 127 species, 86 genera and 50 families were recorded. The Euphorbiaceae and Meliaceae were the most dominant families that comprises 15 and 14 species, representing 28.4% (216 trees) and 18.9% (139 trees) of the stand respectively. The most leading species were *Dendrocnide sinuta* (IV18.00), *Parashorea lucida* (IV17.30), *Rinorea sclerocarpa* (IV 16.50) *Agtata cauliflora* (IV 13.60) and *Paranephelium nitidum* (IV 11.90).

In 1995, all trees were reinvestigated. In 15 years 167 (22.81%) trees in 62 species no longer existed. More than 20% of the dead trees in the plot were those of light demanding secondary species including *Dendrocnide sinuata* (18), *Macarango diepenhorstii* (8), and *Croton argyratus* (7). The other dead trees were mostly the prevalence species such as *Paranephelium nitidum* (15), *Rinorea sclerocarpa* (9), and *Aglaia cauhlilora* (7). In contrast, 215 new trees in 65 species were recruited. The most recruited trees were *Aglaia cauliflora* (18), *Paranephelium nitidum* (17), *Pseudavaria rugosa* (13), *Rinorea sclerocarpa* (11) and *Parashorea lucida* (10). Changes in population size of the species and forest structure over 15 years will be further discussed.

SPATIAL DYNAMICS OF CANOPY BREAKDOWN AND RECOVERY IN FOREST ECOSYSTEMS

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ABSTRACT

Spatial patterns of tree mortality in forest ecosystems have, so far, received little attention in ecological research. In contrast, recovery patterns following gap formation in tropical rain forests and successional processes following larger-area disturbances have traditionally received primary attention in vegetation research. However, in addition to the building factors operating in forest ecosystems, disturbance regimes are equally important in ecosystem development.

At the recent Singapore Workshop of DIWPA (diversitas Western Pacific and Asia), I have suggested this knowledge gap as a new focus for cooperative international/ interdisciplinary research on the function of biodiversity. The research hypothesis reads, "Spatial dynamics of forest canopy breakdown and recovery is a function of disturbance regime and biodiversity."

My paper will deal with an elaboration of this new hypothesis by discussing examples from Pacific forests. They may also apply to differences in the disturbance dynamics of Sri Lanka's lowland and montane rain forests.

EFFECTS OF ECONOMIC DEVELOPMENT ON THE EXTRACTION OF NTFP AMONG THE COMMUNITIES OF SINHARAJA

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ABSTRACT

Protected areas such as biosphere reserves were established in many parts of Asia to conserve important natural resource systems for the benefit of the human community. However, consequences of the protection strategy have often denied human access to their traditional rights. Sinharaja Forest is the sole lowland rainforest in Sri Lanka, big enough to have a reasonable chance to conserve uniquely diverse flora and fauna of the island. Under the present management policy, all uses of the Sinharaja Forest resource other than conservation, research, education and recreation are illegal. However, the non-timber resources of this species rich forest have always been critical in meeting the basic needs of the rural population. The villagers use the resource for subsistence and income. Forest clearing to plant agricultural crops is the base for almost all subsistence or income generating activity, other than forest products extraction. As the non agricultural economic sector or the existing agricultural lands do not have the capacity to absorb the growing rural working force, many rural poor have appropriated forest lands for plantation agriculture. Tea, which remains Sri Lanka's highest net foreign exchange earner and the principal agricultural product, during the last two decades has become the only important source of small holder income and economic development in the Sinharaja region. Villagers have even neglected their traditional homegardens and land diversification practices in the rush to grow as much tea as possible. The objectives of this research are to: (i) Estimate the current household needs met by the Sinharaja reserve; (ii) Examine what happens to people's use of tropical rain forest resources with economic development; (iii) Analyse changing forest uses due to significant distinction in social structure in response to economic development.

The study provides information on what makes villagers in the vicinity of forest depend on it, and how agriculture is intertwined with the social and economic life of a community posing simultaneously complementary, competitive and conflicting demands on the community and its natural resource base. As incomes rise, the share of household income from forest products has declined, overshadowed by income from tea. The dependence on forest products in the household economy bears an inverse link to a household's total income.

The changing economies due to tea have displaced existing practices and have brought changes in social structure. Over time, the increased productivity provided by the new technology has compelled significant changes in the social order. Such changing economies due to new land use practices could displace existing practices and could bring changes in social cycles in the community. Issues of resource control and the changing uses in relation to socioeconomic transformations are explored to understand the resource management issues and resource conflicts at the forest edge. The study elucidates the underlying relationships which help policy makers, and it can also act as a model to extend the conservation concept to other forest areas in the country.

BETWEEN CONSERVATION AND MANAGEMENT: TOGETHER, A FUTURE FOR TROPICAL RAINFORESTS EXISTS

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ABSTRACT

The future of tropical rainforests, particularly in the population-dense regions of tropical Asia, is uncertain. Nevertheless, possibilities for managing them on a sustainable basis exist. Knowledge about these forests has steadily increased, to a point where we can today predict the general patterns of species richness more accurately. Locally, it appears to be dependent on soil nutrient availability, water stress, frequency of canopy disturbance, and so on. We also have a reasonable understanding of what factors are involved in the maintenance of species richness, including their genetic diversity. Knowledge on both the patterns of species richness and their maintenance should be translated into existing management systems. Based on the above, some of the changes to existing management systems are discussed. It is concluded that the future of the tropical rainforests in Asia would depend much on both conservation and management working unitarily to complement each other.

MANAGEMENT ISSUES IN THE SUSTAINABLE UTILIZARION OF FOREST RESOURCES IN THE HUMID TROPICS

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ABSTRACT

Forest management in Sri Lanka has been formally assigned to the state sector while informally people have not withdrawn their engagement in forest management. This paper presents a number of complex issues arising from this situation. When, the utilization of forest resources has to be considered wisely for the sustainability of the ecosystems a number of policy and strategic reformulations are needed. Based on the experience gained in Kalugala forest and Adam's Peak Wilderness, the author suggests that no blanket recommendation could be made. Sustainable management is beyond the interests of many parties who utilize the resources. Not only do the resources of forests vary, but cultural dimensions and local community interests also become diverse. For the purpose of developing both locally appropriate, viable and acceptable strategies, policy makers need to examine the local situation and have confidence in local peoples' capacities. Institutional building, improvement of access and user rights are essential for better management. Issues related to forest management are categorized under environmental conditions, patterns in the use of non-timber forest products, socio-economics of local communities and ownership status of forests. Compartmentalization of state sectors responsible for management and the separation of such sectors from local communities have resulted in rather uncoordinated forest resource management in Sri Lanka.

FLORISTICS OF SOIL SEED BANKS IN RELATION TO LIGHT AND TOPOGRAPHIC POSITION IN A SRI LANKAN RAIN FOREST

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ABSTRACT

Soil seed banks have been reported to play an important role in the regeneration of tropical moist forest after disturbance. We examined this phenomenon for mixed-dipterocarp forest of south western Sri Lanka. Experiments were conducted at the Sinharaja World Heritage Site that compared soil seed banks exposed to different amounts of light (full sun; partial shade-40% of full sun); and taken from two topographic positions (valleys;ridges). In all instances plots, where soil was collected, were located beneath late-successional closed canopied forest stands. For each plot the surface litter layer was scrapped away and soil was collected up to 5 cm in depth. The soil from each plot was placed in wooden trays within shelters at the field station. All treatments were watered periodically to maintain field capacity. Germinating seeds were tagged and recorded every five days for a period of six months.

A total of 42 species germinated during the study period. Results showed that germination was significantly affected by light. Soils exposed to partial shade exhibited greater seed germination than soils placed in full sun. In all treatments pioneer herbs (*Emilia exserta, Eupatorium* spp.), grasses *(Eragrostis japonica, Panicum gardneri, Frimbristylis manticola)* and shrubs *(Clidemia hirta, osbeckia octandra)* represented a far greater proportion of seeds and species than pioneer trees *(Macaranga peltata, Trema orientalis).* Late-successional trees, or herbs and shrubs of the late-successional forest understorey were negligible. There were also

differences between sites. Some species were recorded solely from soils of ridges (7 spp.), while others were associated with soils of valleys (15 spp.). However, most species were common to soils from both valleys and ridges. The total number of germinants was significantly less on soils taken from ridges than those from valleys. Results suggest that within the mixed-dipterocarp forest type in Sri Lanka the buried seed phenomenon plays a varied role in the regenerative capacity of the forest after sever disturbance. This capacity depends in part on topographic location and exposure to sun. Findings also suggest that the kind and severity of disturbance that releases the soil seed bank within mixed - dipterocarp forest will promote a very different vegetation composition, structure and successional process than that of the original forest.

CONSERVATION OF GENETIC RESOURCES OF IMPORTANT TREES SPECIES IN SRI LANKA

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ABSTRACT

Genes in living organisms determine different qualities of the organisms and transfer them to offspring during reproduction. There is variation in genes among members of the same species and among those of different species. Some genes produce useful qualities while others produce poor qualities in the organism. Sri Lanka is blessed with a unique tree flora. Many species have high quality hard wood and are endemic to the country.

Expansion of the human population has resulted in deforestation reducing Sri Lanka's forests to nearly 24% of their original extent. In turn, this has definitely reduced the habitats of many tree species and the diversity of the gene pools. The most affected are the economically important tree species where people selectively cut trees with good qualities such as large diameter, straight bole, defect free, etc. These trees carry most of the genes that can produce useful qualities.

Narrowing down of natural habitats and selective removal of trees with useful genes degrade the gene pool so that future potential for production of high quality wood from these tree species can be lost. Some of the species affected by genetic degeneration are, *Diospyros* species, *Vitex altissima, Pterocarpus marsupium, Albizia odoratissima, Melia dubia* etc.

Therefore, it is important to take immediate action to safeguard the genetic resources of these important tree species. This should be one of the priority actions in conservation of biological diversity in Sri Lanka.

Protection of the remaining natural habitats, identifying the areas with high genetic diversity for strict conservation (in-situ), establishment of artificial plantations, selecting and propagation of genetically superior individual trees (ex-situ) are some of the measures that can prevent further depletion of the genetic resource.

CONSERVATION AND IMPORTANCE OF SOME MEDICINAL PLANTS OF SRI LANKA

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ABSTRACT

Sri Lanka is another country where dependence on herbal treatments have been gaining popularity over the recent past. The population of 17.1 million on the small island demand fresh and dried plants and plant material for their porridge and treatment for ailments and illnesses. There has been state support to preserve and develop herbal treatment systems and as a result significant changes have been brought and established in this important area. These state endeavours have increased the demand for medicinal plants and their products many fold.

Sri Lanka possess and interesting flora with a remarkable diversity both at species and genetic levels. This is attributed to many aspects special to Sri Lanka.

A survey of presence, abundance, conservation and sustainable utilisation of some important medicinal plants from three dry zone districts of the Island are presented and ten important tree species are discussed.

This survey revealed the serious reduction of population sizes thus narrowing the genetic base. This calls for an immediate need to conserve the existing population levels.

The survey also recognises the immediate need to expand the cultivation of medicinal plants to meet the increasing demand and popularity for these plants.

SUSTAINABLE DEVELOPMENT THROUGH SUSTAINABLE USE OF BIODIVERSITY: ECONOMIC POLICY OPTIONS

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ABSTRACT

Sri Lanka is persevering to achieve simultaneously, the development objectives of alleviating poverty and conserving the environment. Biodiversity is an environmental resource that Sri Lanka is richly endowed, which if sustainably used could contribute to sustainable development of Sri Lanka. Regrettably, there are powerful economic forces acting against conservation and use of biodiversity. This paper examines economic policy options that could be implemented to conserve and use biodiversity in Sri Lanka.

The concept of sustainable development, has evolved as a development paradigm, that recognizes the need to conserve the environment such that future generations too would be provided with the same or better opportunities of development. Conservation of the environment is required because it contributes to development through its source, sink and global functions, of which some can not be substituted by human creations.

Biodiversity is the diversity of plants and animals living on earth. As an environmental resource, it contributes to development through its multifaceted uses. These are direct uses for food, fibre, clothing, medicines and recreation etc, indirect uses of maintaining ecological functions, watershed protection etc, and option uses of the potential of biodiversity to be directly used in the future. Further, people prefer the undisturbed existence of biodiversity too.

The term 'sustainable use of biodiversity' although widely used, has not been precisely defined. Sustainable use of biodiversity systems could be defined as increased (or least non decreasing) use of biodiversity overtime, whilst maintaining constancy of production of uses of biodiversity, resilience of the ecological system in supplying biodiversity and achieving equitable intra and inter-generational sharing of the use of biodiversity.

At present what has been achieved in Sri Lanka in biodiversity conservation and use is the gathering of biodiversity information and development and implementation of strategies for conservation of natural habitats. Policies and strategies for biodiversity use has not been adequately addressed.

Sustainable use of biodiversity requires that the benefits of uses are larger than costs of conservation. Knowing the factors determining benefits and costs would enable to identify policies to promote increased benefits and reduced costs of biodiversity conservation and use. Biodiversity conservation is a land use economic policy issue. This paper identifies the factors that determines the magnitude of the benefits from pharmaceutical industry (number of plants endangered, probability of inventing a drug from a plant, rate of royalty payment, probability of appropriating values, market value of medicines, extent of land conserved) and the factors effecting the cost of biodiversity conservation as the value of development opportunities foregone on land. The opportunity cost of land depends on rationality of land use, polices effecting land use, land tenure etc,. Specific policies to influence the above mentioned variables are identified in a policy matrix. This methodology can be used to identify economic policy to influence sustainable use of other biodiversity uses, such as provision of genetic material for plant and animal production improvements etc.

CONSERVATION AND DEVELOPMENT IN THE HUMID TROPICS

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ABSTRACT

Perspectives concerning tropical forests have changed considerably since the 1956 Kandy symposium. The population of the world has more than doubled, from about 2.8 billion to 5.8 billion and the timber trade has increased even more. As a result, the tropical forest cover area has been reduced by some 30% since then, without much possibility for regeneration and continuous to be reduced at a rate of some 16 million hectares per year. Thus, while the concern for conservation was somewhat secondary in the past, it has now become the top priority. This situation is emphasized by the rapid entry into force of the Convention on Biological Diversity and of the Convention on Climate Change, reflecting other concerns of carbon absorption.

The sequence of issues and actions for tropical forests is now to conserve, to study and to use them in a sustainable way.

The status of tropical forests varies greatly from country to country and from site to site, and various approaches have been attempted to ensure adequate conservation measures with enlightened use. Among those, the concept of Biosphere Reserves, promoted by UNESCO since the mid-seventies, is proving to offer a practical tool combining conservation of ecosystems and biodiversity, ecological research and monitoring, as well as sustainable use of forest resources in co-operation with local populations. While many Biosphere Reserves do not yet perform these three

functions adequately, the potential exists for their improvement. This is particularly so after the adoption of the so-called "Seville Strategy" and of the Statutory Framework which is now governing the World Network of Biosphere Reserves, where exchange of data and experience is progressively organized through UNESCO-MABnet. The conservation, research and experimental activities within biosphere reserves are thus promoting sustainable exploitation of timber and non-destructive use through the collection of forest products for the benefit of local populations, including the maintenance of their cultural values.

Countries in Asia are, however, still unevenly represented in the Network of Biosphere Reserves and would benefit from greater involvement in the development of this innovative tool.

SUSTAINABLE UTILIZATION OF TROPICAL HUMID FOREST

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ABSTRACT

The humid forests of Nepal are being cleared or degraded at a rapid rate mainly to satisfy the basic substantial need of poor rural communities. The main cause of destruction and degradation of tropical forests is due to poverty of people living in and around them and their dependence on forest land for their basic needs. In the context of obvious destruction of forest resources, H.M.G. has an important role to play to implement development strategy affectively, considering the possible future long term consequences so as to deal with current rural energy, fodder, soil erosion crises effectively. Afforestation areas of about 1.3 million ha of plantation by the turn of century will be needed to meet the demands of rural and urban populations for fuelwood and partly to supply the manufactured forest products for economic growth (timber and paper). This will have a significant impact with sustainable contribution to tree fodder. If reforestation programmes are not implemented in time, the rural populace will be forced to burn increasing quantities of dried animals, dung, agricultural residues and livestock fodder to meet their basic needs such as heating and cooking.

The responsibility for using natural resources as well as sustaining them must lie on some people. Users and others who participate in decision making of protection and management of forests, should be encouraged to take timely steps in preventing these crises.

Research studies on forest resources and their protection and management have made it clear that indigenous systems of forest management are widely distributed throughout Nepal. It is commonly recognised to-day that the indigenous systems of forest protection and management have, (i) effectively arrested the process of deforestation in many areas, (ii) been existing as a sustainable institution, (iii) sustainably supplied of forest resources and (iv) operated within the local environmental context and been better than what the scientific community has heretofore known or recognized.

CONVERSION OF PINE PLANTATIONS IN THE BUFFER ZONE OF THE SINHARAJA MAB RESERVE TO MIXED SPECIES STANDS OF MULTIPLE-USE PRIMARY FOREST SPECIES

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ABSTRACT

Dipterocarpus zeylanicus, Mesua ferrea, Shorea disticha, S. megistophylla and *S. trapezifolia*, all timber species and four non-timber species, *Coscinium fenestratum, Arundina graminifolia, Calamus ovoideus* and *Elettaria cardamomum* grow naturally in the primary lowland rain forests in Sri Lanka. In an attempt to convert *Pinus* plantations to mixed species stands, the performance of these species were examined in a field trial in the buffer zone of Sinharaja under four different light environments (3, 5, 10, 22 mols/m^2/day). Each light treatment had three replicates, with 20 individuals per species per replicate, planted in a split plot design. The growth performance over 4 years for the timber and over 3 years for the non timber species, from initiation of the trial, was evaluated by measuring for each of the woody species, stem height and basal stem diameter, for *E. cardamomum* shoot number and leaf number, and for *A. graminifolia* shoot number. The data was statistically analyzed using ANOVA and differences among means were examined using Duncans Multiple Range Test. In general, all species showed relatively low mortality and better growth in the 10 and 22 mols/m^2/day light environments.

This trial provides valuable information to construct enrichment planting guidelines suitable for the conversion of lowland wet zone pine plantations into mixed species stands of multiple-use, primary forest species in Sri Lanka. It successfully demonstrates that at least some timber and non timber species, useful both to the

timber industry as well as to villagers around Sinharaja, can be grown outside their natural habitats, from where they can be exploited at a future date. This would help to conserve the germplasm of these species in their natural ecosystems.

DEFORESTATION AND ITS IMPLICATIONS FOR CONSERVATION OF ELEPHANT IN SUMATRA AND SRI LANKA

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ABSTRACT

Both Sumatra and Sri Lanka are land-bridge islands, whose faunas have been slowly dwindling since their separation from the Malayan and Indian mainlands respectively. This slow process of species loss is being accelerated by the wave of deforestation that is sweeping across these islands. The Asian elephant (Elephas maximus) becomes vulnerable and extinction prone when confined to limited areas. The main agents of deforestation in the humid tropics are logging, human settlements, shifting or swidden cultivation, agricultural expansion, forest fires, fuel wood collection and road building. One of the negative aspects of deforestation is that it has led to the fragmentation and isolation of some elephant populations in Sumatra and Sri Lanka, while the establishment of human settlements and agricultural expansion have resulted in increased conflicts between man and elephant. Road building has not only fragmented elephant habitats, but more seriously, has provided access to illegal settlers and ivory poachers. Poaching of tuskers can skew the adult sex ratio and in extreme situations, can result in lowered fertility among elephants and reduce their rate of growth. On the other hand, deforestation has had some beneficial effects too on the elephant populations: logging, if carefully controlled and selective, can enhance the carrying capacity of herbivores in general, and the elephant in particular. The best opportunity for elephant conservation in the tropics at present lies in some form of multiple-use-pattern of land development. This could be achieved by the establishment of "Managed Elephant Reserves" where priority is given to the requirements of elephants, but human activities that are compatible with

elephant conservation are permitted. This may be the last hope for the elephant in such densely populated islands of Sumatra and Sri Lanka.

CHANGING RELATIONSHIPS BETWEEN FORESTRY RESEARCH AND LANDSCAPE MANAGEMENT IN THE HUMID TROPICS

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ABSTRACT

Sustainable use of tropical humid forests, over the last two-to-three decades, has come to be recognized as a broader notion including but not restricted to, sustainable timber production. Before industrialization became the driving force for national economic development in countries of the humid tropics, tropical forests were exploited by local communities for extraction of a range of resources and products. Industrial production of timber however, disrupted multiple-use regimes that favoured sustainable use of tropical humid forests. As we near the end of the millennium, multiple use models are regaining their earlier importance as the basis for sustainable management of tropical humid forest landscapes. The present search for multiple use-models, however calls for the inclusion of (a) the long-term socio-economic development of forest-based communities and (b) the potential for commercializing exchanges of non-timber forest products, as initial conditions for model design. Neither of these conditions merited the concern it currently receives in pre-industrial economics of the humid tropics.

The challenge faced by researches and managers today is to develop skills and knowledge for guiding changes to any given set of uses of tropical humid forests along ecologically, economically, socially and culturally sustainable pathways. In responding to this challenge, researches and managers are forging new partnerships. Model parameters are likely to be site specific; but model design

needs to: (a) be based on regional landscapes or similarly extensive spatial planning units; (b) incorporate short, medium and long-term time horizons; (c) include a role for the private sector; and (d) bring social and cultural benefits and economic profits to local communities, in the short-to medium term. Issues centred around non-wood forest products and rehabilitation of degraded forest lands generate crucial research questions whose answers will significantly influence model design for managing tropical humid forest landscapes. Examples of such issues include: adding value to the production, processing and marketing of non-timber forest products; regenerating biodiversity and environmental/ ecological services lost from degraded forest lands; zoning schemes for spatial planning and management of a given set of resource use regimes. Trends in UNESCO's work in humid tropical regions, since the launching of the Humid Tropics Programme in 1956, are used to illustrate key concepts, approaches and activities which have brought researchers and managers closer to one another in the search for multiple use models for humid tropical forest landscapes.

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