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Plant Diversity and Conservation Value of Ayer Hitam Forest, Selangor, Peninsular Malaysia

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Keywords: Plant diversity, conservation, Ayer Hitam Forest

ABSTRAK

Hutan Ayer Hitam dengan keluasan 1248 hektar terletak di Negeri Selangor dan merupakan hutan pamah dipterokarpa yang pernah dibalak. Ia merupakan satu daripada hutan yang baki di Lembah Klang selain Hutan Bukit Nenas di Kuala Lumpur. Hutan ini telah disewakan kepada Universiti Putra Malaysia (UPM) selama 80 tahun bermula tahun 1996 untuk tujuan pendidikan, penyelidikan dan pengembangan. Sejak itu berbagai usaha telah dijalankan untuk mengetahui kepelbagaian sumber yang terdapat di dalamnya. Dengan itu, satu pengkalan maklumat mengenai tumbuhan yang terdapat di hutan ini telah dimulakan pada tahun 1998. Maklumat ini diperolehi dari kajian pada beberapa plot dan pungutan tumbuhan dari masa ke semasa. Hasil awal dibentangkan di sini. Sebanyak 430 spesies tumbuhan berbiji yang terangkum dalam 203 genus dan 72 famili terdapat di sini. 33 spesies paku-pakis dan sekutunya, 127 spesies balak, 29 spesies buah-buahan dan 98 spesies ubat telah direkodkan dari hutan ini. Daripada jumlah takson ini, sebanyak 20 spesies yang endemik kepada Semenanjung Malaysia terkandung di hutan ini. Lima daripada spesies endemik ini merupakan rekod baru bagi Negeri Selangor. Walaupun Hutan Ayer Hitam ini belum terpulih sepenuhnya, ia merupakan satu ekosistem terserpih yang kaya dengan kepelbagaian tumbuhan dan perlu dipulihara untuk generasi akan datang.

ABSTRACT

The Ayer Hitam Forest, a logged-over lowland mixed-dipterocarp forest in the State of Selangor covers an area of 1248 hectares. It is one of the remaining forests left in the Klang Valley besides the Bukit Nenas Forest in Kuala Lumpur. This forest has been leased to Universiti Putra Malaysia(UPM) in 1996 for 80 years for the purpose of education, research and extension. Since then various efforts have been taken to know the biodiversity it houses. Thus, a database on the plants of Ayer Hitam Forest was started in 1998. Several plots have been established and plant collections were made to achieve this and is still progressing. Results presented here are still preliminary. A total of 430 species of seed plants in 203 genera and 72 families occur here. 33 species of ferns and fern-allies, 127 timber species, 29 fruit tree species and 98 species with medicinal values were recorded from this forest. Of these taxa, 20 species which are endemic to Peninsular Malaysia are found here, five being new records for Selangor. Although Ayer Hitam Forest is still regenerating, it is nevertheless a rich fragmented ecosytem that needs to be conserved for future generations to come.

INTRODUCTION

The Ayer Hitam Forest is an important support facility of Universiti Putra Malaysia (UPM) for studies in forestry, environment, zoology, botany and related fields. This forest is classified as a disturbed Kelat – Kedondong – Mixed Dipterocarp type of lowland forest (Faridah Hanum and Zamri Rosli 1999). It is located 25 km away from the UPM main campus in Serdang. The Selangor State Government leased it to UPM in 1996 for 80 years and the Faculty of Forestry in UPM is trusted to manage the forest for teaching, research and extension activities. This lease involves Compartments 1, 2, 12, 13, 14 and 15. For the past three years, some works have been carried out to gather information on

the plant resources of Ayer Hitam and subsequently, a database on the plant diversity of Ayer Hitam was started. Information on a few related aspects of plant diversity studies in the Ayer Hitam Forest was earlier discussed in Faridah Hanum *et al.* (1997) and Faridah Hanum and Zamri Rosli (1999). In this paper, a summary of selected plant taxa will be presented to give a picture of the diversity of this forest. The significance of conserving Ayer Hitam Forest is also discussed.

SITE DESCRIPTION AND METHODS

Ayer Hitam Forest

The Ayer Hitam Forest was much larger covering an area of about 3500 hectares prior to the lease to UPM in 1996. The size of this forest is now 1248 ha, after it was further excised for some socio-economic development projects such as housing estates, oil palm plantations, new townships, factories and highways. This lowland forest is thus surrounded by development, making it an isolated patch of forest in the middle of modern infrastuctures and society. Being strategically located within the Multimedia Super Corridor, that connects Kuala Lumpur with the new administrative city of Putrajaya and business city of Cyberjaya, it is one of the two remaining forests left in the Klang Valley; the other being Bukit Nenas in the city of Kuala Lumpur. Even more unique is the habitation of this forest by a group of indigenous people of the Temuan Tribe. This forest is also readily accessible by all kinds of vehicle up to the base camp.

This forest was selectively logged several times between 1936 to 1965. There are three major rivers i.e. Sg. Rasau, Sg. Bohol and Sg. Biring flowing in this forest which is generally a low lying area with several steep slopes and many streams. Altitude ranges between 5 - 80 metres a.s.l. and the highest peak at Permatang Kuang is 213 metres a.s.l. (*Fig.1*). A small patch of swamp is found in Compartment 15 and some sandy patches are also found along the major rivers.

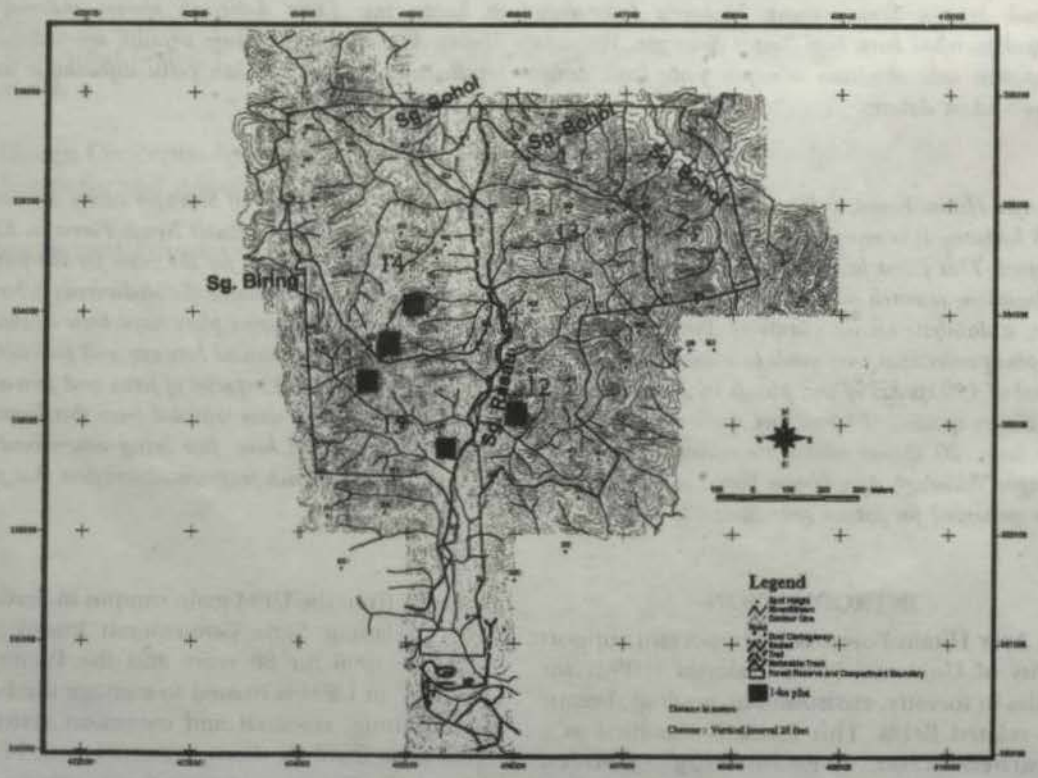

Fig. 1. Location of plots at Ayer Hitam Forest, Selangor

The soil is of the Serdang-Kedah Series and Durian Series, a combination of alluvium-colluvium soil which reshaped from metamorphic stones with sandy clay loam soil texture. Average yearly temperature is 25.3°C with the maximum temperature of 27.7°C and minimum at 22.9°C. The relative humidity averages at 87.6 % with a maximum at 97.8% and minimum of 77.4%. Average annual rainfall is 2178 mm (Ahmad Ainuddin Nuruddin, pers. comm.).

With the receding size of the forest, many of the larger mammals have dissapeared or reduced in number. Of noteworthy attention is the tiger which have been sighted in this forest. Other mammals recorded include the wild boars and mousedeers. Some 160 species of birds were also recorded from this forest, mainly frugivorous and insectivorous birds. Migratory birds such as the Siberian Blue Robins were also sighted here (Mohd. Zakaria Hussin, pers. comm.).

Methods

Plant specimens were collected over a period of three years and this was done either through five 1 – ha plots (100m x 100m) which were placed in several locations in the forest (*Fig. 1*) or regular collecting trips made to the forest. In either attempt, specimens were collected for the record and identification of uncertain taxa, in duplicates of three for flowering or fruiting specimens or one only for sterile specimens. Where plot studies are concerned, all trees greater than 5 cm in diameter breast height were measured, tagged and enumerated. The initial census of the five 1 – ha plots was carried out in 1998.

RESULTS AND DISCUSSION

PLANT DIVERSITY

Taxonomic Composition of Seed Plants

430 species of seed plant taxa in 203 genera and 72 families were recorded from Ayer Hitam Forest (Table 1). Detailed species composition of seed plants of Ayer Hitam is not included in this paper as it will be presented in another companion manuscript in the very near future. For tree taxa alone, this forest contains almost half the total number of tree families, one-sixth and one-third the total number of genera and species respectively in Peninsular Malaysia (Table 2). Comparisons cannot be made with other

TABLE 1
Composition of seed plant taxa at Ayer Hitam Forest, Selangor

Family	No. Genera	No. Species
Euphorbiaceae	18	39
Myrtaceae	4	26
Lauraceae	5	23
Moraceae	7	21
Myristicaceae	4	20
Rubiaceae	13	17
Burseraceae	3	16
Guttiferae	3	15
Piperaceae	1	15
Leguminosae	12	14
Anacardiaceae	6	14
Annonaceae	7	13
Dipterocarpaceae	5	12
Zingiberaceae	7	10
Melastomataceae	6	8
Elaeocarpaceae	1	8
Sapotaceae	4	8
Meliaceae	5	7
Polygalaceae	2	7
Fagaceae	2	6
Sapindaceae	2	6
Apocynaceae	4	5
Rhizophoraceae	2	5
Thymelaeaceae	2	5
Myrsinaceae	2	5
Celastraceae	3	5
Ulmaceae	1	5
Sterculiaceae	4	5
Rutaceae	3	4
Acanthaceae	4	4
Compositae	4	4
Ebenaceae	1	4
Marantaceae	3	4
Tiliaceae	1	4
Palmae	4	4
Flacourtiaceae	4	8
Dilleniaceae	2	3
Dioscoreaceae	1	3
Bombacaceae	2	3
Olacaceae	2	3
Verbenaceae	2	3
Proteaceae	1	3
Graminae	3	3
Menispermaceae	2	2
Linaceae	2	2
Gnetaceae	1	2
Combretaceae	1	2
Araliaceae	1	1
Lecythidaceae	1	1
Ochnaceae	1	1

Table 1 (Continued)

Crypteroniaceae	1	1	
Opiliaceae	1	1	
Hypericaceae	1	1	
Sonneratiaceae	1	1	
Orchidaceae	1	1	
Simaroubaceae	1	1	
Icacinaceae	1	1	
Theaceae	1	1	
Podocarpaceae	1	1	
Rosaceae	1	1	
Vitaceae	1	1	
Oxalidaceae	1	1	
Scrophulariaceae	1	1	
Taccaceae	1	1	
Asclepiadaceae	1	1	
Aristolochiaceae	1	1	
Malvaceae	1	1	
Araceae	1	1	
Labiatae	1	1	
Cyperaceae	1	1	
Cornaceae	1	1	
Solanaceae	1	1	
Total	72	203	430

TABLE 2
Comparison of tree taxa at Ayer Hitam Forest, Selangor

	Ayer Hitam	Peninsular* Malaysia
No. Family	56	100
No. Genus	160	532
No. Species	400	2830

* *Source*: Ng *et al.* (1990)

lowland forests if we limit to trees of 5cm dbh and above because many past plot studies enumerated trees of 10cm dbh and above. Thus, when the diversity of Ayer Hitam was compared for trees of 10 cm dbh and above, this forest was about 35% lower in diversity than Pasoh Forest with 210 species per ha (Kochummen *et al.* 1990) and about 25% lower in diversity than Bangi Forest with 167 species per ha (Rashidah Johar 1993). The mean diversity per hectare at Ayer Hitam Forest for trees greater than 10 cm dbh was about 60 species per ha (Faridah Hanum and Zamri Rosli 1999).

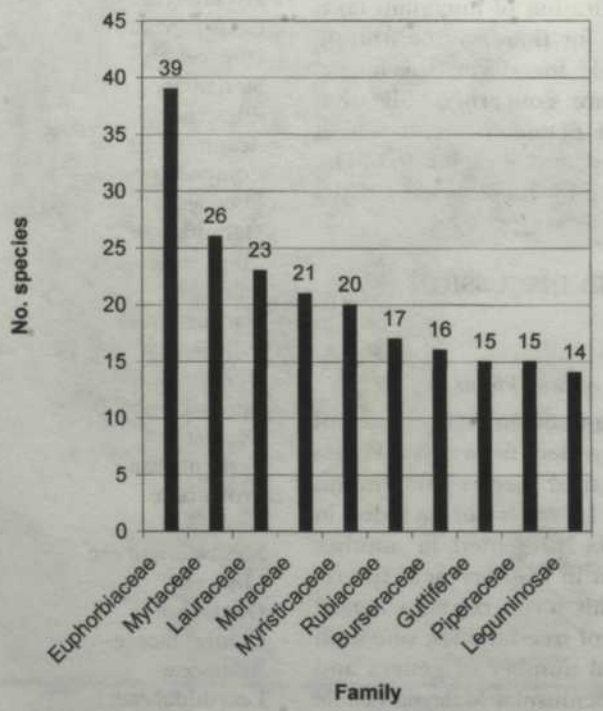

Fig. 2. Species diversity of 10 largest families in Ayer Hitam Forest, Selangor

Fig. 2 shows the species diversity of 10 largest families in Ayer Hitam Forest. So far, Euphorbiaceae was found to be the most diverse family with 39 species. Most Euphorbiaceae as well as other families such as Ulmaceae, Rubiaceae and Melastomataceae are commonly found in disturbed forest. *Gironiera parvifolia* (Ulmaceae) for instance was found to be the most frequent occuring species in a 1-ha plot at Ayer Hitam Forest (Faridah Hanum and Zamri Rosli 1999).

Eight species of monocots were recorded this far. Examples worth mentioning include *Schizostachyum latifolium*, a bamboo commonly seen at forest fringes and streams, and *Cyrtostachys renda*, a beautiful palm frequently occuring in swampy places. *Podocarpus teysmanii* was the only conifer collected from this forest.

Timber Trees

127 tree species that occur in Ayer Hitam Forest thus far, are classified as timber trees and this constitutes about 30% of the total number of tree species existing in this forest(Table 3). Of

TABLE 3
List of timber species in Ayer Hitam Forest, Selangor

Family	Species
Anacardiaceae	*Bouea oppositifolia*
	Buchanania sessifolia
	Campnosperma auriculatum
	Gluta elegans
	Melanochyla angustifolia
Annonaceae	*Alphonsea elliptica*
	Cyathocalyx pruniferus
	Goniothalamus malayanus
	Polyalthia rumphii
	Xylopia ferruginea
Bombacaceae	*Durio lowianus*
	Durio griffithii
Burseraceae	*Canarium apertum*
	Canarium littorale
	Canarium patentinervium
	Dacryodes laxa
	Santiria apiculata
	Santiria laevigata
	Santiria oblongifolia
Combretaceae	*Terminalia subspathulata*
Compositae	*Vernonia arborea*
Celastraceae	*Bhesa robusta*
	Kokoona ochracea
	Lophopetalum pachyphyllum
Crypteroniaceae	*Crypteronia griffithii*
Ctenolophonaceae	*Ctenolophon parvifolius*
Dipterocarpaceae	*Anisoptera costata*
	Anisoptera curtisii
	Dipterocarpus crinitus
	Dipterocarpus verrucosus
	Hopea beccariana
	Shorea bracteaolata
	Shrorea dasyphylla
	Shorea leprosula
	Shorea macroptera
	Shorea parvifolia
	Shorea platycarpa
	Vatica lobata
Elaeocarpaceae	*Elaeocarpus ferrugineus*
	Elaeocarpus robustus
Euphorbiaceae	*Antidesma cuspidatum*
	Aporusa aurea
	Aporusa confusa
	Aporusa stellifera
	Baccaurea macrophylla
	Blumeodendron tokbrai
	Drypetes pendula
	Elateriospermum tapos
	Endospermum diadenum
	Paracroton pendulus
	Sapium baccatum
	Sapium discolor
Fagaceae	*Lithocarpus cantleyanus*
	Lithocarpus gracilis
	Lithocarpus rassa
	Lithocarpus sundaicus
Flacourtiaceae	*Hydnocarpus filipes*
	Hydnocarpus kunstleri
Guttiferae	*Calophyllum ferrugineum*
	Calophyllum pulcherrimum
	Calophyllum rubiginosum
	Calophyllum macrocarpum
	Calophyllum wallichianum
	Garcinia cuspidata
	Mesua ferrea
	Mesua lepidota
Ixonanthaceae	*Ixonanthes icosandra*
Lauraceae	*Actinodaphne macrophylla*
	Actinodaphne pruinosa
	Actinodapne sphaerocarpa
	Litsea firma
	Litsea gracilipes
	Litsea grandis
Leguminosae	*Archidendron splendens*
	Callerya atropurpurea
	Sindora coriacea
Meliaceae	*Chisocheton patens*
	Dysoxylum cauliflorum
	Walsura pinnata
Moraceae	*Artocarpus dadah*

TABLE 3 (Continued)

	Artocarpus lowii
	Artocarpus maingayi
	Artocarpus scortechinii
Myristicaceae	*Horsfieldia fulva*
	Horsfieldia irya
	Horsfieldia sucosa
	Knema curtisii
	Knema furfuracea
	Knema intermedia
	Knema kunstleri
	Knema laurina
	Myristica iners
Myrtaceae	*Syzygium conglomeratum*
	Syzygium fastigiatum
	Syzgium filiforme
	Syzygium lineatum
	Syzygium papillosum
	Rhodamnia cinerea
Ochnaceae	*Brackenridgea hookeri*
Olacaceae	*Ochanostachys amentacea*
Podocarpaceae	*Podocarpus teysmanii*
Polygalaceae	*Xanthophyllum affine*
	Xanthophyllum amoenum
	Xanthophyllum eurhynchum
	Xanthophyllum griffithii
Rhizophoraceae	*Carallia brachiata*
	Pellacalyx saccardianus
Rosaceae	*Prunus arborea*
Rubiaceae	*Neolamarckia cadamba*
	Nauclea officinalis
	Porterandia anisophyllea
	Timonius wallichianus
	Urophyllum blumeanum
Rutaceae	*Acronychia pedunculata*
	Melicope glabra
Sapotaceae	*Palaquium rostratum*
	Palaquium stellatum
	Pouteria malaccensis
Sonneratiaceae	*Duabanga grandiflora*
Sterculiaceae	*Scaphium macropodum*
	Sterculia parviflora
Thymelaeaceae	*Gonystylus affinis*
	Gonystylus confusus
Ulmaceae	*Gironniera parvifolia*
	Gironniera subaequalis
	Gironniera nervosa
Verbenaceae	*Teijsmanniodendron coriaceum*

this percentage, approximately 3% are dipterocarps (Faridah Hanum and Zamri Rosli 1999). 12 species from the family Dipterocarpaceae are represented in 5 genera viz., *Anisoptera, Dipterocarpus, Hopea, Shorea* and *Vatica* constituting about half the total number of genera that are found in Peninsular Malaysia (Table 3). Their diversity could be due to remnants of extensive logging of once a lowland dipterocarp forest here in the past. The Dipterocarpaceae is the dominant family among upper canopy trees in this forest. Five dipterocarp species that most commonly occur in the swampy areas of this forest are *Shorea platycarpa, S. bracteolata, S. leprosula, S. parvifolia* and *Vatica lobata.* The remaining timber genera from the non-dipterocarp families that are diverse and worth mentioning include *Lithocarpus* (4 spp.), *Xanthophyllum* (4 spp.), *Artocarpus* (4 spp.), *Knema* (5 spp.), *Syzygium* (5 spp.) and *Calophyllum* (5 spp.).

Fruit Trees

An estimated 100 species of native fruit trees are found in the Malaysian forests (Soepadmo 1973). Composition of fruit trees in a primary forest is moderate in diversity and low abundance (Soepadmo 1979; Whitmore 1971). 29 species that are found in the wilderness of Ayer Hitam Forest are edible fruits as categorized by Jansen *et al.* (1991). Especially diverse are the wild species of tampoi (*Baccaurea*, 5 spp.) and terap (*Artocarpus*, 4 spp.). Other wild fruit species as shown in Table 4 would be of economic potential or for selection and breeding. Based on observations made by the author, 14 species (Table 5) are considered to have potential as edible fruits because they were seen eaten by birds and animals.

Ferns and Fern-allies

Ferns are usually considered to be plants of shady damp places. But with disturbance, species preferring more open places with lots of sunlight and less humid conditions have spread and become more common. Some species have stringent requirements and grow only when all these are met, but where they do, the species is often abundant (Piggott 1988).Only a small collection of fern and fern-allies were made from this forest, with a total of 33 species (Table 6). The most common occuring species in Ayer Hitam Forest is the terrestrial thicket sun-fern, *Dicranopteris linearis.* This could be due to Ayer Hitam Forest having many areas that have been disturbed at various degrees in the past. Known locally as resam, *Dicranopteris linearis* grows long fronds that cannot support themselves in erect

TABLE 4
Wild fruit species in Ayer Hitam Forest, Selangor

Family	Species
Anacardiaceae	*Bouea oppositifolia*
Bombacaceae	*Durio lowianus*
Burseraceae	*Canarium pilosum*
	Dacryodes rugosa
Euphorbiaceae	*Baccaurea brevipes*
	Baccaurea kunstleri
	Baccaurea parviflora
	Baccaurea motleyana
	Baccaurea racemosa
	Pimelodendron griffithianum
	Ptychopyxis caput-medusae
Gnetaceae	*Gnetum gnemon*
Guttiferae	*Garcinia atroviridis*
	Garcinia mangostana
Leguminosae	*Archidendron bubalinum*
	Parkia speciosa
Moraceae	*Artocarpus elasticus*
	Artocarpus integer
	Artocarpus lanceifolius
	Artocarpus nitidus
	Ficus variegata
Myrtaceae	*Rhodamnia cinerea*
Oxalidaceae	*Sarcotheca monophylla*
Passifloraceae	*Paropsia vareciformis*
Sapidaceae	*Nephelium ramboutan-ake*
	Xerospermum laevigatum
	Xerospermum noronhianum
Sterculiaceae	*Sterculia macrophylla*
Tiliaceae	*Grewia laevigata*

TABLE 5
Potential edible fruit species in Ayer Hitam Forest, Selangor

Species	Notes
Aidia densiflora	Ripe fruit red, eaten by birds
Champereia manillana	Fruit eaten by birds
Elaeocarpus petiolatus	Fruit eaten by animals
Elaeocarpus stipularis	Fruit eaten by birds
Endospermum diadenum	Fruit yellowish, eaten by birds
Ficus grossularioides	Fruit eaten by birds
Knema curtisii	Fruit eaten by animals
Lithocarpus gracilis	Fruit eaten by animals
Litsea grandis	Fruit eaten by animals
Mallotus paniculatus	Fruit eaten by birds
Monocarpia marginalis	Fruit eaton by animals
Polyalthia hypoleuca	Fruit eaten by animals
Porterandia anisophyllea	Fruit eaten by animals
Xanthophyllum affine	Fruit eaten by animals

position, thus forming a tangled thicket and thrives well in forest gaps and fringe. Another fern which is commonly found in open areas is the terrestrial solitary sun-fern, *Blechnum orientale*. *Cyathea latebrosa* is more specific in requirements and was observed to occur beside streams. Other species found in the Ayer Hitam Forest that require more specific requirements include *Mesophlebion chylamydophorum* and *Tectaria singaporeana* which were found in shady wet places of the forest, *Diplazium riparium* on banks of streams and swampy areas of the forest. A common epiphytic fern observed was *Asplenium nidus* or commonly known as bird's nest fern. Woodsiaceae (*Diplazium*, 4 spp.). is the most diverse fern family present in this forest.

Medicinal Plants

Well over 1000 species in Malaysia have been claimed to have uses or used by the multiethnic groups of Malaysia for generations (Latiff *et al.* 1980). About one-teenth of these species are recorded from Ayer Hitam Forest. A total of 98 species in 83 genera and 53 families are found in this forest. 140 different uses were recorded from informants and grouped into 7 methods of application i.e. drink, eat, chew rub, poultice, bath and shampoo. Examples of medicinal plant species that are both used by the forest dwelling indigenous community, the Temuans and fringing Malay community of Ayer Hitam Forest are shown in Table 7. Details on the composition and uses of medicinal plants in the Ayer Hitam Forest were discussed at length in a companion paper (Faridah Hanum and Nurulhuda Hamzah 1999).

Other Plants of Ethnobotanical Interests

Besides timber, medicinal and fruit species diversity that are found in the Ayer Hitam Forest, there are a number of ethnobotanically useful species enumerated here. Secondary products such as resin from *Dipterocarpus crinitus* are still tapped by the Temuans to be sold, while leaves of *Licuala spinosa* (palas) are rather commonly sold in the market as a local cake wrapper. There are also beautiful flowering trees, young flushes or desirable architecture such as *Pometia pinnata*, *Mesua ferrea* and *Callerya atropurpurea* from this forest that are ornamental.The rattans (*Calamus manan*) are still collected by the Temuans for a substantial income together with *Parkia speciosa* (petai).

TABLE 6
Fern and fern-allies in Ayer Hitam Forest, Selangor

Adiantaceae	Polypodiaceae
Cheilanthes tenuifolia	*Platycerium coronarium*
Taenitis blechnoides	*Pyrrosia nummulariifolia*
Aspleniaceae	*P. piloselloides*
Asplenium nidus	Schizaeaceae
Blechnaceae	*Lygodium circinnatum*
Blechnum orientale	*L. flexuosum*
Cyatheaceae	*L. longifolium*
Cyathea latebrosa	*L. microphyllum*
C. moluccana	*Schizaea dichotoma*
Dryopteridaceae	*S. digitata*
Tectaria singaporeana	Selaginellaceae*
T. crenata	*Selaginella ascenden*
Gleicheniaceae	*S. ciliaris*
Dicranopteris linearis	*S. intermedia*
Lycopodiaceae*	*S. stipulata*
Lycopodium cernuum	*S. willdenowii*
Oleandraceae	*S. wallichii*
Nephrolepis auriculata	Thelypteridaceae
Ophioglossaceae	*Mesophlebion chylamydophorum*
Helmintostachys zeylanica	Woodsiaceae
Ophioglossum pendulum	*Diplazium riparium*
	D. tomentosum
	D. crenatoserratum
	D. allantoideum

* *Fern–allies*

TABLE 7
Some medicinal plants and uses at Ayer Hitam Forest, Selangor

Scientific names	Local names	Uses and parts used
Goniothalamus macrophyllus	Gajah beranak	Decoction of root to eliminate excessive gas in body
Homalomena sagittifolia	Keladi kemoyang	Decoction of root and leaves for fever
Elephantopus scaber	Tapak Sulaiman	Leaf and root decoction as supplement after childbirth, tonic, deworming, venereal disease and cough
Tetracera indica	Mempelas	Root decoction to treat high blood pressure and high fever
Donax grandis	Bemban	Poultice of leaf or stem for eye refreshment
Vitex pinnata	Halban	Decoction of bark and leaf for stomach-ache and given after childbirth
Costus speciosus	Setawar hutan	Decoction of roots to reduce high body temperature, decoction of rhizome as tonic

CONSERVATION VALUE

Plant and animal species require a certain range or size of population in order to persist. This means if the area of the Ayer Hitam Forest is further excised, there will be a failure in their breeding systems such as pollination mechanisms or food will not be substantial enough to support certain populations of animals. Certain populations of species will thus not only be vulnerable, but also threatened. There will not only be habitat loss, but also inevitable species loss. The remaining four tigers in the forest will probably be threatening the safety of users of Ayer Hitam if the forest size is reduced, more critically diminished with time. A whole cycle of growth, maturity and decomposition is necessary to provide a sustainable and ecologically biodiverse habitats within the Ayer Hitam Forest for the animals to live in. Unlike human that can be expected to be temporarily squattered, the diverse animals of this forest will cease to exist. Especially of scientific interest are the endemics, which are species that grow in a specific area and have a restricted distribution. There are 746 endemic tree species in Peninsular Malaysia (Ng *et al.* 1990). To date Ayer Hitam Forest houses 20 endemic plant species. Of these endemics, one species is with the status uncommon (*Ptychopyxis caput-medusae*) while five species are new records for Selangor (Table 8). Forest fragmentation has severe implications on the survival of these endemic species. Endemics may exist due to natural extinction thoughout much of their range (termed paleo-endemics or relicts) or due to actively evolving groups giving rise to localized distinct species (termed neo-endemics). Thus, conservation considerations should also include conserving as much evolutionary functions that give rise to these endemics, besides conserving particular sites of inferred rich biodiversity such as the Ayer Hitam Forest. There is no better way than protecting a habitat or ecosytem where all natural requirements are met if plants and animals in the Ayer Hitam Forest are to be protected.

As with the case of Ayer Hitam Forest, it is the only sanctuary for migratory birds and tigers in the Klang Valley. It is also one of the only two natural green lungs left in the Klang Valley for now and the generations to come. More importantly, there are still indigenous people of the Temuan Tribe dwelling this forest and relying on forest resources to support their life. Being strategically located in the midst of development in the Klang Valley, it is just fair that the public also enjoys this place, with a limited carrying capacity – for educating the public about forest, its environment and why we need to conserve it. This way, UPM not only enjoys this forest as an important support facility for education, research and extension but more importantly, the public gets a share of both the tangible and non-tangible benefits of what this forest has to offer.

It takes to know what this remaining fragmented forest contains in order to develop a sound management and conservation plan for the very near future. It is thus encouraged that other research efforts in related disciplines in UPM or other institutions be concentrated at the Ayer Hitam Forest to call for more information on the biodiversity it houses, be it at the species, genetic or ecosystem level. A policy

TABLE 8
Peninsular Malaysia endemics in Ayer Hitam Forest, Selangor

Species	Status
Actinodaphne pruinosa	Common*
Actinodaphne sphaerocarpa	New record for Selangor
Anisophyllea griffithii	Common
Calophyllum ferrugineum	Common
Calophyllum pulcherrimum	New record for Selangor
Cyathocalyx pruniferus	Common
Diospyros foxworthyi	New record for Selangor
Eleocarpus ferrugineus	Common
Gardenia costata	New record for Selangor
Gardenia griffithii	Common
Hydnocarpus filipes	Common
Mallotus kingii	New record for Selangor
Memecylon cinereum	Common
Palaquium maingayi	Common
Pellacalyx saccardianus	Common
Ptychopyxis caput-medusae	Uncommon**
Sarcotheca monophylla	Common
Syzygium conglomeratum	Common
Thottea dependens	Common
Vatica lobata	Common

* *Common* – more than 10 collections
** *Uncommon* – (6-10) collections

should also be formulated by UPM to designate the permanence of Ayer Hitam Forest as a research and education forest in the near future, so that it does not have to be mismanaged by the future decision makers. The author would like to suggest to the relevant authority in UPM to pipe out some development fund in demarcating the forest boundary by fencing, and enforcing the UPM security in preventing encroachment especially at the northern end of the forest. These suggestions are especially crucial to prevent unauthorized exploitation of the forest resources, especially medicinal plants and unlawful cutting if we are to conserve the Ayer Hitam Forest in entirety and for the coming generations. A certain hectarage of this forest should also be formally designated as Permanent Ecological Plot for long-term studies.

CONCLUSION

Although the database is still in its infancy, the diversity captured this far, certainly is reputable for a fragmented ecosystem like the Ayer Hitam Forest. With work still progressing in Ayer Hitam Forest, a greater plant diversity information is expected. The database on the plants of Ayer Hitam will be updated with the completion of a 10-ha permanent plot in the near future.

Each ecosystem is idiosyncratic and has a continuum of ecological complexity, thus requires a specific study. Species rarely occur in isolation in nature, so understanding the interactions between species is equally important as understanding the interactions within species for survival. A more vigorous research programme to be considered for this forest that the author thinks relevant would include the effects of fragmentation on species interaction and community structure, ecosystem processes, single species (especially rare and endangered species), population dispersal and genetics and traits of rare species; employment of ecologically significant species for management and monitoring (eg. indicator species, keystone species) of the forest ecosystem, population genetics in relation to inbreeding depression, fitness, heterozygosity and bottlenecks, reproductive biology, population ecology and viability, and ethnobiology.

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The Use of Medicinal Plant Species by the Temuan Tribe of Ayer Hitam Forest, Selangor, Peninsular Malaysia

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Keywords: Medicinal plant species, uses, plant parts, method of application, Temuan tribe, Ayer Hitam Forest

ABSTRAK

Hasil awal kajian ke atas kegunaan spesies tumbuhan ubatan oleh masyarakat Temuan di Ayer Hitam dipersembahkan. Walaupun hutan ini dikelilingi oleh kegiatan pembangunan sosio-ekonomi yang pesat, ia merupakan gedung ubat yang agak mencukupi untuk masyarakat Temuan ini. 98 spesies tumbuhan yang mempunyai nilai perubatan serta 140 kegunaan telah direkodkan. Kegunaan telah dikumpulkan dalam tujuh cara penggunaan iaitu minum, makan, kunyah, tampal, sapu, mandi dan syampu.

ABSTRACT

Preliminary results of a study on the use of medicinal plant species by the indigenous people from the Temuan tribe at Ayer Hitam Forest are presented. Although this forest is surrounded by rapid socio-economic development, it is ironically a substantial pharmacopoeia for the Temuans. A total of 98 plant species with 140 different uses were recorded and they were grouped into seven methods of application namely drink, eat, chew, poultice, rub, bath and shampoo.

INTRODUCTION

Plants have been used for many thousands of years to treat human disorders and pains. To the aborigines, plants which are found in their surroundings are not only important sources of food and materials for shelter but also valuable sources of medicines. In many developing countries of the world, pharmacognosy owes its development to a certain extent to the aborigines and native medicine men, who through history have used the therapeutic qualities of herbs with special skills (Gimlett 1939). It has been indicated that of the 7000 species of angiosperms and 600 species of ferns in Malaysia, about 1150 species are reported to have medicinal properties (Latiff 1985). While many species are more popularly known and used than others, many species form the minor ingredients of a decoction or components of a wider curative concept.

SITE DESCRIPTION AND METHODS

This study was conducted in Compartments 12, 14 and 15 of the Ayer Hitam Forest, Selangor, Peninsular Malaysia. The details of the site have been presented in a companion paper (Faridah Hanum 1999). This forest is inhabited by about 150 aborigines or "orang asli" from the Temuan tribe who still rely on the forest resources for their living.

Data were gathered following a method modified from Martin (1995). In this study, four permanent 1-ha plots (100m x 100m) that have been established for other studies in the forest were used. The informants were two elderly medicine men from the Temuan tribe and they were walked into the plots and asked to identify all plant species that were used as medicines in their community. Information on the plant parts used, uses and method of use were recorded only when there was mutual agreement between the two medicine men. Discussion on the administration and method of application of the medicinal plant species was conducted in the Malay language, which is fairly understood by both parties. When a misunderstanding of terms cropped up, another Temuan who worked in

the Universiti Putra Malaysia and well-versed in both the Malay and Temuan languages clarified. The data collected were supported by herbarium voucher specimens which are deposited at the Herbarium, Faculty of Forestry, Universiti Putra Malaysia. Turner (1995) was used as the main reference with regards to the name of plants in this study.

RESULTS AND DISCUSSION

The total number of medicinal plant species collected during this study was 98, representing 83 genera and 53 families (Table 1). Among the plant families present, Zingiberaceae, Euphorbiaceae, Lauraceae, Leguminosae, Melastomataceae and Piperaceae comprise many species with purpoted medicinal values from this

TABLE 1
Enumeration of medicinal plant taxa in 4- ha plot at Ayer Hitam Forest, Selangor

Family	Species	Vernacular names
Acanthaceae	*Asystasia gangetica* (L.) T.Anderson	Ara songsang
	Justicia gendarussa Burm. f.	Gandarusa
Adiantaceae	*Taenitis blechnoides* (Willd.) Sw.	Paku balu
	Cheilanthes tenuifolia (Burm.f.) Sw.	Telur belangkas
Anisophylleaceae	*Anisophyllea disticha* (Jack)Baill.	Kalis utan
Annonaceae	*Goniothalamus macrophyllus* (Blume)Hook.f. and Thomson	Gajah beranak
Apocynaceae	*Alstonia angustifolia* Wall.	Pulai
	Catharanthus roseus (L.) G. Don	Kemunting cina
Araceae	*Homalomena sagittifolia* Jungh. ex Schott.	Keladi kemoyang
Aristolochiaceae	*Thottea dependens* (Planch.) Klotzsch	Telinga beruang
Asclepiadiaceae	*Toxocarpus griffithii* Decne.	Melati hutan
Aspleniaceae	*Asplenium nidus* L.	Daun semum
Blechnaceae	*Blechnum orientale* L.	Paku ikan
Compositae	*Blumea balsamifera* (L.) D.C	Sembung
	Elephantopus scaber L.	Tapak sulaiman
	Eupatorium odoratum L.	Busuk-busuk
Costaceae	*Costus speciosus* (J. Konig)Sm.	Setawar hutan
Cyperaceae	*Mapania cuspidata* (Miq.) Uittien	Pandan tikus
	Kyllinga brevifolia Rottb.	Rumput teki
Dillenniaceae	*Dillenia suffruticosa* (Griff.) Martelli	Setawan
	Tetracera indica (Christm. & Panz.) Merr.	Mempelas
Dioscoreaceae	*Dioscorea glabra* Roxb.	Ubi torak
	Dioscorea hispida Dennst.	Ubi gadong
Dryopteridaceae	*Tectaria crenata* Cav.	Paku kikir
Elaeocarpaceae	*Elaeocarpus stipularis* Blume.	Mendong
Euphorbiaceae	*Acalypha indica* L.	Galak kucing
	Mallotus leucodermis Hook. f.	Balik angin bopeng
	Mallotus paniculatus (Lam.) Mull. Arg.	Balit gajah
	Phyllanthus amarus Schumach. & Thonn.	Dukung anak
Flacourtiaceae	*Hydnocarpus kunstleri* (King) Warb.	Setumpul
Gleicheniaceae	*Dicranopteris linearis* (Burm. f.) Underw.	Resam
Gnetaceae	*Gnetum gnemon* L.	Melintajau /melinjau
Gramineae	*Lophantherum gracile* Brongn.	Rumput kelulut
	Themeda arguens (L.) Hack.	Misai adam
Guttiferae	*Mesua ferrea* L.	Penaga lilin
Hypoxidaceae	*Molineria latifolia* (Dryand.)Herb. ex Kurz	Lemba
Ixonanthaceae	*Ixonanthes icosandra* Jack	Pagar anak
Lauraceae	*Cinnamomum iners* Reinw.	Kayu manis hutan
	Alseodaphne intermedia Kosterm.	Keledang utan
	Litsea grandis (Wall. ex Nees)Hook.f.	Medang daun lebar
	Cinnamomum porrectum (Roxb.) Kosterm.	Kayu manis
Lecythidaceae	*Barringtonia racemosa* (L.) Spreng.	Putat kedul
Leguminosae	*Mimosa pudica* L.	Semalu

TABLE 1 (Continued)

	Adenanthera malayana Kosterm.	Saga
	Derris microphylla (Miq.)B.D. Jacks	Tuba
	Flemingia macrophylla (Willd.) Merr.	Seringin
Lycopodiaceae	*Lycopodium cernuum* L.	Kenarus
Marantaceae	*Donax grandis* (Miq.) Ridl.	Bemban
Melastomataceae	*Oxyspora bullata* (Griff.) J.F. Maxwell	Senduduk gajah
	Dissochaeta gracilis (Jack)Blume	Akar senduduk
	Melastoma malabathricum L.	Senduduk
	Phyllagathis griffithii (Hook. f. ex Triana) King	Tutup bumi hutan
Menispermaceae	*Coscinium fenestratum* (Gaertn.) Colebr.	Akar mengkunyit
	Tinospora macrocarpa Diels	Seruntum
Moraceae	*Ficus lepicarpa* Blume	Ara kayan
	Ficus grossularioides Burm. f.	Ara derek
	Ficus aurantiacea Griff.	Akar tengkuk biawak
Myrsinaceae	*Labisia pumila* (Blume) Fern.-Vill.	Kacip Fatimah
Ophioglossaceae	*Helminthostachys zeylanica* (L.) Hook.	Tunjuk langit/ Jelai
	Ophioglossum pendulum L.	Langsiur
Orchidaceae	*Plocoglotthis lowii* Rchb.f.	Sepulih
Palmae	*Iguanura wallichiana* (Wall. ex Martelli) Hook.f.	Palas tikus
Piperaceae	*Piper betle* L.	Sirih
	Piper caninum Blume	Sirih hutan
	Piper lanatum Roxb.	Kaduk
	Piper umbellatum L.	Sirih
	Peperomia pellucida (L.) Kunth	Ketumpang air
Polypodiaceae	*Pyrrosia piloselloides* (L.) M.G. Price	Sakat ribu-ribu
	Platycerium coronarium D. Koenig ex O.F. Mull.	Pakis tanduk rusa
	Pyrrosia nummularifolia (Sw.) Ching	Berunas jantan
Rubiaceae	*Ixora concinna* Hook. f.	Siantan hutan
	Pavetta wallichiana Streud.	Jejarum
	Psychotria sarmentosa Blume	Salang-salang
Schizaeaceae	*Lygodium microphyllum* (Cav.) R. Br.	Duit-duit
	Lygodium circinnatum (Burm. f.)Sw.	Ribu-ribu duduk
	Schizaea dichotoma (L.) J.Sm	Paku tombak
Scrophulariaceae	*Scoparia dulcis* L.	Rempah padang
Selaginellaceae	*Selaginella ciliaris* (Retz.)Spring	Semerak-merak
	Selaginella willdenowii (Desv.) Baker	Paku merak
Simaroubaceae	*Eurycoma longifolia* Jack	Tongkat Ali
Solanaceae	*Physalis minima* L.	Pokok leletup
Sterculiaceae	*Scaphium macropodum* (Miq.) Beumee ex Heyne	Kembang semangkuk sejantung
Taccaceae	*Tacca leontopetaloides* (L.) Kuntze	Janggut adam
Thymelaeaceae	*Aquilaria malaccensis* Lamk.	Gaharu/ karas
	Gonystylus affinis Radlk.	Ramin dara elok
Ulmaceae	*Gironniera nervosa* Planch.	Hampas tebu
Verbenaceae	*Vitex pinnata* L.	Halban
	Vitex trifolia L.	Lemuni hitam
Vitaceae	*Pterisanthes* sp.	Akar kalis
Woodsiaceae	*Diplazium allantoideum* M.G. Price	Paku kijang
Zingiberaceae	*Alpinia conchigera* Griff.	Lengkuas kecil/padi
	Curcuma aeruginosa Roxb.	Temu hitam
	Curcuma zedoaria (Christm.) Roscoe	Temu kuning
	Etlingera elatior (Jack) R.M. Sm.	Kantan
	Zingiber griffithii Baker	Tepus kecil/huma
	Zingiber puberulum Ridl.	Tepus
	Zingiber officinale Roscoe	Halia bara
	Zingiber spectabile Griff.	Tepus tanah/ Langkinang

forest (Table 1). There are 140 different uses recorded from the medicinal plants listed and grouped into seven methods of application viz., drink, eat, chew, rub, poultice, bath and shampoo (Table 2). Majority of the medicinal plant species were decoctions of different plant parts mainly taken as a drink. The rest of the medicinal plant parts were either used as a rub, bath or poultice. To a small extent, some plant parts were chewed such as the stem of *Costus speciosus* with betel nut to relieve coughs, and sometimes eaten raw such as the ripe fruits of *Gnetum gnemon* for a laxative. A medicinal plant species may be multipurpose in use such as the leaves of *Asystasia gangetica* which can be used as a bath, poultice or rub for different treatment of diseases. The same plant parts when prepared in different ways will also treat different health problems as shown by *Alpinia conchigera* (Table 2). Ocassionally, there is a mixture of plant parts from different species for the treatment of certain diseases. An example includes decocting together leaves of *Piper caninum* with roots of *Labisia pumila* for the relief of throat ache.

When compared with some relevant ethnobotanical literatures mainly of Burkill

TABLE 2
Temuan administration and application of medicinal plant species

Scientific names	Uses and parts used	Method of application
Acalypha indica	Root and leaf decoction for skin complaints, ulcer, constipation and brochitis; whole plant decoction for stomach cleansing and aphrodisiac	Drink
Adenanthera malayana	Leaf and bark decoction as antiseptic	Rub
Alpinia conchigera	Root decoction to clean hair from fleas	Shampoo
	Prounded leaves to treat boils and swelling on stomach after childbirth.	Poultice
	Pounded rhizome for pain inside bone	Rub
	Powdered rhizomes with water for stomach ache	Poultice
Alseodaphne intermedia	Juice from leaves to prevent insect bites	Rub
	Pounded bark with water to protect from shingles	Drink
Alstonia angustifolia	Pounded leaves applied on head to treat high fever	Poultice
Anisophyllea disticha	Leaves pounded to treat pain inside bones	Rub
Aquilaria malaccensis	Bark and root decoction as tonic preparation during pregnancy, after chidbirth and various other diseases of women	Drink
Asystasia gangetica	Juice from leaves for eye treatment	Bath
	Leaves chewed raw and applied externally to wound	Poultice
	Leaves mixed with 'paku merah' to relieve pain inside bone	Rub
Barringtonia racemosa	Leaves of roots and bark for itch and chicken pox	Rub
Blechnum orientale	Pounded roots and leaves to treat skin complaints	Rub
	Decoction of plant for dropsy	Drink
Blumea balsamifera	Leaf decoction for cough and distended stomach, high blood and insomia	Drink
	As lotion after childbirth to whole body and on head for headache	Rub

TABLE 2 (Continued)

Catharanthus roseus	Decoction of stem, leaves and root to treat diabetes, insect bites, period pains and high blood pressure	Drink
Cheilanthes tenuifolia	Decoction of leaves and stems for healthy hair	Drink
Cinnamomun iners	Juice of leaf for food poisoning and root decoction given after childbirth	Drink
	Poultice of leaves squeezed into wound, pounded leaves for rheumatism	Poultice
Cinnamomun porrectum	Juice of leaf for food poisoning and root decoction given after childbirth and given to girls attaining maturity	Drink
Coscinium fenestratum	Stem and root decoction as aphrodisiac and given after chilbirth	Drink
	Ash of roots or stems to treat nose ulcer	Rub
Costus speciosus	Root decoction given after chilbirth and high fever	Drink
	Scrape of stem applied to leprous skin	Poultice
	Pounded stems rubbed for skin complaints	Rub
	Stem eaten with betel nut to treat cough.	Chew
	Decoction of leaves to treat stomach ache and stomach ulcers in children	Drink
	Decoction of rhizome as tonic	Drink
Curcuma aeruginosa	Rhizome decoction for treatment after childbirth	Bath
Curcuma zedoaria	Rhizome as universal tonic to regain strength for women and constipation	Drink
	Pounded rhizomes for wound	Poultice
	Pounded rhizomes as medicine for after childbirth	Eat
Derris microphylla	Decoction of pounded leaves for skin complaints	Rub
Dillenia suffruticosa	Pounded leaves for rheumatism	Poultice
Dicranopteris linearis	Juice of leaves to treat high fever	Bath
Dioscorea glabra	Pounded leaves to cure sores	Poultice
Dioscorea hispida	Leaves pounded for sores of yaw	Rub
Diplazium allantoideum	Pounded leaves rubbed at armpits to prevent body odour	Rub
Dissocheata gracilis	Leaves decoction as an antidote for "Ipoh" poison	Drink
Donax grandis	Decoction of leaves and roots for cooling body during fever	Bath
	Juice of stems applied for snake bites	Rub
	Poulice of leaf or stem for eye refreshment	Poultice
Elaeocarpus stipularis	Pulped leaves to cure sores	Poultice
Elephantopus scaber	Leaf and root decoction as supplement after childbirth, tonic, deworming, veneral disease and cough	Drink
	Pounded leaves for distended stomach and wound	Poultice
Etlingera elatior	Rhizome mixed with *Piper betle* to eliminate excessive gas after childbirth	Chew

TABLE 2 (Continued)

Eupatorium odoratum	Leaves pounded for wound and stop bleeding	Poultice
Eurycoma longifolia	Decoction of roots as aphrodisiac for men and used as tonic	Drink
Ficus aurantiacea	Root decoction as aphrodisiac	Drink
	Leaves pounded for tootache	Rub
Ficus grossularioides	Crushed bark to treat ring worms and shingles	Poultice
Ficus lepicarpa	Pounded leaves to treat ring worms	Rub
Flemingia macrophylla	Pounded leaves for stomach ache	Rub
Gironniera nervosa	Root decoction to prevent skin diseases	Bath
Gnetum gnemon	Ripe fruits for stomach cleansing and prevent constipation	Eat
Goniothalamus macrophyllus	Decoction of root to eliminate excessive gas in body	Drink
	Decoction used as lotion to treat body pains and rheumatism	Rub
	Pounded leaves and bark for skin complaints	Bath
Gonystylus affinis	Oil from wood to treat asthma	Rub
Helminthostachys zeylanica	Decoction of leaves as tonic after childbirth	Drink
	Rhizome mixed with *Piper betle* for cough and venereal diseases	Eat
Homalomena sagittifolia	Decoction of root and leaves for fever	Drink
	Pounded roots applied on distended stomach	Poultice
Hydnocarpus kunstleri	Decoction of bark for internal disorders and skin disease	Drink
Iguanura wallichiana	Roots and leaves for birth control for woman	Eat
Ixonanthes icosandra	Decoction of root for whooping cough	Drink
	Juice of leaves rubbed for chest pains	Rub
Ixora concinna	Flowers decoction to treat dysentry and stimulate gastric secretions	Drink
Justicia gendarusa	Leaves pounded with lemon for deworming and stomach ache	Poultice
	Pounded roots for mouth during fits	Rub
Kyllinga brevifolia	Pounded roots applied externally for skin complaints	Poultice
Labisia pumila	Roots decoction to treat haemorrhoids and rheumatism. Roots mixed with decoction of other herbs given after childbirth.	Drink
Litsea grandis	Bark decoction as tonic to treat pain inside sores and headache	Drink
	Leaf poultice to treat insect bites and snake bites	Poultice

TABLE 2 (Continued)

Lophantherum gracile	Decoction of root for childbirth treatment, mixed with tea as carminative and stomach ache treatment	Drink
	Roots decoction to treat swelling on body	Rub
Lycopodium cernuum	Decoction of plants for cough and asthma	Drink
Lygodium microphyllum	Leaf decoction to treat fever and high temperature	Bath
	Leaves chewed to prevent fits	Chew
Lygodium circinnatum	Exudate from rhizome as insect repellent and to treat aquatic animal bites and snake bites	Rub
Mallotus leucodermis	Decoction of roots to treat skin complaints	Bath
Mallotus paniculatus	Decoction of roots to treat after childbirth	Bath
Mapania cuspidata	Root decoction for treatment after childbirth and leaves to treat diarrhoea	Drink
Melastoma malabathricum	Decoction with other plants given after childbirth, pounded leaves for tooth ache and eliminate excessive gas inside body. For leukorea, mix with sugar and ginger	Drink
	Fruits pounded to treat small wound	Poultice
	Pounded roots and leaves for skin complaints	Rub
Mesua ferrea	Decoction of seed oil, root and flowers taken after childbirth	Drink
	Decoction of dried flowers for external skin complaints	Rub
Mimosa pudica	Root decoction as tonic	Drink
	Pounded leaves for swelling on body	Poultice
Molineria latifolia	Decoction of rhizome with *Areca* for menorrhagia	Drink
Ophioglossum pendulum	Juice of leaves to cleanse and treat hair	Shampoo
Oxyspora bullata	Roots and leaves decoction given after childbirth	Drink
Pavetta wallichiana	Flowers decoction to prevent from cough, roots decoction given after childbirth	Drink
	Lotion from bark to treat nose ulcers	Rub
Peperomia pellucida	Decoction of plants to treat rheumatism	Drink
Phyllanthus amarus	Decoction of plant for diarrhoea, high blood pressure	Drink
	Decoction of plant with goat milk for diabetes	Drink
	Decoction of plants for cleansing wound and skin complaints	Rub
Phyllagathis griffithii	Decoction of root mixed with other plants given after childbirth and to treat irregular menses	Drink
Physalis minima	Decoction of plants to treat high fever	Drink
	Ripe fruits to avoid stomach ulcer and stomach ache	Eat
Piper betle	Leaves to cure disease of mucous membrance of the mouth	Chew

TABLE 2 (Continued)

Piper caninum	Decoction with *Labisia pumila* (Kacip Fatimah) roots to cure throat-ache	Drink
Piper lanatum	Decoction of plants for malaria, toothache, rheumatism, deworming, fever and influenza	Drink
	Eaten raw to cure stomach ulcer	Eat
Piper umbellatum	Decoction of plant to prevent malaria, treat cough, influenza, kidney ache, rheumatism and tooth ache	Drink
Plocoglottis lowii	Juice of pounded leaves to treat skin complaint	Rub
Psychotria sarmentosa	Roots and leaves decoction given after childbirth	Drink
	Decoction of plants to cure fever	Bath
Pterisanthes sp.	Pounded roots rubbed for relieving swellings	Rub
Pyrrosia piloselloides	Decoction of plant to treat cough, diarrhoea and gonorhoea	Drink
	Decoction of plants to treat shingles and ring worms	Bath
Pyrrosia nummularifolia	Decoction from leaves to cure cough and fits	Drink
Scaphium macropodum	Decoction of plants to treat high fever, and cooling down for refreshing body	Drink
	Ripe fruits to treat high body temperature	Eat
Schizaea dichotoma	Decoction of roots to treat cough and throat ache	Drink
Scoparia dulcis	Decoction of plant to eliminate excessive gas in the body after childbirth	Drink
Selaginella ciliaris	Lotion from leaves for skin complaints	Rub
Selaginella wildenowii	Decoction of leaves to cleanse wound	Bath
Tacca leontopetaloides	Decoction of roots with "selayar hitam" for good kidney function	Drink
	Decoction of roots to eliminatate excessive gas after childbirth	Drink
Taenitis blechnoides	Decoction of plant to treat ring worm and shingles	Drink
Tectaria crenata	Decoction of plants to treat venereal disease like gonorrhoea	Drink
Tetracera indica	Root decoction to treat high blood pressure and high fever	Drink
	Leaves and roots pounded together for skin itch	Poultice
Themeda arguens	Decoction of root as aphrodisiac, blood cleansing and body refreshing	Drink
	Plant poultice to treat lumbago	Poultice
Thottea dependens	Leaves pounded for skin complaints; rubbed behind ear for fever	Rub
Tinospora macrocarpa	Decoction of leaves for vermifuge and cholera	Drink
	Juice of leaves to treat wound	Rub
	Decoction of rhizome to eliminate excessive gas after childbirth	Drink

TABLE 2 (Continued)

Toxocarpus griffithii	Fruits eaten raw for general well-being	Eat
Vitex pinnata	Decoction of bark and leaf for stomach-ache and given after childbirth	Drink
	Bark and leaves pounded with other plants to treat fever and wounds	Poultice
Vitex trifolia	Decoction of stem as diurretic, roots decoction to reduce high fever and after childbirth	Drink
Zingiber aromatica	Decoction for cough and one of ingredients for traditional tonic	Drink
Zingiber cassumunar	Decoction of leaves with black pepper for stomach ache	Drink
Zingiber griffithii	Decoction of root to eliminate excessive gas in the body	Bath
	Pounded flowers to avoid fainting	Rub
	Lotion from leaves to treat rheumatism	Rub
Zingiber officinale	Pounded plants to treat toothache	Poultice
	Rhizome pound with flowers of *Ixora* sp. to treat stomach-ache, rheumatism and headache	Eat
Zingiber puberulum	Decoction of leaf to treat fever	Drink
Zingiber spectabile	Juice from leaves to treat eye-ache and swelling	Bath

(1966), a substantial amount of overlap in the use of medicinal plant species by the Temuans with other people elsewhere occurs, suggesting that these species are indeed effective in the treatment of certain diseases. Thus, these species should be taken as clues for the development of new drugs. Medicinal plant resources can be used directly as pharmaceuticals (plant extracts and products), serve as templates for chemical synthesis of related medicinal compounds and used as investigative or evaluative tools in the drug development and testing process of chemical compounds.

CONCLUSION

The Temuans have not lost their traditional knowledge in the use of medicinal plants as a panacea for various health problems and diseases despite their exposure to the socio-economic transformation and improved communications surrounding the forest. It is however feared that when the Temuan elderlys have gone and development further seeps into this forest, both knowledge and medicinal plant resources will also perish. It is not unlikely that knowledge and resources will remain with habitat loss or conversion for other land uses.

The conservation of the medicinal plant species in this forest can be done in two ways: conservation in natural areas and cultivation. In the former, which is more desirable as plant species grow naturally and cheaper in management, there is a risk of encroachment. Encroachment in the Ayer Hitam Forest is rather rampant especially in the northern part. Being the only larger forest left in the midst of development in the Klang Valley (the other being Bukit Nenas Forest Reserve), it is inevitable that species of economic value especially those with medicinal properties will be over-exploited by local vendors. So as to safeguard the medicinal plant resources of this forest,the author would like to suggest an arboretum i.e. an area devoted to the cultivation of a wide selection of woody plants (trees, shrubs, vines,etc.) to be set up as a back-up. Although the main objective of an arboretum is not for the conservation of medicinal plants, allocations

can be given for this noble purpose in the fenced part of the forest. An arboretum can simultaneously be maintained as both centres of research, education and recreational areas.

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Bird Species Composition in Ayer Hitam Forest, Puchong, Selangor

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Keywords: Bird species composition, Mist-netting, Distance Sampling-Point Count, trophic structures, primary forest, logged forest

ABSTRAK

Kajian ini tertumpu pada komposisi spesies burung di Hutan Ayer Hitam, Puchong, Selangor. Hutan ini ialah hutan sekunder tanah pamah yang terasing dan telah dibalak antara tahun 1936 hingga 1954. Dua kaedah telah digunakan untuk menyiasat komposisi burung di kawasan ini iaitu Penjaringan Kabut dan Pensampelan Jarak Jauh-Pengiraan Titik. Keputusan menunjukkan bahawa sejumlah 38 famili yang merangkumi 160 spesies burung telah direkodkan. Tiga famili yang paling besar yang mewakili 23.5 peratus daripada keseluruhan spesies ialah Timaliidae, Cuculidae dan Pycnonotidae. Bilangan individu yang paling kerap direkodkan tergolong dalam famili Pycnonotidae. Hutan ini dikuasai oleh kumpulan insektivor/frugivor di mana kebanyakannya diwakili oleh spesies sekunder jajah. Sesetengah spesies enggang (contoh Buceros rhinoceros) dan burung rimba (contoh Pomatorhinus montanus) yang kebiasaannya dijumpai di hutan primer tidak hadir. Keputusan ini juga mencadangkan bahawa komposisi famili dan struktur trophik burung di Hutan Ayer Hitam adalah sebanding dengan mereka yang berada di kawasan hutan simpan yang lain. Walau bagaimanapun, ketidakhadiran banyak spesies hutan primer mencadangkan bahawa hutan ini masih di dalam proses pemulihan. Adalah direkomenkan supaya sebahagian besar hutan ini dibiarkan tanpa sebarang gangguan untuk menghalang habitat hidupan liar yang semakin sedikit ini daripada terus dimusnahkan dan untuk membenarkan komposisi spesies hidupan liar kembali kepada keadaan asal.

ABSTRACT

This study focused on the avian species composition in Ayer Hitam Forest, Puchong, Selangor. The forest is an isolated secondary lowland forest and was logged between 1936 to 1954. Two methods were used to examine the composition of birds in the area namely by Mist-netting and Distance Sampling-Point Count. Results indicated that a total of 38 families which comprised of 160 species of birds have been recorded. The three biggest families that represent about 23.5 percent of the total species are Timaliidae, Cuculidae and Pycnonotidae. The most common individuals recorded belong to the family Pycnonotidae. The forest is dominated by insectivore/frugivore group which is represented by mainly colonising secondary species. Certain species of hornbills (e.g. Buceros rhinoceros) and babblers (e.g. Pomatorhinus montanus) that are normally found in primary forest are absent. These results suggested that the composition of families and trophic structures of birds in Ayer Hitam Forest Reserve are comparable with those at other forest reserve areas. However, the absence of many primary forest species suggested that the forest is still under recovering process. It is recommended that the major part of the forest is left undisturbed to prevent the few remaining wildlife habitats from further destruction and to allow the wildlife species composition to return to the original condition.

INTRODUCTION

Most wildlife in the tropic depends on the forest for their existence. In Malaysia, almost 90 percent of the birds inhabit tropical forest (Wells 1988). The tropical forest is the most diverse ecosystem and it provides the basic necessities such as cover, refugia, feeding and breeding habitats for the birds to survive and reproduce.

Unfortunately, the size of undisturbed primary tropical rain forest is shrinking at a

rapid rate. A large proportion of the forested areas remaining are either logged-over or degraded forests (secondary forests). As a consequence, the size of the secondary forests is expanding. Furthermore, previous studies have shown that most species particularly birds are adversely affected in disturbed habitats (Johns 1986, 1987, 1988, 1989; Zakaria and Nordin 1998, Zakaria and Francis, in press). It is therefore crucial for us to examine not only the effects of habitat disturbance on the population of wildlife but also to understand their recovery processes.

Many questions related to changes in wildlife species in secondary forest need to be answered. Does the diversity of wildlife in secondary forest remain the same as that in primary forest? If not, what are the changes occuring to the species composition? Does the abundance of each species in secondary forest remain the same as that in primary forest? If not, which species increase or decrease in secondary forest? Which species are the most adversely affected and can be used as indicator species? How long does it take for them to recover? These are a few questions that need to be answered in order to understand the dynamic of wildlife population in tropical forest.

Before answers of the above questions are found, much preliminary works need to be done. In this study, the composition of bird species in the isolated secondary forest of Ayer Hitam Forest Reserve is examined. The study is an on going long-term study and the results presented here are preliminary. The ultimate aim is to assess whether the forest-dependent bird species particularly those that are adversely affected can recover or survive in secondary forest. The information obtained is useful in understanding and protecting wildlife species in the forest.

STUDY AREA AND METHODOLOGY

The study was conducted in the 1248ha of Ayer Hitam Forest, Puchong, Selangor. The area is located at about 3°00.00'N to 3°02.20'N and 101°37.90'E to 101°40.00'E, approximately 20 kilometers southwest of Kuala Lumpur. This is an isolated lowland dipterocarp forest and was selectively logged. The forest is divided into six compartments (Compartments 1, 2, 12, 13, 14 and 15), and each compartment was logged in different years. The earliest logging history was in 1936 and the latest was in 1954. The effects of logging are most severe in Compartment 15. The forest in Compartments 1, 13 and 14 are only slightly damaged and many big timber species are still present.

The results presented here were based on a study conducted in all the compartments within the forest reserve. At this stage, only the composition of species was presented and discussed. No attempts were made to obtain the density of species since the number of observations recorded was still very small.

Two survey methods were implemented in this study. To assess mainly the canopy species, the Distance Sampling-Point Count method was used (Buckland *et al.* 1993). For this method, ten transect lines, each of at least 500 meters in length has been built at random. Each line was walked at least 3 times. The transects were built in such a way to represent the whole area of the forest. All species seen and heard were recorded.

To assess the understorey species, mist-netting method was used. The mist-nets used were of size 14m in length and 3m in width with the mesh size of 1cm. Since the main objective is to record all species present in the area, the nets were placed in as many habitats (lowland, ridge, riverine areas, hill top and swampy areas) as possible. They were placed at random in each of the habitat and were checked every three hours. The netting activities were started early in the morning (between 6:00 -7:00am) and ended late in the evening (6:30 - 7:00pm). A total of 11,000 net-hours have been conducted during the study period between January to July 1998. All birds caught were identified, tagged and released at the place where they were caught.

RESULTS

The results show that a total of 160 species of birds have been recorded which represented 38 families (see Appendix). The three largest families were Timaliidae (13 Babbler species), Cuculidae (12 Cuckoo species) and Pycnonotidae (12 Bulbul species) (Table 1). The smallest families that were represented by only one species included Raillidae, Podargidae and Coraciidae.

To examine the different assemblages of birds present in the area, the species recorded was categorised into trophic levels (Karr 1980, Nordin and Zakaria 1997, Wong 1986; Table 2). Results clearly indicated that insect-eating birds (insectivores) representing the highest number of species (73 species), followed by birds that eat insects and fruits (insectivores/frugivores; 40

TABLE 1
Number of bird species recorded for each family

No.	Family	Species
1	Ardeidae	2
2	Accipitridae	5
3	Phasianidae	3
4	Raillidae	1
5	Columbidae	5
6	Psittacidae	2
7	Cuculidae	12
8	Strigidae	4
9	Podargidae	1
10	Caprimulgidae	2
11	Apopidae	3
12	Hemiprocnidae	2
13	Trogonidae	2
14	Alcedinidae	7
15	Meropidae	3
16	Coraciidae	1
17	Bucerotidae	2
18	Capitonidae	5
19	Picidae	9
20	Eurylaimidae	4
21	Hirundinidae	1
22	Camphephagidae	5
23	Chloropseidae	5
24	Pycnonotidae	12
25	Dicruridae	4
26	Oriolidae	2
27	Corvidae	3
28	Sittidae	1
29	Timaliidae	13
30	Turdidae	5
31	Sylviidae	4
32	Muscicapidae	7
33	Motacillidae	1
34	Laniidae	2
35	Sturnidae	4
36	Nectariniidae	7
37	Dicaedae	4
38	Ploceidae	5

species) and birds that eat small vertebrates (carnivores; 19 species). The insectivores were mainly flycatcher and babbler species. The smallest trophic group was insectivore/carnivore/frugivore and was represented by mainly hornbills.

DISCUSSION

The Ayer Hitam Forest (AHFR) has been logged several times and the logging activities were terminated in the 70's. Although this is a secondary forest, it is still very rich of bird species. Even many other large primary forests contain only slightly higher number of species

TABLE 2
Classification of birds in Ayer Hitam Forest Reserve according to trophic structures

No.	Trophic Structure	No. of Species
1.	Carnivore	19
2.	Carnivore/Insectivore	6
3.	Insectivore	73
4.	Insectivore/Frugivore	40
5.	Frugivore	12
6.	Nectarivore/Insectivore/Frugivore	7
7.	Insectivore/Carnivore/Frugivore	3
Total	7 trophic levels	160

The classification of birds was partly extracted from Karr (1980) and Wong (1986) and reevaluated according to personal observations (Zakaria 1994).

than in the secondary forest of AHFR. For example in the primary forest of Sungai Tekam Forest Reserve, Pahang, the number of species recorded was 225 species while in the logged forest was 181 species (Johns 1989). Moreover, in the primary and logged forests of Ulu Segama Forest Reserve, Sabah, the number of species obtained was 222 and 188 species, respectively (Nordin and Zakaria 1997). However, we should keep in mind that the species number might be the same but the species composition in logged and unlogged forests might be different (Zakaria and Francis, in press).

In this study the number of species recorded was 160. Many of the species recorded are normally found in not only primary but also secondary forests. In fact, many of them are considered common species and can be found elsewhere. The forest has not been thoroughly surveyed particularly in the north part. It is expected that at least another 20 species to be recorded. Many of the species that were not recorded are the primary forest species. This was reflected by the absence of many primary forest species such as Rhinocerous Hornbills (*Buceros rhinoceros*) and a few species of babblers (e.g. *Pomatorhinus montanus, Stachyris poliocephala* and *Stachyris leucotis*). This suggested that the forest is still in the process of recovery. Twenty years after logging may not be sufficient for the forest to return to the original condition (Wong 1985). Although there are primary forest species in the forest, their numbers are lesser than those normally present in primary forest.

The diversity of families recorded is also comparable to other primary forest areas. Almost all of the families recorded in other primary forest areas are also found here. Bird assemblages according to the trophic structures also suggested that most of the compositions of the trophic groups are similar to other primary forest reserves. The only major difference is for the trophic insectivore/frugivore. In most primary forests, the insectivore/frugivore group is normally represented by fewer species and is replaced by the insectivore group (Zakaria and Nordin 1998). The higher number of insectivore/frugivore species is mainly contributed by the bulbul species. They are known as colonising secondary species and prefer to inhabit logged forest.

Other than bulbul species, groups of sunbirds and spiderhunters are also abundant in the forest. These species are especially abundant at the southern region of the forest. The damage to this region seems to be quite extensive. The area is dominated with secondary plant species such as *Macaranga*. There are very few primary tree species remained and most of them are still small. This could be the reason why there are abundant of bulbuls, sunbirds and spiderhunters which prefer the easily available small fruits and flower nectars of secondary plants (Zakaria and Nordin 1998).

At present, the total size of the forest (including the surrounding areas) is still large but it is shrinking at a very rapid rate and eventually only the 1248ha of AHFR will be left due to development of the surrounding areas. Thus, all of the birds from the affected areas will have to move into the permanent forest reserve. It is not known whether the remaining small forest reserve will be able to maintain the increasing number of birds. However, it is expected that the limited food and cover resources will affect the birds negatively (Zakaria and Nordin 1998). Thus, it is highly recommended that the forest reserve be protected from further disturbance. By doing this it is hoped that the forest and the birds can recover faster to their original state and prevent further species disappearance from occurring (Chapman and Chapman 1995, 1996).

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APPENDIX

LIST OF BIRD SPECIES IN AYER HITAM FOREST RESERVE

No.	English Name	Scientific Name	Malay Name
	ARDEIDAE		
1	Little Heron	*Butorides striatus*	Pucong Keladi
2	Cinnamon Bittern	*Ixobrychus cinnamomeus*	Pucong Bendang
	ACCIPITRIDAE		
3	Black-shouldered Kite	*Elanus caeruleus*	Lang Bahu Hitam
4	Crested Serpent-Eagle	*Spilornis cheela*	Lang Berjambul
5	Japanese Sparrowhawk	*Accipiter gularis*	Lang Sewah
6	Crested Honey-Buzzard	*Pernis ptilorynchus*	Lang Lebah
7	White-bellied Fish-eagle	*Haliaeetus leucogaster*	Lang Siput
	PHASIANIDAE		
8	Crested Fireback	*Lophura ignita*	Ayam Pegar
9	Great Argus	*Argusianus argus*	Kuang Raya
10	Crested Wood Partridge	*Rollulus rouloul*	Burung Siul
	RAILLIDAE		
11	White-breasted Waterhen	*Amaurornis phoenicurus*	Ruak-ruak
	COLUMBIDAE		
12	Little Green Pigeon	*Treron olax*	Punai Daun
13	Pink-necked Pigeon	*Treron vernans*	Punai Gading
14	Spotted Dove	*Streptopelia chinensis*	Merbok Balam
15	Peaceful Dove	*Geopelia striata*	Merbok Aman
16	Green-winged Pigeon	*Chalcophaps indica*	Punai Tanah
	PSITTACIDAE		
17	Long-tailed Parakeet	*Psittacula longicauda*	Bayan Nuri
18	Blue-crowned Hanging Parrot	*Loriculus galgulus*	Bayan Kecil
	CUCULIDAE		
19	Moustached Hawk-Cuckoo	*Cuculus vagans*	Sewah Tekukur Kecil
20	Hodgson's Hawk-Cuckoo	*Cuculus fugax*	Sewah Hantu
21	Indian Cuckoo	*Cuculus micropterus*	Sewah India
22	Plaintive Cuckoo	*Cacomantis merulinus*	Sewah Mati Anak
23	Drongo Cucukoo	*Surniculus lugubris*	Sewah Sawai
24	Common Koel	*Eudynamys scolopacea*	Sewah Tahu
25	Black-bellied Malkoha	*Phaenicophaeus diardii*	Cenok Perut Hitam
26	Raffles' Malkoha	*Phaenicophaeus chlorophaeus*	Cenok Kerak
27	Red-billed Malkoha	*Phaenicophaeus javanicus*	Cenok Api
28	Chestnut-breasted Malkoha	*Phaenicophaeus curvirostris*	Cenok Birah
29	Greater Coucal	*Centropus sinensis*	But-but Carik Anak
30	Lesser Coucal	*Centropus bengalensis*	But-but Kecil
	STRIGIDAE		
31	Collared Scops-Owl	*Otus bakkamonea*	Hantu Reban
32	Reddish Scops-Owl	*Otus rufescens*	Hantu Merah
33	Common Scops-Owl	*Otus scops*	Hantu Kuang Kuik
34	Brown Wood-Owl	*Strix leptogrammica*	Hantu Punggor
	PODARGIDAE		
35	Large Frogmouth	*Batrachostomus auritus*	Segan Besar

	CAPRIMULGIDAE		
36	Malaysia Eared Nightjar	*Eurostopodus temminckii*	Tukang Malaysia
37	Large-tailed Nightjar	*Caprimulgus macrurus*	Tukang Kubur
	APOPIDAE		
38	Silver-rumped Swift	*Rhaphidura leucopygialis*	Layang-layang Kecil
39	Fork-tailed Swift	*Apus pacifus*	Layang-layang Ekor Cabang
40	Brown Needletail	*Hirundapus gigantea*	Layang-layang Besar
	HEMIPROCNIDAE		
41	Whiskered Treeswift	*Hemiprocne comata*	Layang-layang Jambu Kecil
42	Grey-rumped Treeswift	*Hemiprocne longipennis*	Layang-layang Jambu Kelabu
	TROGONIDAE		
43	Scarlet-rumped Trogon	*Harpactes duvaucelii*	Kesumba Puteri
44	Red-naped Trogon	*Harpactes kasumba*	Kesumba
	ALCEDINIDAE		
45	Common Kingfisher	*Alcedo atthis*	Pekaka Cit-cit Kecil
46	Blue-eared Kingfisher	*Alcedo meninting*	Pekaka Bintik-bintik
47	Black-backed Kingfisher	*Ceyx erithacus*	Pekaka Rimba
48	Rufous-backed Kingfisher	*Ceyx rufidorsus*	Pekaka Api
49	Stock-billed Kingfisher	*Pelargopsis capensis*	Pekaka Paroh Pendek
50	Black-capped Kingfisher	*Halcyon pileata*	Pekaka Kopiah Hitam
51	White-throated Kingfisher	*Halcyon smyrnensis*	Pekaka Belukar
	MEROPIDAE		
52	Blue-tailed Bee-Eater	*Merops philippinus*	Berek-berek Carik Dada
53	Blue-throated Bee-Eater	*Merops viridis*	Berek-berek Tadah Hujan
54	Red-bearded Bee-Eater	*Nyctyornis amictus*	Berek-berek Janggut Merah
	CORACIIDAE		
55	Dollarbird	*Eurystomus orientalis*	Tiong Batu
	BUCEROTIDAE		
56	White-crowned Hornbill	*Berenicornis comatus*	Enggang Jambul Putih
57	Black Hornbill	*Anthracoceros malayanus*	Enggang Gatal Birah
	CAPITONIDAE		
58	Gold-whiskered Barbet	*Megalaima chrysopogon*	Takor Jambang Emas
59	Yellow-crowned Barbet	*Megalaima henricii*	Takor Mahkota Kuning
60	Red-throated Barbet	*Megalaima mystacophanos*	Takor Raya
61	Blue-eared Barbet	*Megalaima australis*	Takor Akar
62	Brown Barbet	*Calorhamphus fuliginosus*	Takor Dahan
	PICIDAE		
63	Rufous Piculet	*Sasia abnormis*	Belatok Kecil
64	Rufous Woodpecker	*Micropternus brachyurus*	Belatok Biji Nangka
65	Checker-throated Woodpecker	*Picus mentalis*	Belatok Ranting
66	Banded Woodpecker	*Picus miniaceus*	Belatok Merah
67	Common Goldenback	*Dinopium javanense*	Belatok Pinang Muda
68	Buff-rumped Woodpecker	*Meiglyptes tristis*	Belatok Awan
69	Buff-necked Woodpecker	*Meiglyptes tukki*	Belatok Tuki-tuki
70	Grey-and-Buff Woodpecker	*Hemicircus concretus*	Belatok Punggoh
71	Maroon Woodpecker	*Blythipicus rubiginosus*	Belatok Punggor
	EURYLAIMIDAE		
72	Banded Broadbill	*Eurylaimus javanicus*	Takau Rimba
73	Black-and-Yellow Broadbill	*Eurylaimus ochromalus*	Takau Hitam Kuning

74	Black-and-Red Broadbill	*Cymbirhynchus macrorhynchus*	Takau Rakit
75	Green Broadbill	*Calyptomena viridis*	Takau Selawit
	HIRUNDINIDAE		
76	Pacific Swallow	*Hirundo tahitica*	Sualo Batu
	CAMPHEPAGIDAE		
77	Black-winged Flycatcher-Shrike	*Hemipus hirundinaceus*	Rembah Batu
78	Lesser Cuckoo-Shrike	*Coracina fimbriata*	Sewah Kecil
79	Pied Triller	*Lalage nigra*	Sewah Kapas
80	Fiery Minivet	*Pericrocotus igneus*	Mas Tulin
81	Scarlet Minivet	*Pericrocotus flammeus*	Mas Belukar
	CHLOROPSEIDAE		
82	Green Iora	*Aegithina viridissima*	Kunyit Bakau
83	Common Iora	*Aegithina tiphia*	Kunyit Kacat
84	Lesser Green Leafbird	*Chloropsis cyanopogon*	Daun Kecil
85	Greater Green Leafbird	*Chloropsis sonnerati*	Daun Besar
86	Blue-winged Leafbird	*Chloropsis cochinchinensis*	Daun Kepak Biru
	PYCNONOTIDAE		
87	Black-headed Bulbul	*Pycnonotus atriceps*	Merbah Siam
88	Puff-backed Bulbul	*Pycnonotus eutilotus*	Merbah Coklat Berjambul
89	Yellow-vented Bulbul	*Pycnonotus goaivier*	Merbah Kapor
90	Olive-winged Bulbul	*Pycnonotus plumosus*	Merbah Belukar
91	Cream-vented Bulbul	*Pycnonotus simplex*	Merbah Mata Putih
92	Red-eyed Bulbul	*Pycnonotus brunneus*	Merbah Mata Merah
93	Spectacled Bulbul	*Pycnonotus erythropthalmos*	Merbah Kecil
94	Black-and-White Bulbul	*Pycnonotus melanoleucos*	Merbah Tanduk
95	Yellow-bellied Bulbul	*Criniger phaeocephalus*	Merbah Perut Kuning
96	Finches Bulbul	*Criniger finschii*	Merbah Rempah
97	Buff-vented Bulbul	*Hypsipetes charlottae*	Merbah Riang
98	Hairy-backed Bulbul	*Hypsipetes criniger*	Merbah Bulu Panjang Tengkok
	DICRURIDAE		
99	Bronzed Drongo	*Dicrurus aeneus*	Cecawi Keladi
100	Crow-billed Drongo	*Dicrurus annectans*	Cecawi Sawai
101	Lesser Racket-tailed Drongo	*Dicrurus remifer*	Cecawi Hamba Kera
102	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	Cecawi Anting-anting
	ORIOLIDAE		
103	Black-hooded Oriole	*Oriolus xanthornus*	Dendang Belukar
104	Asian Fairy Bluebird	*Irena puela*	Dendang Gajah
	CORVIDAE		
105	Crested Jay	*Platylophus galericulatus*	Gagak Jerit
106	Black Magpie	*Platysmurus leucopterus*	Gagak Kambing
107	Large-billed Crow	*Corvus macrorhynchos*	Gagak Paroh Besar
	SITTIDAE		
108	Velvet-fronted Nuthatch	*Sitta frontalis*	Patok Baldu
	TIMALIIDAE		
109	Short-tailed Babbler	*Trichastoma malaccense*	Rimba Ekor Pendek
110	Ferruginous Babbler	*Trichastoma bicolor*	Rimba Sampah
111	Abbot's Babbler	*Trichastoma abbotti*	Rimba Riang
112	Sooty-capped Babbler	*Malacopteron affine*	Rimba Tinjau Belukar
113	Scaly-crowned Babbler	*Malacopteron cinereum*	Rimba Tua Kecil
114	Rufous-crowned Babbler	*Malacopteron magnum*	Rimba Tua Besar
115	Chestnut-rumped Babbler	*Stachyris maculata*	Rimba Rembah Besar

116	Chestnut-winged Babbler	*Stachyris erythroptera*	Rimba Merbah Sampah
117	Rufous-fronted Babbler	*Stachyris rufifrons*	Rimba Api
118	Striped-tit Babbler	*Macronus gularis*	Rimba Berjalor
119	Fluffy-backed Tit-Babbler	*Macronus ptilosus*	Rimba Pong-pong
120	Brown Fulvetta	*Alcippe brunneicauda*	Rimba Murai Coklat
121	White-bellied Yuhina	*Yuhina zantholeuca*	Yuhina Perut Putih
	TURDIDAE		
122	Siberian Blue Robin	*Erithacus cyane*	Murai Siberia
123	Magpie Robin	*Copsychus saularis*	Murai Kampong
124	White-rumped Shama	*Copsychus malabaricus*	Murai Rimba
125	Chestnut-naped Forktail	*Enicurus ruficapilus*	Murai Cegar
126	White-crowned Forktail	*Enicurus leschenaulti*	Murai Cegar Belukar
	SYLVIIDAE		
127	Yellow-bellied Warbler	*Abroscopus superciliaris*	Cekup Paroh Kuning
128	Arctic Warbler	*Phylloscopus borealis*	Cekup Artik
129	Common Tailorbird	*Orthotomus sutorius*	Perenjak Pisang
130	Dark-necked Tailorbird	*Orthotomus artogulais*	Perenjak Belukar
	MUSCICAPIDAE		
131	Grey-chested Flycatcher	*Rhinomyias umbratilis*	Sambar Batu
132	Asian Brown Flycatcher	*Muscicapa latirostris*	Sambar Asia
133	Tickell's Blue Flycatcher	*Cyornis tickelliae*	Sambar Kelicap Ranting
134	Pied Fantail	*Rhipidura javanica*	Sambar Murai Gila
135	Black-naped Monarch	*Hypothymis azurea*	Sambar Uban Hitam
136	Maroon-breasted Flycatcher	*Philentoma velatum*	Sambar Ungu
137	Asian Paradise Flycatcher	*Terpsiphone paradisi*	Sambar Ekor Panjang
	MOTACILLIDAE		
138	Richard's Pipit	*Anthus novaeseelandiae*	Pipit Tanah
	LANIIDAE		
139	Brown Shrike	*Lanius cristatus*	Tirjup Tanah
140	Tiger Shrike	*Lanius tigrinus*	Tirjup Rimau
	STURNIDAE		
141	Philippine Glossy Starling	*Aplonis panayensis*	Perling Mata Merah
142	Common Myna	*Acridotheres tristis*	Tiong Gembala Kerbau
143	Jungle Myna	*Acridotheres fuscus*	Tiong Hutan
144	Hill Myna	*Gracula religiosa*	Tiong Mas
	NECTARINIIDAE		
145	Plain Sunbird	*Anthreptes simplex*	Kelicap Kelabu
146	Purple-naped Sunbird	*Hypogramma hypogrammicum*	Kelicap Rimba
147	Little Spiderhunter	*Arachnothera longirostra*	Kelicap Jantong
148	Long-billed Spiderhunter	*Arachnothera robusta*	Kelicap Jantong Paroh Panjang
149	Yellow-eared Spiderhunter	*Arachnothera chrysogenys*	Kelicap Jantong Telinga Kuning
150	Spectacled Spiderhunter	*Arachnothera flavigaster*	Kelicap Jantong Besar
151	Grey-breasted Spiderhunter	*Arachnothera affinis*	Kelicap Jantong Bukit

DICAEDAE			
152	Yellow-breasted Flowerpecker	*Prionochilus maculatus*	Sepah Puteri Raja
153	Crimson-breasted Flowerpecker	*Prionochilus percussus*	Sepah Puteri Pelangi
154	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	Sepah Puteri Bukit
155	Plain Flowerpecker	*Dicaeum concolor*	Sepah Puteri Bongsu
PLOCEIDAE			
156	Eurasian Tree-Sparrow	*Passer montanus*	Ciak Urasia
157	Baya Weaver	*Ploceus philippinus*	Ciak Tempua
158	White-bellied Munia	*Lonchura leucogastra*	Pipit Padi
159	Chestnut Munia	*Lonchura malacca*	Pipit Rawa
160	White-headed Munia	*Lonchura maja*	Pipit Uban

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Abundance of Primates in Ayer Hitam Forest, Puchong, Selangor

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ABSTRAK

Satu kajian tentang bilangan dan taburan primat telah dijalankan di Hutan Simpan Ayer Hitam, Puchong, Selangor (HSAH). Objektif utama kajian ini ialah untuk meneliti komposisi spesies dan densiti primat di dalam kawasan hutan tersebut. Sejumlah sembilan garisan transek telah dibina dan di sepanjang kajian setiap garisan dilalui sebanyak empat kali. Keseluruhannya sepanjang 34,080 meter telah dilalui. Densiti primat ditentukan melalui program DISTANCE V 2.2. Keputusan menunjukkan bahawa hanya lima spesies primat daripada sepuluh keseluruhannya yang berada di Semenanjung Malaysia telah direkodkan. Spesies yang telah direkodkan ialah Presbytis melalophos (Lotong Ceneka), P. obscura (Lotong Cengkong), Hylobates lar (Ungka Tangan Putih), Macaca nemestrina (Beruk) and M. fascicularis (Kera) dengan densiti masing-masing 0.21, 0.09, 0.08, 0.07 and 0.04 individu per hektar. Saiz kumpulan terbesar dipamerkan oleh P. melalophos (4.0 individu/kumpulan) dan diikuti oleh M. fascicularis (2.6 individu/kumpulan), P. obscura (2.5 individu/kumpulan), H. lar (2.3 individu/kumpulan) dan M. nemestrina (1.6 individu/kumpulan). Densiti kumpulan bagi keseluruhan primat ialah 0.19 kumpulan/ha. Densiti dan saiz kumpulan primat di HSAH adalah dianggap rendah berbanding dengan kawasan lain di Semenanjung Malaysia. Aktiviti pemburuan haram dan pemburuan berlebihan oleh Orang Asli dan saiz hutan yang semakin kecil mungkin menyumbang kepada densiti primat yang rendah.

ABSTRACT

A study on the abundance and distribution of primates was conducted in Ayer Hitam Forest Reserve, Puchong, Selangor (AHFR). The main objective of this study was to examine the species composition and density of primates in the area. A total of nine transect lines were established and each line was walked four times during the study period. The total length of transect walked was 34,080 meters. The density was calculated using DISTANCE program V 2.2. The result showed that only five species of primates from a total of ten species present in Peninsular Malaysia were recorded. The species recorded were Presbytis melalophos (Banded-leaf Monkey), P. obscura (Dusky-leaf Monkey), Hylobates lar (White-handed Gibbon), Macaca nemestrina (Pig-tailed Macaque) and M. fascicularis (Long-tailed Macaque) with the densities of 0.21, 0.09, 0.08, 0.07 and 0.04 individuals per hectare, respectively. The largest group size was demonstrated by P. melalophos (4.0 individuals/group) followed by M. fascicularis (2.6 individuals/group), P. obscura (2.5 individuals/group), H. lar (2.3 individuals/group) and M. nemestrina (1.6 individuals/group). The group density of all primates was 0.19 groups/ha. The density and group size of primates in AHFR are relatively lower compared to other areas in Peninsular Malaysia. Illegal hunting and over hunting activities by the Orang Asli and the shrinking forest size may contribute to the low density of primates in AHFR.

INTRODUCTION

Vertebrate composition in tropical rain forest is complex and diverse (Harmelin-Vivien and Bourliere 1989). Some species are highly specialised to a particular microhabitat or microclimate and some are not so obvious. Any disturbance to the microhabitats and microclimates will severely affect the specialised species (Johns 1992, Zakaria and Nordin 1998). However, the degree of responses of vertebrates to the disturbance varies and it is difficult to assess the factors inducing the responses (Arshad and Zakaria 1999, Zakaria *et al.* 1999). Previous studies have shown that large disturbances can cause a reduction in numbers rather than a deletion in species (Gamar *et al.* 1999, Nordin and Zakaria 1997, Pimm 1979).

Disturbance to the natural forest has affected significantly to the population of primates. For example, the *M. fascicularis* showed a significant population increase in disturbed forest (Ibrahim 1995) and many other species show a significant population decrease after severe habitat disturbances (Johns 1992). The decline in population of various primate species, has generally altered the ecological balance of the biological community in Malaysia (Marsh *et al.* 1981).

It is recommended that wildlife management within Ayer Hitam Forest Reserve (AHFR) must be based upon information obtained on wildlife species composition and abundance. Unfortunately, there is no detailed information on primates that composed one of the major components of wildlife community. Information on primates is very crucial because they have been recognised as indicator species that may reflect the condition of the forest as wildlife habitats (Johns 1992). Furthermore, information on wildlife population is necessary in order to be able to undertake sound management action.

This study will provide detailed information on the composition and density of primates in AHFR. It is hoped that the knowledge obtained can be used in formulating wildlife management strategies in the area.

STUDY AREA AND METHODOLOGY

The study was conducted in Ayer Hitam Forest Reserve, Puchong, Selangor Darul Ehsan. The area is located at about 3°00.00'N to 3°02.20'N and 101°37.90'E to 101°40.00'E, approximately 20 kilometers southwest of Kuala Lumpur. The forest is about 1,248 hectares in size and was selectively logged about 20 years ago.

The study was started in September and completed in December 1998. The Distance Sampling Method (Buckland *et al.* 1993, Burnham and Anderson 1984) for line transects (Burnham *et al.* 1981) was chosen for this study. The line transect is suitable for large rain forest area such as AHFR. It can be utilised to compare the density of different species of primates.

Nine transect lines were established in AHFR to represent the whole area of the forest. Plastic tags were placed at every twenty meter intervals to enable us to mark the animals location. The length of each transect line varied from 640 to 1,200 meters according to the topography condition. The surveys were conducted between 0715 and 0730 hours. Since primates are inactive at about midday, the surveys were designed to be completed by 1200 hours (Marsh 1981). Each line was surveyed four times with the walking speed of 500 meters per hour which lasted for two to four hours depending on the length of the transect. The total distance walked on the transects was 34,080 meters. In order to reduce bias on primates detection, the surveys were stopped when the weather became cloudy or when it was raining.

Analysis of Data

The density of primates was analysed using DISTANCE program (Buckland *et al.* 1993) based on the following principle:

$$\text{The density } D = n \,/\, 2L\int_0^w g(x)\,dx$$

Where, n = no. of individuals
L = Total length of transect
g(x) = probability of detection of primate at line
w = perpendicular distance

RESULTS

Species Composition

A total of five primate species were observed in AHFR. The species were *Presbytis melalophos* (Banded-leaf Monkey), *P. obscura* (Dusky-leaf Monkey), *Hylobates lar* (White-handed Gibbon), *Macaca fascicularis* (Long-tailed Macaque) and *M. nemestrina* (Pig-tailed Macaque).

Abundance

Altogether 101 observations of primates were recorded during the study period. A total of 40 observations were obtained for *P. melalophos* , 25

for *H. lar*, 15 for *P. obscura*, 13 for *M. fascicularis* and 8 for *M. nemestrina* (Table 1). The species *P. melalophos* showed the highest values for the density of individuals (0.21 animals/hectare) and groups (0.05 groups/hectare). The *M. fascicularis* indicated the lowest density of individuals and groups (0.04 and 0.03 per hectare, respectively). The density of *H. lar* was 0.08 individuals per hectare and 0.03 groups per hectare, *P. obscura* was 0.09 individuals/hectare and 0.04 groups/hectare and *M. nemestrina* was 0.07 individuals/hectare and 0.04 groups/hectare (Table 2).

The average group size of primates (average number of individuals/group) was 2.7 animals. Among the species *P. melalophos* showed the largest group size (4.0 individuals/group), followed by *M. fascicularis* (2.6 individuals/group), *P. obscura* (2.5 individuals/group), *H. lar* (2.3 individuals/group) and *M. nemestrina* (1.6 individuals/group).

DISCUSSION

Species Composition

There were only 5 species of primates from a total of ten present in Peninsular Malaysia were recorded by Distance Sampling method in Ayer Hitam Forest Reserve. The species that were not observed were *M. arctoides* (Stumped-tailed Macaque), *H. syndactylus* (Siamang), *H. agilis* (Black-handed Gibbon), *P. cristata* (Silvered-leaf Monkey) and *Nycticebus coucang* (Slow loris). Out of these five, *N. coucang* is known to occur in the area since it has been trapped many times previously. Sundai (1996) reported that this species was trapped in a small mammal trap and was released back to the forest. Furthermore, this species was a nocturnal animal and the chance to observe this species during the study was very low.

Other species were known to occur only at specific habitats and locations in Peninsular (Khan 1992, Chivers 1974, Lekagul 1974, Medway 1969). For example, the *H. syndactylus* is more restricted to the main range of the peninsular, from the northern parts to the north of Selangor. Moreover, the *H. agilis* was restricted between the forest of Perak and Muda rivers. On the other hand, *P. cristata* was observed only at coastal area especially at the West Coast of Peninsular Malaysia. Therefore, AHFR does contain all species of primates that were supposed to occur within their normal range.

TABLE 1
Number of observations of primates in Ayer Hitam Forest Reserve

No.	Species	No. of times observed in group	Total no. of individuals in the groups	No. of times observed in single individual	Total no. of individuals observed
1.	*Presbytis melalophos*	11	40	0	40
2.	*Hylobates lar*	11	25	0	25
3.	*Presbytis obscura*	3	13	2	15
4.	*Macaca fascicularis*	5	13	0	13
5.	*Macaca nemestrina*	4	7	1	8
	Total				101

TABLE 2
The individual and group density of primates in Ayer Hitam Forest Reserve

No.	Species	Density	
		Individuals/ha	Group/ha)
1.	*Presbytis melalophos*	0.21 ± 0.42	0.05 ± 0.02
2.	*Hylobates lar*	0.08 ± 0.20	0.03 ± 0.03
3.	*Presbytis obscura*	0.09 ± 0.56	0.04 ± 0.02
4.	*Macaca fascicularis*	0.04 ± 0.02	0.03 ± 0.01
5.	*Macaca nemestrina*	0.07 ± 0.60	0.04 ± 0.01
	Total Density	0.49 ± 0.22	0.34 ± 0.02

Species Abundance

The density of primates at AHFR during the study was relatively low compared to other studies in the Peninsular. For example, the estimated mean group density of primates in the primary lowland forest at Krau Game Reserve was 1.35 groups/hectare (Marsh 1981). That includes 0.60 groups/hectare for *P. melalophos*, 0.38 groups/hectare for *P. obscura* and 0.28 groups/hectare for *Hylobates* spp. compared to only 0.05, 0.04 and 0.03 (*H. lar* only) groups/hectare respectively at AHFR. In the same study, the individual density (all species) was 3.96 animals/hectare in primary forest and 3.17 individuals/hectare in five-year old logged area, while at AHFR was only 0.49 individuals/hectare. The same author reported that at Sungai Depak in Kelantan and Kota Tinggi, Johor the density was 1.47 and 3.07 animals/hectare.

It is well known that the *M. fascicularis* was the most common species in many disturbed areas and secondary forests in Peninsular Malaysia (Loong 1980, Mah 1980). For instance, the density recorded at Kuala Rompin, Pahang was 3.09 individuals/ha in primary forest and 1.07 individuals/ha in logged forest (Marsh 1981). According to Yuop (1998) the density of *M. fascicularis* at the Campus of University Malaya, Kuala Lumpur was 0.6 individuals/hectare and in Kuala Lumpur was 3.03 individuals/hectare (considering only the green area at Kuala Lumpur). However, at AHFR there was only 0.04 individuals/hectare of *M. fascicularis*.

The main cause for the lower density of primates in AHFR was probably due largely to illegal hunting. The forest is surrounded by human inhabitants and is not fenced. It is also not strictly monitored and people can easily enter from several entry points. Moreover, there is an Orang Asli settlement adjacent to the forest reserve. According to Marsh (1981), the primates were traditionally hunt by most of the Orang Asli and in AHFR the hunting activity was probably very high. In addition, the behaviour nature of *Macaca* species which is not that wild, made it an easy target for hunters. They hunt primates as their sources of protein. A few illegal traps of wildlife were found during the study. According to the DWNP, one Chinese Restaurant at Puchong has been identified to sell the wildlife meat and it was thought that the Orang Asli's might act as its supplier. However, there is no documented proof to show that they were responsible for the decreasing number of primates in Ayer Hitam Forest Reserve.

The lower density of primates in the area may be also due to the condition of the forest itself. Although the reserve is only 1248ha, the forested area was originally about ten times bigger. Unfortunately, the forested area is shrinking at a very rapid rate and eventually only the allocated reserve will remain intact due to the surrounding development activities. Thus, it is expected that a small pocket of forest will contain a small number of primates. Since these primates are social animals, other factors such as minimum home range size, minimum group size for population viability and quality of habitats may also affect the population size. More detailed study is needed to examine these factors.

CONCLUSIONS

It is recommended that any future planning or development within AHFR should take into consideration the existing wildlife population in the area. The forest reserve should be gazetted as a protected area such as wildlife reserve to ensure the continued existence of wildlife species and to protect wildlife habitats in the area.

Illegal hunting of wildlife by Orang Asli in the area was one of the main factors contributing to the decline of wildlife population. In order to protect and conserve the remaining wildlife population, the relevant agencies (UPM, Forestry Department and DWNP) should initiate awareness programme for the local people nearby, and at the same time provide alternative source of income to reduce their dependency on wildlife as main food.

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A Preliminary Study of Genetic Variation of Selected Species of a Lowland Forest at Ayer Hitam Forest Reserve, Selangor

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Keywords : genetic variation, starch gel electrophoresis, polymorphism, heterozygosities

ABSTRAK

Kajian awal mengenai corak variasi genetik ke atas 10 spesies pilihan (Shorea parvifolia, Shorea macroptera, Shorea acuminata, Shorea leprosula, Hopea beccariana, Dipterocarpus crinitus, Endospermum malaccensis, Artocarpus elasticus, Palaquium gutta dan Macaranga gigantea) dari Hutan Simpan Ayer Hitam telah dijalankan menggunakan kaedah elektroforesis gel kanji. Analisis ke atas 8 enzim menunjukkan yang mereka dikawal oleh 9 ke 12 lokus.Tahap polimorfik dan purata heterozigositi jangkaan bagi spesies-spesies ini berjulat daripada 0.9 ke 1.0 dan daripada 0.454 (S. leprosula) ke 0.602 (H. beccariana) masing-masing.

ABSTRACT

A preliminary study of the extent and pattern of genetic variation of 10 selected species (Shorea parvifolia, Shorea macroptera, Shorea acuminata, Shorea leprosula, Hopea beccariana, Dipterocarpus crinitus, Endospermum malaccensis, Artocarpus elasticus, Palaquium gutta and Macaranga gigantea) at Ayer Hitam Forest Reserve was carried out using the horizontal starch gel electrophoresis. Analysis of eight enzymes indicated that they were coded by 9 to 12 loci. Levels of polymorphism and mean of expected heterozygosities of these species ranged from 0.9 to 1.0 and from 0.454 (S. leprosula) to 0.602 (H. beccariana) respectively.

INTRODUCTION

Tropical forest is rich in genetic resources. High species diversity is the most peculiar feature of tropical rainforest. For instance, the dipterocarps are the most dominant canopy component and represent the richness of tropical taxa (Ashton 1988). The complex community process and reproductive process of these diversified species are challenged by recent tropical ecology (Ashton 1988). Although the genetic studies of tropical species are expected to provide important information on the community, organisation and reproductive ecology, studies on native tree species in tropics are relatively scarce (Hamrick and Loveless, 1986; Loveless 1992 and Kijkar 1992).

Effective forest management needs a thorough understanding of many aspects including biology, ecology and genetics. Information on the genetics of species would be useful in designing appropriate tree breeding programmes. Lewontin (1974), Endler (1977) and Loveless (1992) stated that the presence of variability within a population is responsible in generating and maintaining a population sustainably. Genetic variation is the fundamental requirement for the maintenance and long term stability of forest ecosystem since the amount and pattern of genetic variation would determine the ability of forest tree species to adapt to variable environmental conditions (Bergmann *et al.* 1989). In fact, many studies of genetic variation showed that it is correlated with life history characteristics, breeding system and population dynamics (Loveless and Hamrick 1984). Genetic studies can also help in the identification of superior populations.

Among the many reliable and practical methods used in the study of genetic variation is by isozyme analysis. Isozyme markers have been found to be the cheapest and reliable when compared to the traditional morphological

markers. Its utilisation enables the separation of products of the same genes, regardless of environment. Individuals may be characterised by their genotypes, composed of a sample of gene, comparison of individuals or groups of individuals could be made using specific genetic markers.

Thus, the objective of this study is to assess the genetic variation (inter and intra specific) of 10 selected lowland forest species at Ayer Hitam Forest Reserve, Selangor.

MATERIALS AND METHODS

Samples of cambial tissues of 10 selected species (*Shorea parvifolia, Shorea macroptera, Shorea acuminata, Shorea leprosula, Hopea beccariana, Dipterocarpus crinitus, Endospermum malaccensis, Artocarpus elasticus, Palaquium gutta* and *Macaranga gigantea*) were collected from compartment 15, Ayer Hitam Forest Reserve, Selangor. Cambial tissues were collected from 30 trees per species to determine the total variation of the species. The samples were kept in eppendorf tubes and placed in a cooling box during the transportation. They were then filtered and mixed with extraction buffer prior to electrophoretic run.

The buffers used in this study were based on the ones recommended by previous studies on *Shorea* species (Daisy 1995 and Noridah, 1996). The three buffers used were Histidine (H), Lithium (L) and Morpholine Citrate (MC). Electrophoresis was done on a 10.5% potato hydrolysed starch. After electrophoresis, the gels were stained for 8 different enzymes namely *Esterase* (EST), α *Glycerophosphate dehydrogenase* (αGPDH), *Isocitrate dehydrogenase* (IDH), *Malate dehydrogenase* (MDH), *Phosphoglucomutase* (PGM), 6- *Phosphoglucose Dehydrogenase* (6 PDGH), *Phosphoglucose isomerase* (PGI) and *Shikimate Dehydrogenase* (SDH). The genetic interpretation of the enzyme was based on the phenotypes obtained according to the mobility of the isozyme bands. When an enzyme revealed more than one zone of activity, the fastest migrating (most anodal) was designated as locus 1, the next, 2 and so on. In addition, the most anodal allele was labelled as fast(F), medium (M) and the least migrated allele as slow (S). Clear banding patterns were obtained for all 9 loci and the results of the electrophoretic phenotype variation were analysed for allelic frequencies and expected heterozygosities.

RESULTS AND DISCUSSION

Interpretation of the enzyme phenotypes was based on patterns of variability in 10 species. Direct verification of genetic control of the electrophoretic patterns of the enzymes examined was not carried out. It was assumed based on the consistency of the electrophoretic patterns of the monomorphic and polymorphic enzymes from each individual of the species analysed. A total of 9-12 loci were scored from the eight enzyme systems. Almost all of the loci scored were polymorphic except for Sdh-1 in *S. acuminata* and Pgi-2 for *P. gutta*. The average number of alleles per locus ranged from 2.4 to 2.9 (Table 1).

The interspecific genetic variation is quantified by measuring the mean heterozygosity, the percentage of polymorphic loci and the percentage of alleles per locus. The mean observed heterozygosities (H_O) of these species ranged from 0.383 in *S. acuminata* to 0.608 in *P. gutta* while the mean of expected heterozygosities ranged from 0.454 to 0.602. On the other hand, level of polymorphic loci ranged from 0.9 to 1.0 (Table 1). Values of heterozygosities and polymorphisms were found to be similar to those reported by Kong (1994) on *Shorea acuminata* (H_O=0.604, P=1.0); Daim (1993) and Daisy (1995) on *S. leprosula* (H_O=0.565, and H_O=0.457, P=0.9 respectively) (Table 2). However, these values were higher than the values given by Hamrick and Loveless (1986), Loveless and Hamrick (1987), John (1996) and Hazandy (1997) for other tropical tree species (Table 2).

The higher values of heterozygosities and polymorphism in this study indicated that these species have undergone effective competition and selection within and between species for survival in natural stand. The natural forest, which normally portrays heterogeneous ecological condition, would justify them to possess high genetic variability. Thus, the heterozygotes being the fitter genotypes would survive better due to these effects as being indicated by the higher values of H_O over H_e (Feret and Bergmann, 1976) (Table 1). Hamrick and Loveless (1984) also found that the genetic variation of tree species in natural stand higher almost double that of other plant species. In addition, Hamrick (1989) and Hamrick *et al.* (1992) also reported that long-lived woody perennials would show high levels of genetic diversity. Hamrick and Godt (1989) and Hamrick *et al.* (1992) showed that H_e

TABLE 1
Summary on the Mean Observed Heterozygosity (H_o), Mean Expected Heterozygozity (H_e) and Proportion of Polymorphic Loci.

	S. parvifolia (30)	*S. macroptera* (30)	*S. acuminata* (30)	*S. leprosula* (30)	*H. beccariana* (30)	*D. crinitus* (30)	*E. malaccensis* (30)	*A. elasticus* (30)	*P. gutta* (30)	*M. gigantea* (30)
Range										
H_o	0.000	0.200	0.000	0.000	0.100	0.200	0.000	0.100	0.300	0.100
H_o	0.800	1.000	0.900	0.800	1.000	0.900	0.900	0.900	1.000	0.800
Mean	0.446	0.562	0.383	0.510	0.473	0.467	0.422	0.558	0.608	0.440
Range										
H_e	0.255	0.255	0.420	0.255	0.445	0.180	0.322	0.460	0.000	0.255
H_e	0.825	0.743	0.990	0.620	0.695	0.906	0.655	0.665	0.640	0.790
Mean	0.512	0.506	0.582	0.454	0.602	0.471	0.536	0.509	0.482	0.537
L	11	12	12	10	11	9	9	12	12	10
P	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	0.9	1.0
A	2.7	2.6	2.4	2.5	2.9	2.6	2.7	2.8	2.6	2.7

Note : Number in parentheses indicate sample size.
Key : H_o - observed heterozygosity, H_e - expected heterozygosity;
L - loci scored
P - proportion of polymorphic loci
A - average number of alleles per locus

TABLE 2
Genetic diversity parameters of tropical tree species as compared to genetic diversity of ten species obtained in this study.

Species	Heterozygosity Expected	Proportion of Polymorphic Loci (%)	References
Acacia auriculiformis	0.071	39.8	Wickneswari and Norwati (1993)
A. auriculiformis	0.146	n.a.	Moran *et al.* (1989a)
A. crassicarpa	0.086	58.7	John (1996)
A. crassicarpa	0.141	n.a.	Moran *et al.* (1989a)
A. mangium	0.200	67.0	Hamidi (1990)
Artocarpus elasticus	0.508	100.0	Present study
Azadirachta excelsa	0.094	67.5	Házandy (1997)
Dipterocarpus crinitus	0.471	100.0	Present study
Endospermum malacensis	0.536	100.0	Present study
Gliricidia sepium	0.260	59.9	Chamberlain *et al.* (1996a)
Hevea brasiliensis	0.307	87.5	de Paiva *et al.* (1994)
Hopea beccariana	0.602	100.0	Present study
Hopea odorata	0.190	40.7	Wickneswari *et al.* (1995)
Leucaena shannonnii	0.271	65.7	Chamberlain *et al.* (1996b)
Macaranga gigantea	0.538	100.0	Present study
Palaquium gutta	0.482	91.6	Present study
Pinus kesiya	0.166	54.2	Boyle *et al.* (1991)
Pterocarpus macrocarpus	0.246	82.3	Liengsiri *et al.* (1995)
Shorea acuminata	0.604	100.0	Kong (1994)
S. acuminata	0.582	91.7	Present study
S. leprosula	0.565	72.2	Da im (1993)
S. leprosula	0.457	93.3	Daisy (1995)
S. macrophylla	0.209	47.0	Kanzaki *et al.* (1996)
S. macroptera	0.507	100.0	Present study
S. leprosula	0.454	100.0	Present study
S. parvifolia	0.535	95.2	Kong (1994)
S. parvifolia	0.512	100.0	Present study
Tectona grandis	0.347	79.0	Kertadikara and Prat (1995)
Tropical species	0.111	27.6	Hamrick and Loveless (1986)

Note : n.a. - not available.

depends on the geographic range of the species i.e. species with wider distribution range has higher H_e. The outcrossing nature of most of these species can further support such result. An outcrossed species has been reported to produce a more genetically diverse sample (Moran *et al.* 1989a), especially when samples were taken from individuals originating possibly from only a few mother trees. This phenomenon would be likely to occur for species that experience prevalent a sexual reproduction i.e. by apomixis. For instance Kaur *et al.* (1978);(1986) and Somego (1978) have provided some evidence of apomixis of some Malaysian dipterocarps. Thus detailed reproductive biology and cytological studies should be incorporated to clarify the observed genetic status of these species.

CONCLUSION

Genetic variation among the selected species is relatively high in terms of polymorphism and heterozygosity values. High levels of genetic variability for all species are strongly associated with the life history, reproductive biology and their capability for adaptation. The average genetic variation of the available species with H_e of 0.454 to 0.602 is high and sufficient to support a selective breeding programme. However, further verification of genetic control of enzyme loci assayed is required. In addition, evaluation of these parameters should be conducted on similar species from different compartments to assess for the intraspecific variation before any sampling and breeding strategies could be outlined. In addition, growth performances of

these species should also be evaluated so as to capture maximum genetic gain for the purposes of breeding and conservation.

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An Estimate of Forest Biomass in Ayer Hitam Forest Reserve

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ABSTRAK

Daripada inventori yang dijalankan di Hutan Ayer Hitam (AHFR), min dbh berjulat dari 20.6 ke 26.0 cm manakala keluasan pangkal berjulat dari 9.16 ke 21.57 m^2/ha. Modifikasi persamaan regresi biojisim digunakan untuk menanggarkan biojisim. Kepadatan biojisim untuk pokok dbh 10 cm dan ke atas di semua kompartment di AHFR berjulat dari 83.69 ke 232.39 t/ha. Jumlah biojisim di 1248 ha AHFR yang dianggarkan adalah 223,568 t. Variasi dalam kepadatan biojisim antara kompartment menunjukkan peringkat pemulihan yang berbeza atau pada peringkat sasaran yang berbeza. Maklumat biojisim boleh digunakan untuk menanggarkan parameter yang lain seperti kandungan karbon dan kandungan tenaga. Kandungan karbon yang dianggarkan adalah 111,784 t manakala kandungan tenaga dianggarkan adalah 3.74 x 10^{12} kJ. Pengumpulan kandungan karbon tahunan berjulat dari 0.30 ke 0.50 t/ha/yr manakala tenaga yang dihasilkan berjulat dari 1.00 x 10^7 ke 1.67 x 10^7 kJ/ha/yr. Hutan juga memainkan peranan yang penting dalam kitaran karbon dan pengeluaran tenaga. Biojisim adalah bahan organik yang dihasilkan oleh pokok dan ia adalah punca kepada pengeluaran hutan yang lain.

ABSTRACT

From an inventory conducted in Ayer Hitam Forest (AHFR), the average dbh ranged from 20.6 to 26.0 cm while the basal area ranged from 9.16 to 21.57 m^2/ha. Modified biomass regression equation was used in the biomass estimation. The biomass density for trees of 10 cm dbh and above in all the compartments in AHFR ranged from 83.69 to 232.39 t/ha. The total biomass in the 1248 ha of AHFR is estimated at 223,568 t. Variations in biomass density among the compartments indicate the different stages of recovery or different stages of succession. Biomass information was used to estimate other parameters such as carbon content and energy content. The estimated carbon content is 111,784 t while the energy content is 3.74 x 10^{12} kJ. The estimated annual carbon accumulation ranges from 0.30 to 0.50 t/ha/yr while the energy fixed ranges from 1.00 x 10^7 to 1.67 x 10^7 kJ/ha/yr. Forest also plays an important role in carbon cycle and energy production. Biomass is the organic matter fixed by the tree and is the source of all other productivity of the forest.

INTRODUCTION

Tree biomass is defined as the total amount of living organic matter in trees and is expressed as oven-dry biomass per unit area (usually in tonnes/hectare) (Brown 1997). The term has been widely used as a unit of yield since the 1970s as it is a more useful measure than volume as it allows comparisons to be made between different trees as well as among different tree components.

The uses of biomass information are to (i) quantitatively describe ecosystems and indicate the biomass resources available (Young and Tryon 1978 ; Brown 1997), (ii) quantify amount of nutrients in the ecosystem and hence elucidate nutrient cycling (Long and Turner 1974; Golley 1975; Baker *et al.* 1984; Lim 1988), (iii) determine energy fixation in forest ecosystems (Satoo 1968), (iv) provide estimates of the carbon content in forest (Brown and Lugo 1984; Brown *et al.* 1989; Brown 1997), (v) quantify increment in forest yield, growth or productivity (Burkhart and Strub 1973) and (vi) assess changes in forest structure (Brown 1997).

By using information on biomass, content of carbon, energy and nutrient could be estimated rapidly. With this information, detrimental effects of harvesting can be assessed and compensatory programmes for nutrient replacement through fertilization can be considered. This is also important for evaluation and improvement of site and these form the bases for sound forest management (Lim 1993).

Forest can be a carbon source and sink. Therefore, the management of the forests can affect the global carbon cycle and climate change. In a review by Brown (1997), approximately fifty percent of the biomass is carbon. This represents the potential amount of carbon that can be added to the atmosphere as CO_2 when the forest is cleared (Brown 1997). Tipper (1998) estimated that deforestation contributes about 1.8 Gigatonne Carbon (Gt C) per year. However, forests can also remove CO_2 from the atmosphere through photosynthesis. It is estimated that between 1.1 and 1.8 Gt C per year can be sequestered in 50 years (Makundi *et al.* 1998).

There are efforts to reduce fossil fuel use to more friendly energy sources such as solar, wind, hydropower and biomass. Biomass energy is considered low tech and suitable. Tree biomass can also be an energy source to substitute the use of CO_2-emitting fossil fuel. Renewably grown biomass is a carbon-neutral fuel with a low sulphur content and can be converted to electricity, heat, liquid and gaseous fuel. Plant biomass energy can contribute up to 45 million tonnes oil equivalent (Mtoe) per year. This renewable carbon-neutral biomass energy could reduce CO_2 emission by 50 million tonnes (Mt) of carbon per year (Hall 1998).

This paper will highlight the total above ground biomass estimates using a modified biomass equation. Comparisons of total biomass estimates between compartments are made. In addition, estimates of total carbon and energy content are also presented.

MATERIALS AND METHODS

Summarized inventory data of the area were used with a modified equation to estimate the total biomass in all the compartments. All trees data of 10 cm dbh and above were used in the calculation.

Many biomass estimates are based on the Kato's *et al.* (1978) equations (e.g. Soepadmo 1987; Philip 1999). However, these equations are difficult to use as they involve sequential estimates using a number of equations. The different equations used are shown below.

Stem weight-DBH regression

The stem biomass (W_S) is related to the product of the square of Dbh and tree height. The regression equation is:

$$W_s = 0.313*(Dbh^2H)^{0.9733}$$

where:
W_S = Stem biomass (kg)
Dbh = Diameter breast height (dm)
H = Height (dm)

Branch weight-DBH regression

The branch biomass is estimated from the equation

$$W_B = 0.0390*(Dbh^2H)^{1.041}$$

where:
W_B = Branch biomass (kg)

Leaf weight-Stem weight allometry

The leaf biomass is related to the stem weight by the following equation

$$1/W_L = 1/0.124*(W_S^{0.794}) + 1/125$$

where:
W_L = Leaf biomass (kg)
W_S = Stem biomass (kg)

Estimation of tree biomass

Given the value of Dbh of a tree, it is possible to estimate the total biomass (W_T). This is done by the summation of stem biomass (W_S), branch biomass (W_B) and leaf biomass (W_L) estimated from the above equations.

$$W_T = W_S + W_B + W_L$$

where:
W_T = Total biomass (kg)
W_S = Stem biomass (kg)
W_B = Branch biomass (kg)
W_L = Leaf biomass (kg)

Many other studies use a simple allometric equation of the form $Y = a(Dbh)^b$ (Satoo and

Madgwick 1982). Estimates from the Kato *et al.* (1978) equations above were used to develop a regression of the form $Y = a\ (Dbh)^b$. Estimates from *Acacia mangium* stands (AM86, AM88) (Lim 1986, 1988) and modified Kato *et al.* (1978) were incorporated to derive the modified equation. The derived biomass equation is $Y = 0.0921*(Dbh)^{2.5899}$. The list of the equations are as shown in Table 1.

TABLE 1
Summary of the biomass equations

Source	Equations
Modified Kato *et al.* (1978)	$Y = 0.2544*(Dbh)^{2.3684}$
Lim (1986)	$Y = 0.0843*(Dbh)^{2.5201}$
Lim (1988)	$Y = 0.0380*(Dbh)^{2.8320}$
Modified	$Y = 0.0921*(Dbh)^{2.5899}$

Note: Modified Kato *et al.* (1978) equation denotes as Modified Kato
Lim (1986) equation is denoted as AM86
Lim (1988) equation is denoted as AM88
Modified is denoted as derived equation from AM86, AM88 and Modified Kato

where:
Y = Biomass (kg)
Dbh = Diameter breast height (cm)

TABLE 2
The estimated total biomass of different diameter size by using equations by Lim (1986,1988) (AM86, AM88), Modified Kato *et al.* (1978) (Modified Kato) and modified equation (Modified)

Dbh	AM86	AM88	Modified Kato	Modified
10	27.9	25.8	59.4	35.8
20	160.2	183.9	306.8	215.7
30	445.1	579.7	801.6	616.4
40	919.1	1309.3	1584.3	1298.5
50	1612.8	2463.1	2687.6	2314.3
60	2553.4	4127.9	4139.0	3711.0
70	3765.6	6387.3	5962.8	5532.0
80	5272.0	9322.9	8180.8	7817.6
90	7093.9	13014.1	10813.0	10606.0
100	9251.2	17538.8	13877.7	13933.5
110	11762.9	22973.3	17392.1	17834.6

The estimated total biomass by using equations developed by Lim (1986; 1988), modified Kato *et al.* (1978) and the modified equation are as shown in Table 2. The estimated biomass density values were used to estimate carbon and energy content by using conversion factor. The lines of the different equations are shown in *Fig. 1.*

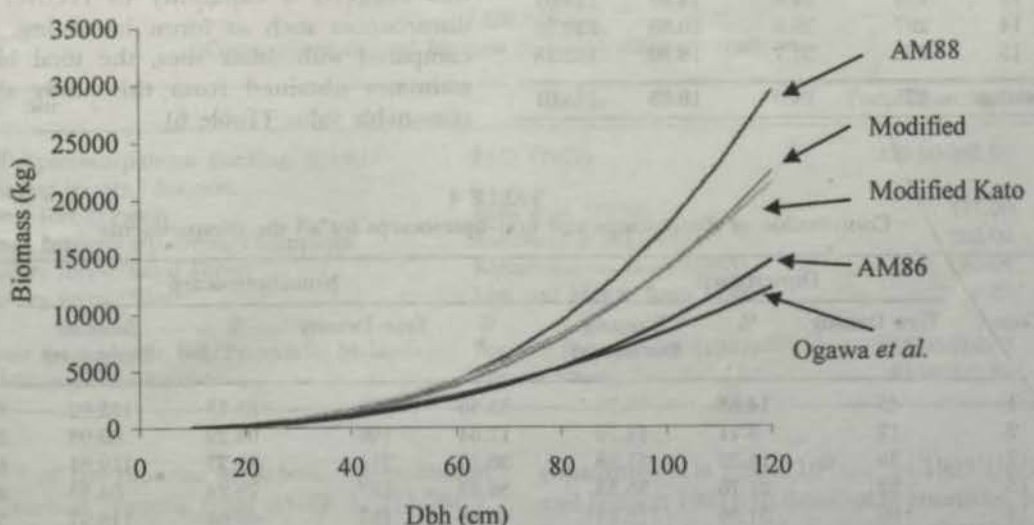

Fig. 1. Biomass regression equations developed by Ogawa et al. (1965), Modified Kato et al. (1978), Lim (1986, 1988) and modification on these equations

RESULTS AND DISCUSSION

The tree densities range from 210 to 366 trees/ha and the basal areas range from 9.16 to 21.57 m^2/ha. The average dbh ranged from 20.6 to 26.0 cm (Table 3). The number of trees in different size classes in most compartments drop rapidly with the increase of size classes (Table 4).

Biomass density is the amount of organic matter expressed in tonne/hectare. It provides a means of comparison between different areas. The estimated biomass density for trees 10 cm dbh and above in Compartment 1 (C1) is 21.57 tonne/hectare (t/ha), Compartment 2 (C2) is 9.16 t/ha, Compartment 12 (C12) is 171.39 t/ha, Compartment 13 (C13) is 149.67 t/ha, Compartment 14 is 232.39 t/ha and Compartment 15 (C15) is 183.28 t/ha (Table 3).

The biomass density values of each compartment are related to their corresponding areas to give estimates of the total biomass of each compartment. Thus, the estimated total biomass for this 1248 ha of Ayer Hitam Forest (AHFR) is 223,568 t (Table 3).

Most of the biomass density in each compartment is contributed by the non-dipterocarps species which ranged from 51.02 to 82.36 % of the total biomass density (Table 5).

There are variations in values of biomass density among the compartments. The lowest was obtained in Compartment 2 with biomass density of 83.69 t/ha. Pioneer species such as *Macaranga* spp., *Sapium* spp. and *Endospermum malaccense* from the family Euphorbiaceae are present in high density (13.3 %) in this compartment. The lowest average dbh (20.6 cm) and basal area (9.16 m^2/ha) were recorded in this compartment. This indicates that the forest stand is in an early stage of succession.

The highest biomass density was obtained in Compartment 14 with 232.39 t/ha. High densities of primary species such as *Shorea* spp., *Hopea* spp., *Dipterocarpus* spp., *Syzygium* spp. and *Palaquium* spp. are found. The families of Dipterocarpaceae (31.7 %), Myrtaceae (15.7 %) and Sapotaceae (10.5 %) are dominant. The average dbh is 25.8 cm and the basal area is 20.89 m^2/ha. This suggests that the compartment has recovered quite well from previous disturbances.

Other compartments are in states intermediate between these two compartments. AHFR has a diversity of states of recovery and this suggests a capability to recover after disturbances such as forest harvesting. When compared with other sites, the total biomass estimates obtained from this study show a reasonable value (Table 6).

TABLE 3
Tree density (no./ha), average dbh (cm), basal area (m^2/ha) and biomass density (t/ha) for all the compartments

Compt.	Tree Density (no/ha)	Average DBH (cm)	BA (m^2/ha)	Biomass Density (t/ha)
1	303	26.0	21.57	229.62
2	210	20.6	9.16	83.69
12	246	25.3	16.40	171.39
13	239	24.6	14.89	149.67
14	287	25.8	20.89	232.39
15	366	21.7	18.39	183.28
Average	275	24.0	16.88	175.01

TABLE 4
Contribution of dipterocarps and non-dipterocarps for all the compartments

Compt.	Dipterocarp				Non-Dipterocarp			
	Tree Density	%	Biomass Density (t)	%	Tree Density	%	Biomass Density (t)	%
1	45	14.85	76.70	33.40	258	85.15	152.92	66.60
2	12	5.71	14.76	17.64	198	94.29	68.93	82.36
12	35	14.23	51.58	30.10	211	85.77	119.81	69.90
13	52	21.76	55.33	36.97	187	78.24	94.33	63.03
14	90	31.36	113.83	48.98	197	68.64	118.57	51.02
15	28	7.65	39.83	21.73	338	92.35	143.45	78.27
Average	44	15.93	58.67	31.47	232	84.07	116.34	68.53

TABLE 5
Biomass density (t/ha) in different diameter class sizes, total biomass (t/compartment) and tree density (no./ha) for all the compartments

DBH (cm)	C1	C2	C12	C13	C14	C15	Total	Average
10.0-19.9	145 (12.52 t)	131 (10.90 t)	114 (9.58 t)	124 (11.30 t)	138 (11.50 t)	208 (15.60 t)		143.3 (11.90 t)
20.0-29.9	54 (20.42 t)	37 (13.99 t)	48 (18.51 t)	36 (12.70 t)	54 (21.72 t)	73 (26.62 t)		50.3 (18.99 t)
30.0-39.9	50 (44.99 t)	24 (20.72 t)	51 (45.65 t)	38 (34.29 t)	48 (42.71 t)	48 (43.17 t)		43.2 (38.59 t)
40.0-49.9	29 (51.40 t)	13 (23.18 t)	19 (33.87 t)	27 (45.18 t)	19 (31.76 t)	28 (47.34 t)		22.5 (38.79 t)
50.0-59.9	11 (32.14 t)	4 (10.80 t)	6 (16.08 t)	11 (31.80 t)	18 (47.33 t)	5 (14.33 t)		9.2 (25.41 t)
60.0-69.9	10 (41.87 t)	1 (4.10 t)	5 (22.05 t)	2 (8.30 t)	4 (16.36 t)	1 (3.72 t)		3.8 (16.07 t)
70.0-79.9	4 (26.28 t)	0 (13.44 t)	2 (6.10 t)	1 (6.10 t)	2 (11.63 t)	2 (13.73 t)		1.8 (11.86 t)
80.0-89.9	0	0	0	0	1 (8.52 t)	0		0.2 (1.42 t)
90.0-99.9	0	0	1 (12.21 t)	0	2 (21.96)	0		0.5 (5.69 t)
100.0-119.9	0	0	0	0	1 (18.90 t)	1 (18.77 t)		0.3 (6.28 t)
Biomass Density (t/ha)	229.62 126	83.69 156	171.39 220	149.67 195	232.39 279	183.28 272	1248	175.01
Compartment Size (ha)								
Total Biomass (t/compartment)	28,932.12	13,055.64	37,705.80	29,185.65	64,836.81	49,852.16	223,568.18	

TABLE 6
Comparisons of total biomass (t/ha) in different study sites

Site	Source	Total Biomass (t/ha)
Mixed dipterocarp-dense stocking, flat to undulating terrain/ Sarawak	FAO (1973)	325.00-385.00
Lowland forest/Pasoh	Kato *et al.* (1978)	475.00
Lowland Dipterocarp forest/Philippines	Kawahara *et al.*(1981)	262.00
Secondary forest/Sabal Forest	Kamaruzaman *et al.* (1983)	53.04
Secondary forest/Sibu	Lim and Mohd. Basri (1985)	6.20
Superior to moderate hill/Peninsular Malaysia	Forestry Department (1987)	245.00-310.00
Ayer Hitam Forest Reserve	Present Study	83.69-232.39

As half of the biomass is carbon, the estimated total carbon content from AHFR is 111,784 t, while the estimated energy content of all the biomass is 3.74×10^{12} kJ. This energy is equivalent to 8.60×10^{4} tonne oil equivalent (toe) (Table 7). It is estimated that the global energy consumption is 7.80×10^{9} toe. in 1993 (Jackson and Jackson 1997). In developing countries, wood fuel is used for cooking, making charcoal, etc. This estimate from AHFR suggests that forests can play an important role in carbon cycle and energy supply.

TABLE 7
The estimated carbon content (t) and energy content (kJ, toe) in 1248 hectare of Ayer Hitam Forest Reserve

Compt.	Biomass (t/compartment)	Carbon (t)	Energy (kJ)	Energy (toe)
1	28,932.12	14,466.06	4.84×10^{11}	1.11×10^{4}
2	13,055.64	6527.82	2.18×10^{11}	5.01×10^{3}
12	37,705.80	18852.90	6.31×10^{11}	1.45×10^{4}
13	29,185.65	14592.83	4.89×10^{11}	1.13×10^{4}
14	64,836.81	32418.41	1.10×10^{12}	2.53×10^{4}
15	49,852.16	24926.08	8.34×10^{11}	1.92×10^{4}
Total	223,568.18	111,784.09	3.74×10^{12}	8.60×10^{4}

Conversion Factors:
1 tonne/hectare = 4000 cal/g =4.0×10^{9} cal/t (Kimmins 1997)
1 kcal = 4.184 kJ (Krebs 1994)
1 kJ = 2.3×10^{-8} tonne oil equivalent (toe) (Jackson and Jackson 1997)

From other unpublished studies in AHFR, we estimate that the biomass increment ranges from 0.60 to 1.00 t/ha/yr. Therefore, the annual carbon accumulation ranges from 0.30 to 0.50 t/ha/yr and the annual energy fixed ranges from 1.00×10^{7} to 1.67×10^{7} kJ/ha/yr.

CONCLUSION

AHFR is recovering after disturbances in the past. Forest stands in the different compartments are in different stages of recovery as indicated by different biomass densities. This biomass is the organic matter fixed by the tree and is the source of all other productivity of the forest.

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Microclimate of Ayer Hitam Forest, Selangor

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ABSTRAK

Mikroklimatologi hutan ialah satu proses penilitian proses fizikal di sempadan lapisan atmosfera hutan pada sesuatu masa. Pemahaman terhadap prinsip biofizikal ini perlu dalam merangka sistem perhutanan yang mampan di mana sumber hutan boleh digunakan untuk pemuliharaan ekologi, sumber kayu, rekreasi, sumber air dan apresiasi estetik. Objektif kajian ini ialah untuk mencirikan mikroklimatologi Hutan Ayer Hitam. Kajian ini dijalankan di Kompartmen 6 Hutan Ayer Hitam. Parameter seperti suhu udara dan tanah, cahaya, kelembapan dan kelajuan angin dimantau pada tempoh kajian dijalankan. Data yang serupa juga diambil (kecuali cahaya) di stesyen kajicuaca UPM. Keputusan kajian menunjukkan stesyen kajicuaca UPM mempunyai suhu udara min dan maximum yang lebih tinggi dan suhu minimum yang lebih rendah jika dibandingkan dengan Hutan Ayer Hitam. Kelembapan min Ayer Hitam adalah lebih tinggi manakala julat harian adalah lebih rendah dibandingkan dengan stesyen kajicuaca UPM. Min suhu tanah pada semua kedalaman di Ayer Hitam adalah lebih rendah dibandingkan pada stesyen kajicuaca UPM. Keputusan daripada kajian ini menunjukan iklim mikro Ayer hitam adalah berbeza daripada stesyen kajicuaca UPM.

ABSTRACT

Forest microclimatology is the study of physical processes in the forest atmospheric boundary layer over time. An understanding of these biophysical principles is essential in the development of sustainable forest management system in which forest resources can be utilized for ecological protection, timber resources, recreation, water resources and aesthetic appreciation. The objective of this paper is to characterise the microclimate of Ayer Hitam Forest. The study was conducted at Compartment 6 of the Ayer Hitam Forest. Parameters such as soil temperature, light, humidity, wind velocity and air temperature were monitored hourly during the study period. Data on the same parameters (except light) were also obtained from the Universiti Putra Malaysia, meteorological station. The UPM meteorological station had higher mean hourly air temperature, recorded higher maximum and lower minimum compared to Ayer Hitam Forest. Mean relative humidity at Ayer Hitam was higher than at UPM meteorological station while daily range relative humidity was higher at UPM meteorological station compared to Ayer Hitam. Mean soil temperatures at all depths in Ayer Hitam Forest were lower compared to the UPM meteorological station. Result from the study shows that microclimate of Ayer Hitam is different from UPM meteorological station.

INTRODUCTION

Microclimate is climate of a small scale. It is concerned with the state of the atmosphere near the ground, the layer in which most animals and plants live. Heat exchange and water vapor transfer between this layer and the ground are active and are greatly affected by land use and micro-relief conditions. Thus, there is a great spatial variation with respect to temperature, humidity and other climate variables within a short

distance. On the other hand, climate describes the atmospheric conditions of general terrain in which the effects of land use and micro-relief are smaller and there is less variation over space.

Forest microclimatology is the study of physical processes in the forest atmospheric boundary layer over time. Lee (1978) defined it as the study of atmospheric processes which include energy and mass exchanges and transformations in a soil-plant-atmosphere continuum where physical stimuli are modified to a large extent by physiological factors. It focuses on the interrelatedness of environment and life process, but it is also concerned with physical effects and the forest's influence on the external environment. An understanding of these biophysical principles is essential in the development of sustainable forest management system in which forest resources can be utilized for ecological protection, timber resources, recreation, water resources and aesthetic appreciation. The objective of this paper is to describe and characterise the microclimate of Ayer Hitam Forest.

MATERIALS AND METHODS

Study Area

This study was conducted at Ayer Hitam Forest, Puchong, Selangor. Ayer Hitam Forest Reserve has been gazetted to University Putra Malaysia in 1996 by Forest Department of Selangor. The Forest was gazetted for forest education and research purpose. It is about 1,248 hectare and has six compartments.

The topography of the forest is rather undulating between 15 to 157 meter above sea level. This forest has been classified as a rich lowland dipterocap forest of *Kempas-Kedondong* and has been logged before in 1930 (Aminuddin 1978). After the logging operation, the Ayer Hitam Forest Reserve was classified as a secondary disturbed forest. The emergent canopy stand is about 20 meters above the ground. The secondary layers are between 12 to 16 meters above ground and the lower canopy consists of saplings and seedlings.

Data Collection

Parameters such as soil temperature, light, humidity, wind velocity and air temperatures were monitored hourly during the study period, 17-23 November, 1986 (Table 1). Data on the same parameters (except light) were also obtained from the University Putra Malaysia meteorological station.

TABLE 1
Instruments and parameter observed during the study.

Parameter measured	Instrument	Position
Soil temperature	Soil temperature thermometer	5cm, 10cm and 20 cm and 30 cm depth
Air temperature	Hygrothermograph	1m
Light	Light meter	1 m
Humidity	Hygrothermograph	1 m
Wind Velocity	Anemometer	10 m

RESULTS AND DISCUSSION

Air Temperature

Air temperature hourly variation is shown in *Fig. 1*. At Ayer Hitam, air temperature increased from 0600 hour until 1400 hours and decreased until 0600 hour. Maximum air temperature was 27.7°C, recorded at 1400 hour while the minimum was 22.9°C recorded at 0500 and 0600 hour. At UPM meteorological station, maximum air temperature was 31.3°C recorded at 1400 hour while the minimum was recorded at 0500 hour. The UPM meteorological station had higher mean hourly air temperature, recorded higher maximum and lower minimum compared to Ayer Hitam Forest (Table 2). This may be due to the protective function of the forest in which during the day incoming solar radiation was being blocked by the vegetative cover while during the night, the vegetative cover prevented the energy being radiated out of the atmosphere.

Relative Humidity

The result of relative humidity is shown in *Fig. 1*. Maximum relative humidity at Ayer Hitam and UPM meteorological station was 97.8 % and 100 %, respectively, while the minimum relative humidity was 77.4 % and 60.2 %, respectively. Mean relative humidity at Ayer Hitam (87.6 %) was higher at UPM meteorological station (80.1 %) while daily range relative humidity was higher at UPM meteorological station (39.8 %) compared to Ayer Hitam (20.4 %). Diurnal variation of

TABLE 2.
Descriptive statistics of hourly air temperature and relative humidity at both sites.

	Air Temperature (°C)				Relative Humidity (%)			
	Max.	Min.	Mean	Range	Max.	Min.	Mean	Range
Ayer Hitam	27.7	22.9	25.3	4.8	97.8	77.4	87.6	20.4
UPM Met Station	31.3	22.1	26.7	9.2	100	60.2	80.1	39.8

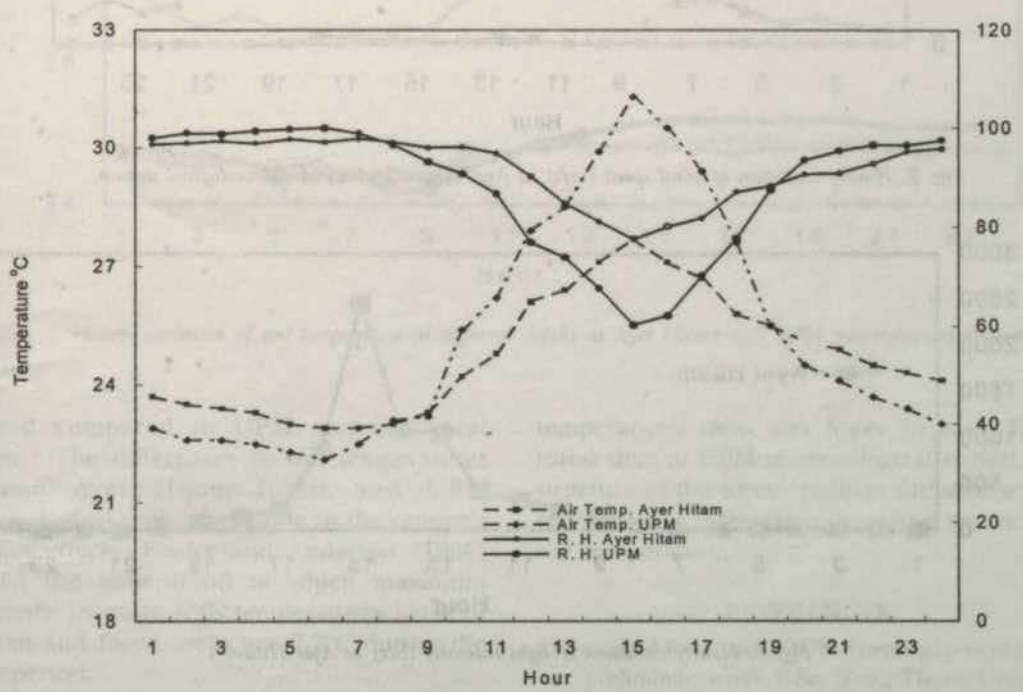

Fig. 1. Hourly Variation of air temperature and relative humidity at Ayer Hitam and UPM meteorological station.

relative humidity for both sites showed the same trend at which maximum relative humidity occurred in the morning, at 0500 hour for UPM meteorological station and 0600 hour for Ayer Hitam while minimum relative humidity occurred during the day at 1400 hour. As in air temperature, the low value of daily range of relative humidity shows the effect of forest in buffering the environment. Relative humidity is a function of air temperature and lower air temperature will lead to higher relative humidity.

Wind Speed

Wind speed at both sites were higer during the day than the night. Wind speed variation at Ayer Hitam forest is shown in *Fig. 2.* Maximum wind speed was 0.0720 m/s occurred at 1600 hour while there was no wind movement during the night. At UPM meteorological station, maximum wind speed was 2.17 m/s occurred at 1400 hour while minimum wind speed was 0.15 m/s occurring at 2300 hour. As a note, wind speed measurement at UPM meteorological station was taken at 0.5 meter height.

Light

Hourly variation of light intensity is depicted in *Fig. 3.* Light intensity increased from 50 lux at 0700 hour and reached maximum of 2460 lux at 1400 hour and decreased to 34 lux at 1900 hour.

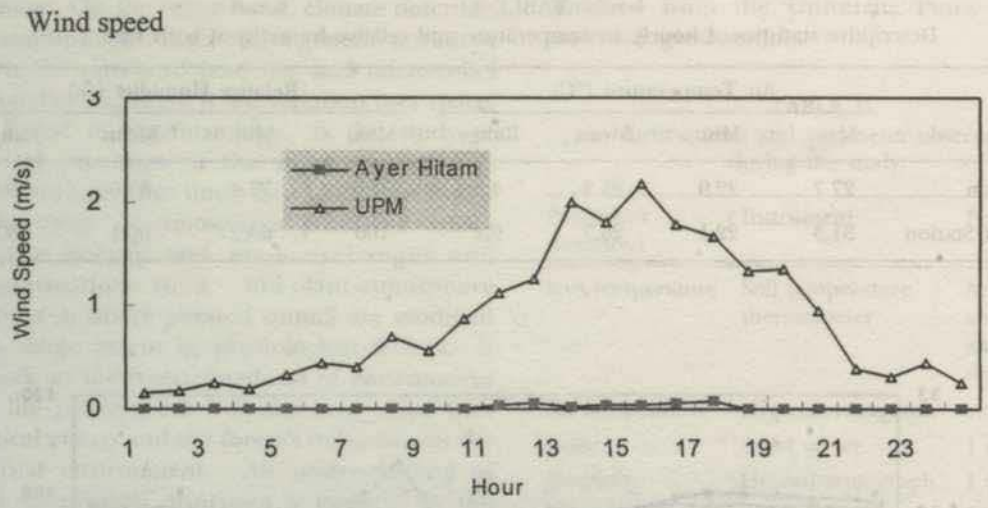

Fig. 2. Hourly variation of wind speed (m/s) at Ayer Hitam and UPM meteorological station.

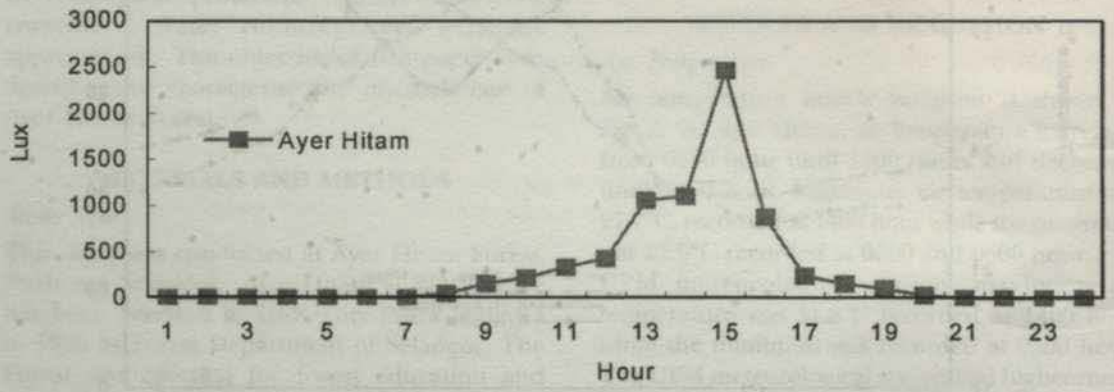

Fig. 3. Hourly variation of light intensity (lux) at Ayer Hitam.

Soil Temperature

Soil temperature at 5 cm depth for the Ayer Hitam forest ranged from 25.2°C to 24.2°C with a mean of 24.7°C. For UPM meteorological station, it ranged from 31.3°C to 26.5°C with a mean of 28.9°C. Soil temperature at 10 cm depth for the Ayer Hitam forest ranged from 24.9°C to 24.1°C with a mean of 24.5°C while for UPM meteorological station soil temperature ranged from 28.4°C to 27.5°C with a mean of 28.0°C. At 30 cm depth, the hourly soil temperature for Ayer Hitam forest ranged from 24.7°C to 24.4°C with a mean of 24.6°C. For the UPM meteorological station, the hourly soil temperature at 30 cm depth ranged from 28.5°C to 28.0 °C with a mean of 28.3°C. Mean soil temperatures at all depths at Ayer Hitam were

TABLE 3.
Descriptive statistics of soil temperature at Ayer Hitam and UPM meteorological station.

	Soil Temperature (°C)			
	Max.	Min.	Mean	Range
Ayer Hitam				
5	25.2	24.2	24.7	1.0
10	24.9	24.1	24.5	0.8
20	24.8	24.3	24.6	0.5
30	24.7	24.4	24.6	0.3
UPM Meteorological Station				
5	31.3	26.5	28.9	4.8
10	28.4	27.5	28.0	0.9
30	28.5	28.0	28.3	0.5

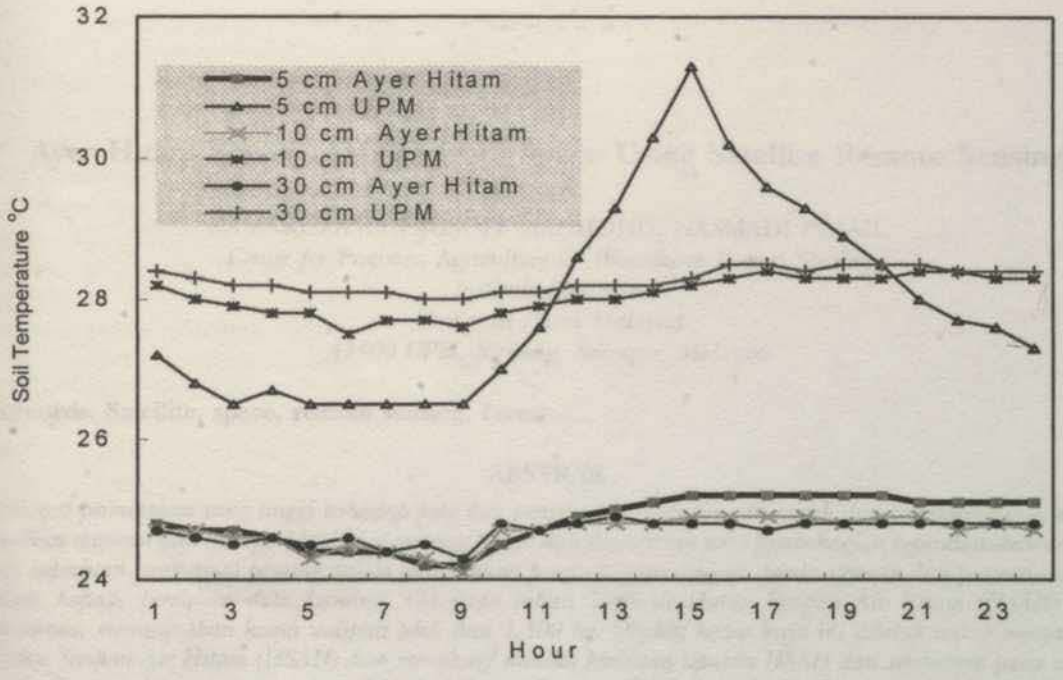

Fig. 4. Hourly variation of soil temperature at different depths at Ayer Hitam and UPM meteorological station

lowered compared to UPM meteorological station. The differences in soil temperatures between Ayer Hitam forest and UPM meteorological station were due to the canopy's shading effect. Fowler and Anderson (1986) showed the same trend in which maximum difference in mean soils temperatures between clearcut and forest areas was 7.7°C during the study period.

CONCLUSION

Results from the study show that the microclimate of Ayer Hitam is different from UPM meteorological station. Mean air temperature was lower while the mean relative humidity was higher compared to UPM meteorological station. Wind speed and soil temperatures were also lower in Ayer Hitam forest than at UPM meteorological station. The structure of the forest reduces the solar energy reaching the forest floor, lowering the air and soil temperature.

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Ayer Hitam Forest (AHFR) from Space Using Satellite Remote Sensing

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Keywords: Satellite, space, remote sensing, forest

ABSTRAK

Terdapat permintaan yang tinggi terhadap peta dan pengawasan penggunaan tanah dan penaksiran disebabkan keadaan ekonomi dan ekologi. Maklumat tentang tanah dan liputannya serta pembahagian kependudukan adalah satu keperluan yang amat penting dalam mana-mana program perancangan, pembangunan dan pengurusan. Di dalam kajian, perolehan data Landsat TM pada tahun 1998 di Hutan Simpan Air Hitam (HSAH) dan sekitarnya, menunjukkan ianya meliputi lebih dari 1,300 ha. Objektif kertas kerja ini adalah untuk memetakan Hutan Simpan Air Hitam (HSAH) dan menaksir/ menilai kawasan liputan HSAH dan sekitarnya pada tahun 1998, di mana ianya menggunakan Teknologi Remote Sensing (Penderiaan Jauh). Pemprosesan data digital dan penganalisaan dibuat menggunakan peralatan PCI/ EASI PACE yang terdapat di Fakulti Perhutanan, UPM. Kaedah 'False Color Composite' (peniruan gabungan mewarna) menggunakan Landsat TM band 4-5-3 (RGB) digunakan untuk mengelolakan/ mengawasi pengkelasan menggunakan ' Maximum Likelihood Classifier" (Pengkelasan secara maksimum). Daripada tafsiran pandangan, keadaan HSAH boleh dibahagikan kepada sistem jalan, jalan hutan, kawasan lapang, kawasan yang sedang dibangunkan, ladang kelapa sawit, kawasan berair, kawasan penanaman getah dan sebagainya. Dalam pada itu, pengkelasan digital menunjukkan bahawa terdapat 7 pengkelasan kawasan penggunaan tanah berdasarkan penggunaan tanah di sekitar HSAH , iaitu hutan, hutan sekunder/ hutan pokok renik, ladang kelapa sawit, ladang getah, kawasan yang dibangunkan, kawasan yang dilapangkan dan kawasan berair yang boleh dipetakan dengan mudah. Secara keseluruhannya, pengkelasan secara tepat mengandungi 86.06 peratus dengan ketepatan 86.64 peratus. Pemetaan satelit terhadap HSAH di dapati amat berguna untuk perancangan makro dan pengurusan terutamanya pada penilaian/ penaksiran kesan persekitaran jika pembangunan pada masa akan datang dipolitikan.

ABSTRACT

There is a high demand to map and monitor the land use and assess their condition for ecological and economic reasons. Information on existing land and cover and their spatial distribution is a pre-requisite for any planning, development and management programme. In this study, Landsat TM data of 1998 were acquired over the AHFR and it's vicinity which covers an area more than 1, 300 ha. The objective of this paper is to map AHFR and assess the land cover of AHFR in 1998 as well as its surrounding area using remote sensing technology. Digital data processing and analysis were carried out using PCI/EASI PACE software, version 6.2 available in Faculty of Forestry, UPM. A false Colour Composite (FCC) of Landsat TM band 4-5-3 (R-G-B) was used in supervised classification using Maximum Likelihood Classifier (MLC). From a visual interpretation, several features of AHFR could be identified such as federal road, forest road, cleared land, built-up area, oil palm, water bodies and rubber plantation etc. Meanwhile, digital classification showed that seven land use types surrounding AHFR such as forest, secondary forest/shrubs, oil palm, rubber, built-up area, cleared land and water bodies could a easily be mapped out. The mean overall classification accuracy obtained is 86.08 percent with an average accuracy of 85.64 percent. Satellite map of AHFR is found to be useful for the macro planning and management purposes especially on the Environmental Impact Assessment (EIA) if further development on the area is to be politicized.

INTRODUCTION

There is a high demand to map and monitor the land use and assess their condition for ecological and economic reasons. Information on existing land use pattern and its spatial distribution is a pre-requisite for any planning, development and management programme. Nowadays, science and technology have provided us with a new dimension and view of planet Earth, first through the electronic eyes of sensor systems on spacecraft whirling around the globe, and then through human eyes, fascinated by its vast range of features and colours. From space, we can see the face of the world, with white of its snow, the green of forest and farmland, the blue ocean, and painted deserts in all their living hues of red to brown and purple.

The study of earth including land, oceans, atmosphere and their interactions has made rapid advances in recent time due to continuous regional and global observation through remote sensing. Space-base remote sensing is one of the process of obtaining information about earth from instruments mounted on Earth Observation Satellites (Anon 1991). Satellite remote sensing provides a means to collect area information repeatedly on a regional or global scale, particularly in remote areas which is difficult to access by road (Mohd. Hasmadi and Kamaruzaman 1999). Hence, Remote sensing are useful spatial tools for interactive land use mapping. The vegetation information in a digital format will help focus and stratify the more costly field data collection.

Most countries worldwide are taking advantages and opportunities using remote sensing technique for sustainable management of natural resources, environmental monitoring, hazard mitigation, education and scientific research with great success. In Malaysia, the significance of using this technology for various purposes particularly natural resources management is obviously gaining wider recognition. The objective of this paper is to map AHFR and assess the land cover of AHFR in 1998 as well as its surrounding area using remote sensing technology.

MATERIALS AND METHODS

Description of Study Area

Air Hitam Forest Reserve (AHFR) is a university forest that plays an important role to the purposes in scientific research and education in forestry. It covers an area of 1, 248 ha. which currently comprises of six compartments namely, 1,2,12,13,14 and 15, and has been allocated as an education forest by the State of Selangor during 22nd June 1994 convention at the Selangor State Meeting Council. This forest is situated approximately 20 km south west of Kuala Lumpur and 6 km from UPM, at latitudes between 20 57' N to 30 04' N and longitudes 101° 38'E to 101° 41' E (Fig. 1).

The climate of AHFR area is typically tropical. The mean monthly temperature is 28.36°C with a mean maximum and minimum of 32°C and 22.6°C, respectively. However, the maximum and minimum relative moisture contents are 97.8% and 77.4%, giving average moisture content of 87.6%, respectively. Annual precipitation in the area is approximately 2316.5 mm – 4223.4 mm. The highest rainfall mainly occurs in May and the lowest is in August. The topography of the area consists of low lying hills with narrow river valleys. AHFR is undulating ranging from 15 m to 157 m above sea level. The average slope is about 20% and there are many flat areas. The area was drained by Rasau and Bohol rivers which generally flow in the north to south direction.

Data Acquisition and Digital Image Analysis

Optical satellite data (Landsat TM) with seven bands were used to map AHFR from space and classify land use/cover in AHFR. Landsat TM spectral data taken on 8 February 1998 (path/row 127/58) were acquired in the form of compact disk with a spatial resolution of 30 m. This image covered the entire study area and no haze or clouds were recorded in the scene. Satellite data were processed digitally and visually. Other references data acquired to support the satellite imagery are topographic map (1:50 000) and classified satellite image of 1990 (1: 50 000). Digital analysis of satellite data was done using PCI/EASIPACE (version 6.2) image processing system available in the Center for Precision Agriculture & Bioresource Remote Sensing, Institute Bioscience, Universiti Putra Malaysia.

Methods

Briefly, the procedures involved are data acquisition, radiometric and geometric correction, interpretation, output derivation and field verification. Digital and visual interpretations were used to classify Landsat TM data. The geocoding correction was based on ground control points

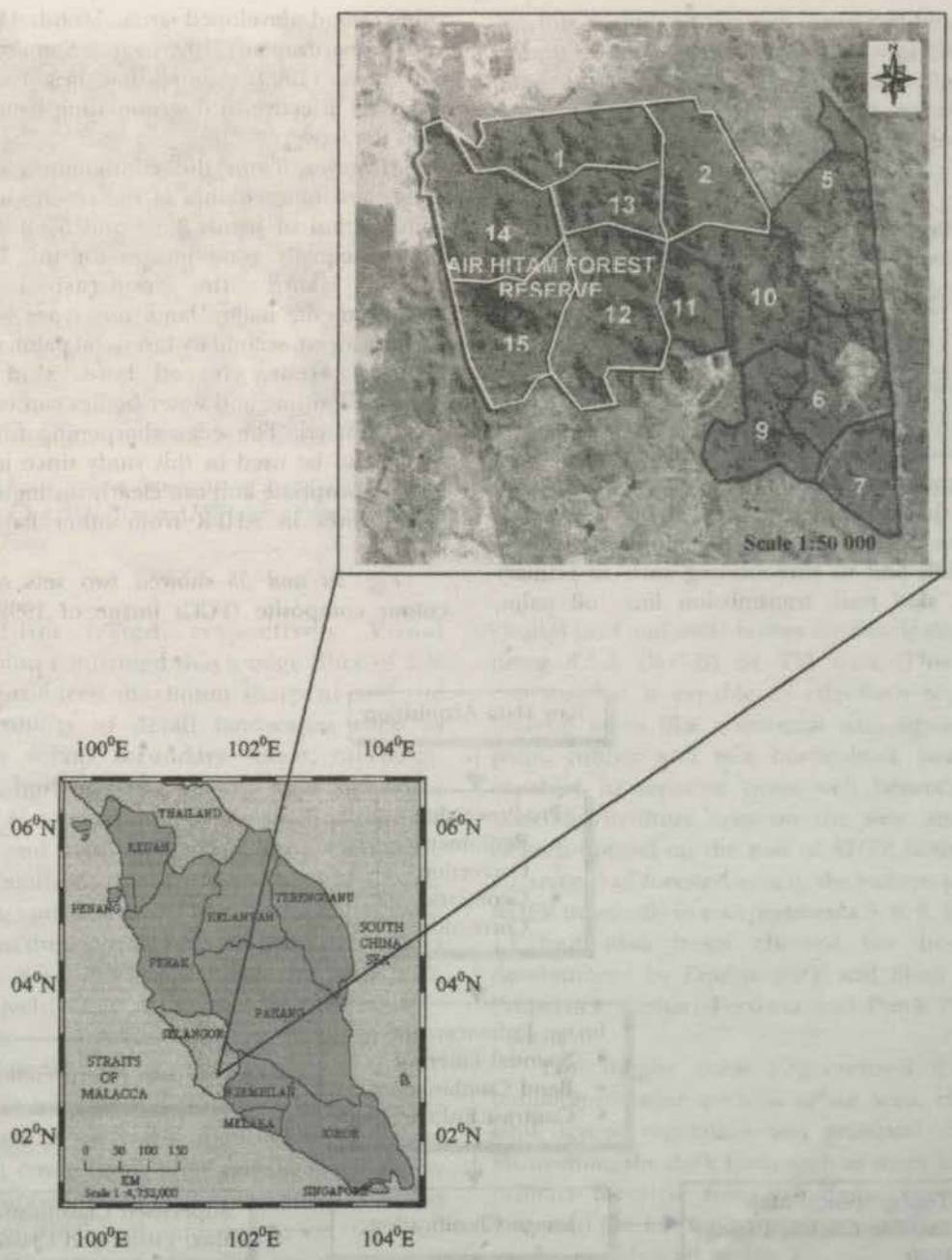

Fig. 1. Satellite Imagery Showing the Location of AHFR and their Compartments

(GCPs), where Landsat TM 1993 were used as a base reference. A total of 10 GCP's were defined to recognize points on both the master and slave data sets (image to image registration approach). The corrected image was enhanced through contrast enhancement and spatial filtering and displayed in a combination of false colour composite. Theoretically, by comparing the spectral signatures of unknown features types with known surfaces, prediction can be made about the of unknown features. The signatures of particular area such as vegetation that was

measured by sensor, may not be unique and can vary with time, seasonal changes, angle of sensor, atmospheric attenuation and local environmental differences (Sanders 1983). The image was interpreted to locate training sites for image classification. Automated image classification namely supervised classification was used and Maximum Likelihood Classifier was chosen. The final classified images were generated using several steps as shown in *Fig. 2.*

RESULTS AND DISCUSSION

Band Combination and Contrast Enhancement

Through band combination and contrast enhancement it is possible to visualize the band that gives maximum information of the data. From the image represented by band 4 and 5, one can clearly distinguish the important features in AHFR and its surrounding such as primary forest, skid trail, transmission line, oil palm, rubber, and developed area. Mohd. Hasmadi and Kamaruzaman (1998), and Kamaruzaman and Aswati (1999) claimed that these bands are relatively effective in discriminating from other land use/cover.

However, from the combination of red, green and blue colours of the seven channels, combination of bands 4,5,3 and 5,4,3 (R-G-B) showed equally good images for this kind of study. Using the contrast-stretching enhancement, major land use types such as primary forest, secondary forest, oil palm, rubber, built-up areas, cleared land, skid road, transmission line and water bodies can easily be discriminated. The edge sharpening filter was applied to be used in this study since it is the most appropriate and can clearly distinguish the forest cover in AHFR from other land use/covers.

Fig. 3a and 3b showed two sets of false colour composite (FCC) image of 1998 using

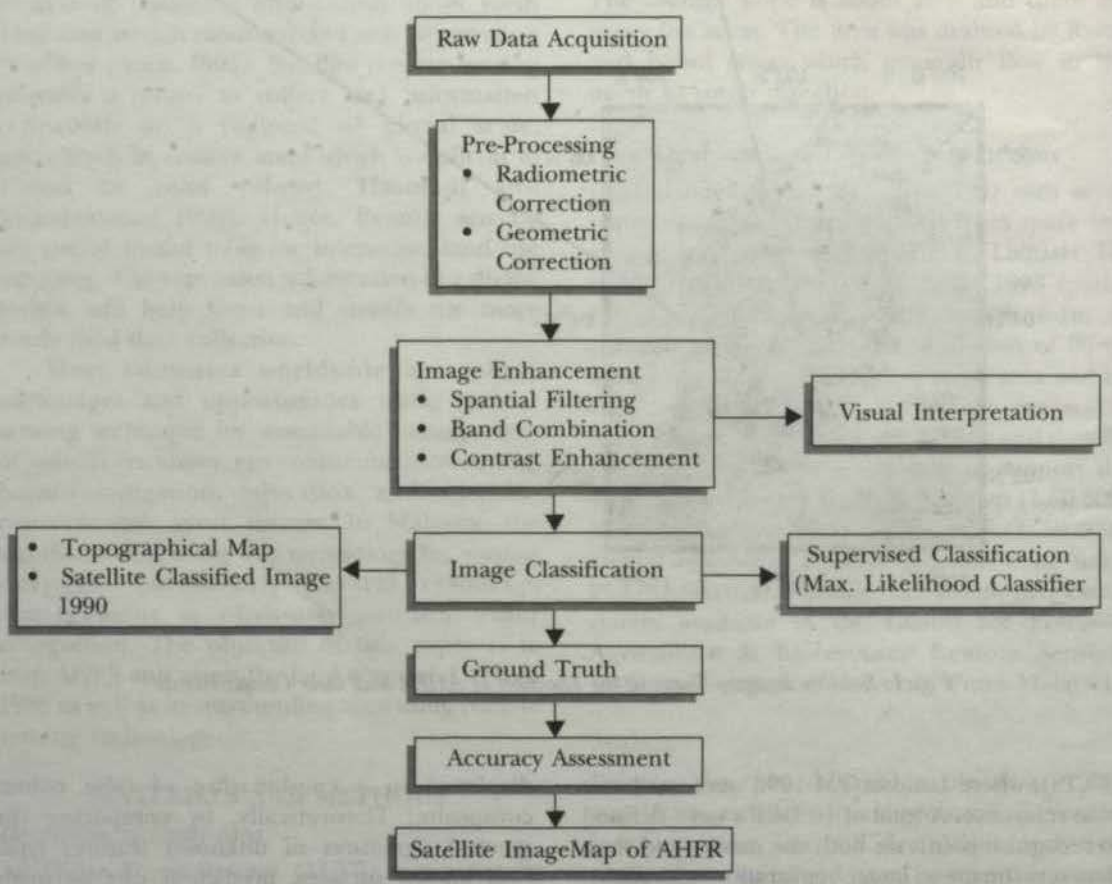

Fig. 2. Flow Diagram of Study

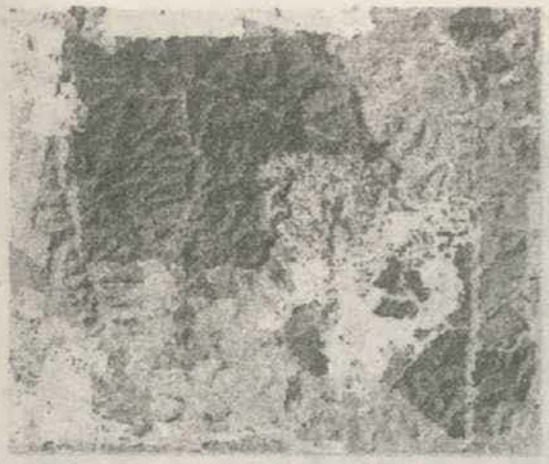

Fig. 3a. False Colour Composite of Band Combination 4,5,3 (R-G-B) over AHFR using Edge Sharpening Filter

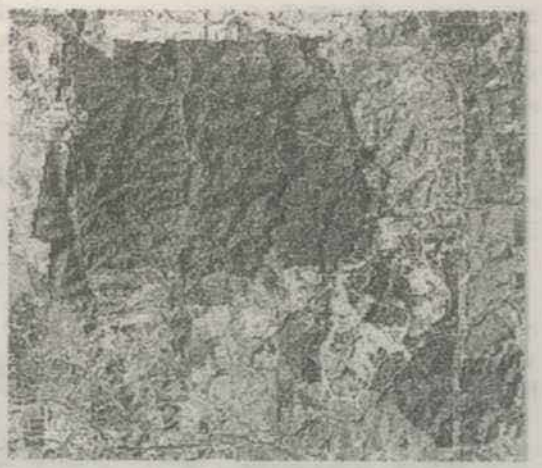

Fig. 3b. False Colour Composite of Band Combination 5,4,3 (R-G-B) over AHFR using Edge Sharpening Filter

edge filter tested, respectively. Visual impression confirmed that a edge filter of 3 X 3 size produced maximum sharpens and the best visibility of detail landscapes such as primary versus secondary forest, oil palm, rubber, built-up area, cleared land and water bodies. However, some of the small patches of shrubs and mix horticulture crop cannot be well visualized due to their almost similar texture and contrast. For example, cleared land and dual carriageway both appear in light blue in 4-5-3 FCC and purple in 5-4-3 FCC, respectively.

Visual Interpretation

The most important step in the analysis was the extraction of spectral signatures that represent selected cover types, after careful investigation of the topographical map and satellite classified image of 1990 and information on the site. Visual interpretation of satellite imagery showed primary forest, secondary forest, oil palm, rubber, built-up area, cleared land and water bodies features based on different spectral reflectance and image contrast. Nevertheless, Landsat TM cannot readily detect significant different or variation in spectral distribution from forest cover types and other vegetation distribution in the scene.

The main land cover/use of primary forest, secondary forest, oil palm, rubber, built-up area, cleared land and water bodies are clearly detected using 4-5-3 (R-G-B) of TM data. This FCC combination is capable to effectively separate built-up areas like residential sites against oil palm, rubber and mix horticulture farms. It capables to separate quite well between the mixed-horticulture area on the west and the cleared upland on the east of AHFR boundary. 90 percent of forested area in the eastern part of AHFR especially in compartments 5, 6, 9, 10 and 11 had also been cleared for housing development by Equine Park and Shah Alam Properties (Lestari Perdana and Putra Permai Park).

The bright areas represented a high temperature zone such as urban area, cleared land, sparse vegetation and grassland/shrubs. Meanwhile, the dark spots such as water bodies' primary forested area and dense vegetation indicated the low temperature zones. The visual images are showed in *Fig. 4*.

Supervised Classification: Maximum Likelihood Classifier (MLC)

Supervised classification with MLC was performed by training the computer to recognize particular ranges of pixel value with the ancillary data available for the study and the knowledge of the interpreter. A total of 15 training samples were used to classify the entire study area according to MLC. The supervised

Fig. 4. Visual Interpretation of AHFR from Landsat TM 1998

1. Puchong Industrial Park
2. Technology Park Malaysia
3. Loong Chuan Rubber Plantation
4. Choong Keow Oil Palm Plantation
5. Shah Alam Properties Development
6. Equine Park
7. Rubbish Dump Site
8. Putra Permai Housing Park
9. Proposed Film park
10. Residential
11. UPM Puchong Farm
12. Puchong Mix-Horticulture
13. Kg. Pasir Baharu Puchong
14. Kg. Sg. Rasau Hilir
15. Kg. Baharu
16. Camp Site

classification using MLC can be seen in *Fig. 4*, respectively. By this technique, seven classes were identified as follows:

1. Forest green
2. Secondary forest/shrubs white
3. Oil palm yellow
4. Rubber purple
5. Built-up area red
6. Cleared land black
7. Water bodies blue

Table 1 shows the statistical results of the supervised classification using MLC for 1998. Built-up areas include Puchong , Kinrara, Equine Park and Lestari Perdana represent the largest i.e. 35.72 percent components of forest conversion activities surrounding AHFR. This is followed by rubber (20.31 percent), oil palm (18.71 percent), cleared land (14.18 percent), forest (6.79 percent), secondary forest/shrubs (3.33 percent) and water bodies (2.07 percent).

Accuracy Assessment

A mean overall accuracy assessment is of 86.08 percent. This is considered acceptable for a satellite image analysis. The summarized statistical

TABLE 1
Statistical results of seven classes by MLC of 1998 over AHFR

Class code	Description	No. of pixels	Areal Extent (ha)	Image percentage(%)
1	Forest	1024	92.16	6.79
2	Oil palm	2819	253.71	18.71
3	Built-up area	5385	484.65	35.73
4	Rubber	3060	275.40	20.31
5	Cleared land	2137	192.33	14.18
6	Water bodies	312	28.08	2.07
7	Secondary forest/shrubs	7	0.63	3.33
	TOTAL	15070	1,326.96	100.00

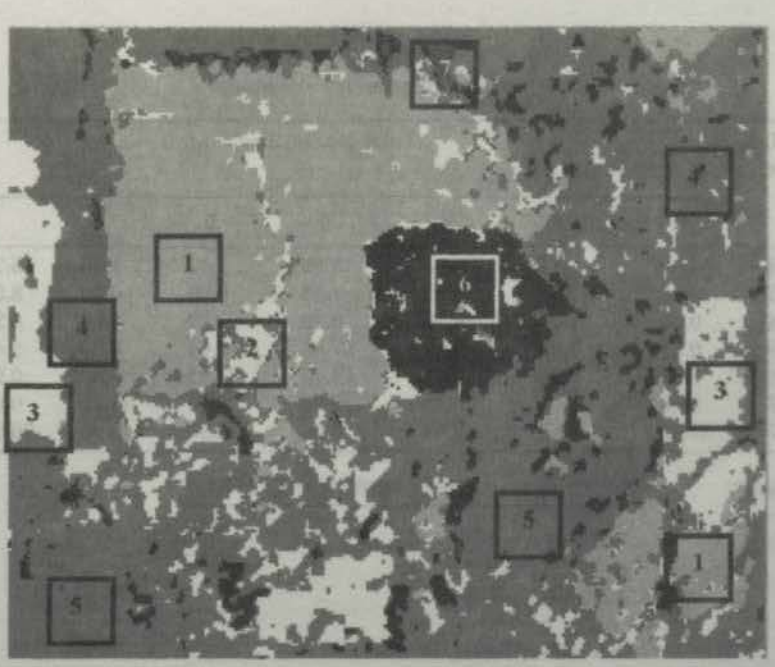

Fig. 5. Seven Clusters of Land use in AHFR 1998 and its Vicinity

result produced from the error matrix is shown in Table 2.

The accuracy ranges from 70.97 percent for secondary forest/shrubs to 94.59 percent for built-up areas. The low classification accuracy for secondary forest/shrubs is due to misinterpreted pixels of built-up areas, cleared land and linear features such as skid road, dual carriageway and transmission line. Although rubber covered the third largest land cover/use in the image, in the actual situation it was very confused with the secondary forest/shrubs due to it age factor and maturity of the vegetation (Mohd. Hasmadi and Kamaruzaman, 1998), canopy closure, background, illumination geometry and spatial resolution of the sensor (Roy, 1999).

CONCLUSION

From this study, several conclusions can be drawn as follows:

- The TM-satellite imagery with 30m X 30m spatial resolution is able to map AHFR from the other surrounding land cover/use such as oil palm, rubber, built-up areas and dual carriageway. Moreover, visually the forest can be separated into two types namely, primary forest and secondary forest using an FCC combination of 4-5-3 (R-G-B). Built-up area can easily be mapped out in the study area. This includes development project like Puchong Industrial Park, Lestari Perdana, Equine Park, Putra Permai Park, Technology Park Malaysia, and public roads such as Damansara-Puchong Expressway and Seri Kembangan-Puchong dual carriageway.

- Digital supervised classification with Maximum Likelihood algorithm is capable of classifying seven land uses/cover in AHFR with a mean overall accuracy of 86.08 percent. Based on satellite imagery analysis, this percentage is acceptable for land use classification and mapping purposes.

- From the visual and digital interpretation, the main factor influencing forest depletion in AHFR is forest clearance for housing and industrial park.

To develop a complete geographical information system (GIS) database integrating remote sensing image of AHFR is highly recommended for future monitoring and sustainable management of AHFR.

TABLE 2
Error matrix of accuracy assessment

Referred Data	Total of Pixel	Total No. of Pixel							Accuracy (%)
		1	2	3	4	5	6	7	
1	806	83.50	1.74	4.84	3.35	1.49	1.36	3.72	83.50
2	225	2.67	87.11	0.89	1.33	0.00	0.00	8.00	87.11
3	314	0.00	1.91	94.59	0.96	1.27	0.96	0.32	94.59
4	165	0.61	1.82	0.61	87.88	3.64	0.00	5.45	87.88
5	166	1.81	0.00	2.41	14.46	81.33	0.00	0.00	81.33
6	17	5.88	0.00	0.00	0.00	0.00	94.12	0.00	94.12
7	7	31.00	6.45	9.68	0.00	12.90	0.00	70.97	70.97

Mean Overall accuracy : $\frac{83.50+87.11+94.59+87.88+81.33+94.12+70.97}{7}$

: 86.08 percent

1. Forest
2. Oil palm
3. Built-up area
4. Rubber
5. Cleared land
6. Water bodies
7. Secondary forest/shrubs

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Antioxidative Responses of Tree Species in Ayer Hitam Forest, Selangor, Peninsular Malaysia

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Keywords: Ayer Hitam Forest, antioxidative responses, tree species, antioxidants, oxidative deterioration

ABSTRAK

Tindakbalas oksidatif lapan spesies pokok, iaitu Atrocarpus elasticus, Endospermum diadenum, Vitex pinnata, Pellacalyx axillaris, Garcinia atroviridis, Gironniera nervosa, Bouea oppositifolia dan Callerya atropurpurea telah ditentukan bagi sampel yang diambil dari kedua-dua kawasan pendalaman dan tepian Hutan Simpan Ayer Hitam. Tindakbalas antioksidatif yang ditentukan termasuklah tahap penguraian oksidatif lipid pada membran sel dan juga kepekatan askorbat serta α-tokoferol, dua antioksidan yang penting. Kesemua lapan spesies menunjukkan perbezaan yang bererti pada tahap penguraian oksidatif antara kawasan pendalaman dan tepian hutan di mana secara amnya, tahap penguraian oksidatif atau peroksidaan lipid pada membran adalah lebih tinggi pada sampel yang diambil dari kawasan tepian hutan kecuali V.pinnata dan G.nervosa. Kepekatan α-tokoferol secara amnya juga didapati lebih tinggi di kawasan tepian hutan kecuali V.pinnata dan G.nervosa. Kepekatan askorbat walaubagaimanapun didapati lebih tinggi bagi semua sampel yang diambil dari kawasan tepian hutan. Ini menunjukkan bahawa terdapat tahap tegasan yang lebih tinggi dari segi tegasan oksidatif akibat gangguan yang lebih ketara di kawasan tepian hutan. C.atropurpurea mungkin merupakan satu spesies penunjuk yang baik dan sensitif dalam menentukan keadaan tegasan di dalam hutan sementara V.pinnata dan G.nervosa pula mungkin merupakan spesies pokok yang dapat mengurangkan tahap penguraian oksidatif dengan cekap dalam keadaan tegasan.

ABSTRACT

Antioxidative responses of eight tree species namely Atrocarpus elasticus, Endospermum diadenum, Vitex pinnata, Pellacalyx axillaris, Garcinia atroviridis, Gironniera nervosa, Bouea oppositifolia and Callerya atropurpurea were determined from samples collected from both the interior and fringe forest regions of Ayer Hitam Forest Reserve. These antioxidative responses measured include the extent of oxidative deterioration of cellular membrane lipids as well as the concentrations of ascorbate and α-tocopherol, two important endogeneous antioxidants. All eight species showed significant differences in the extent of oxidative deterioration between the interior and fringe forest regions where generally higher levels of membrane lipid peroxidation or oxidative deterioration were observed in samples from the fringe forest regions except for V.pinnata and G.nervosa. Concentrations of α-tocopherol were also found to be generally higher in the fringe forest regions except for V.pinnata and G.nervosa. Ascorbate concentrations were however found to be higher in all the tree species sampled from the fringe forest. This thus indicates higher levels of stress conditions with respect to oxidative stress manifested by higher levels of disturbance in the fringe forest regions. While C.atropurpurea may represent a good and sensitive indicator species in determining stress conditions in the forest, V.pinnata and G.nervosa may represent tree species that are efficient in minimising oxidative deterioration in stress conditions.

INTRODUCTION

Plants, in their natural habitats, are often subjected to various stress conditions, which may be due to abiotic factors as well as biotic factors. Abiotic factors, which include drought (Price and Hendry 1991), salinity (Fadzillah *et al.* 1997), anoxia (Crawford 1993), herbicides (Westphal *et al.* 1992), ozone (Tausz *et al.* 1994), sulfur dioxide and other gas pollutants (Bowler *et al.* 1992) as well as biotic factors such as bacterial or fungal infections (Wojtaszek 1997) often lead to decreased growth and yield of the plants affected where in severe conditions, may even lead to death. In most stress conditions, the generation of reactive oxygen species (ROS), have been implicated, where accumulation of these ROS at higher than normal levels may cause various damages at the cellular and molecular levels (Scandalios and Wright 1990). An important measure of this oxidative damage is the extent of oxidative deterioration or peroxidation of tissue and cellular membrane lipids. Through evolutionary pressures however, plants have evolved an antioxidative mechanism comprising of enzymatic as well as non-enzymatic systems. Some plants are more efficient than others in regulating a satisfactory antioxidative defense against the stress conditions, and this is often influenced in part, by their endogeneous antioxidant constituents.

The Ayer Hitam Forest Reserve, flanked by the Puchong Damansara Highway represents a forest ecosystem which can be divided into a more disturbed fringe forest region and a relatively less disturbed interior forest region. Disturbances arising mainly from human activities near the fringe forest which include atmospheric gas pollution may give rise to conditions of oxidative stress which can be measured from the concentration of malondialdehyde (MDA), representing the extent of oxidative deterioration of cellular membrane lipids. Indications of oxidative deterioration as well as status of endogeneous antioxidant, namely ascorbate and α-tocopherol, not only provide information on the level of stress and defense capacity of the plants, but may also provide information on the sensitivity of the plant species in detecting stress conditions. In this study, eight tree species were selected from both the interior and fringe forest regions of Ayer Hitam to determine differences between these two regions in terms of antioxidative responses manifested by different levels of disturbances to these regions. Concentrations of MDA and two important endogeneous antioxidants, namely ascorbate and α-tocopherol, were determined in all the samples collected.

MATERIALS AND METHODS

Plants Samples:

Leaves of eight forest tree species namely *Atrocarpus elasticus* (terap), *Endospermum diadenum* (sesenduk), *Vitex pinnata* (leban), *Pellacalyx axillaris* (membuluh), *Garcinia atroviridis* (kandis), *Gironniera nervosa* (hampas tebu), *Bouea oppositifolia* (kundang), and *Callerya atropurpurea* (tulang daing) were collected from the fringe and interior regions of the Ayer Hitam Forest, Selangor. Leaf tissue of each plant collected was placed in sealed polythene bags, kept in crushed ice and quickly transported to the laboratory for immediate analyses.

Determination of Lipid Peroxidation :

The level of lipid peroxidation in the leaf tissue, measured from concentration of MDA was determined by the thiobarbituric acid (TBA) reaction based on the method by Heath and Packer (1968) with slight modifications by Shaw (1995). Fresh samples (approximately 0.2 g) was homogenized in 1.5 ml 0.1 % (w/v) trichloroacetic acid and clean sand in a prechilled mortar and pestle at 0-4 °C. The homogenate was centrifuged at 10, 000 xg (Universal 16R) for 5 minutes. 0.75 ml of the supernatant obtained was added into 2.25 ml of TBA reagent and the mixture was heated at 95 °C for 30 minutes and quickly cooled in an ice bath for 15 minutes. After centrifuging at 10, 000 xg for 10 minutes, the absorbance of the supernatant obtained was measured at 532 nm with the value of non-specific absorption at 600 nm subtracted from the absorbance values. The concentrations of MDA were calculated using its extinction coefficient of 155 $mM^{-1}cm^{-1}$ and expressed as nmol MDA/g fresh weight of sample. A total of five replicates were used for each plant species from each of the two (interior and fringe forest) locations.

Determination of α-tocopherol :

α-tocopherol was extracted from the leaves tissue based on the method by Hodges *et al.* (1996). Under dim light and over ice, 0.15g of fresh

sample was ground up with 1.5 ml acetone and clean sand in a mortar and pestle at 0-4°C. The mixture was extracted with 0.5 ml hexane followed by vortexing for about 30 seconds. The mixture was then centrifuged at 1000xg for 10 minutes. After the centrifugation, the top layer was removed and the hexane extraction was repeated twice. The assay mixture was prepared as described by Kanno and Yamauchi (1997). 0.5 ml of the hexane-extract was added into 0.4 ml 0.1% (w/v) PDT, (3-(2-pyridyl)-5,6-diphenyl-1,2,4-triazine, prepared in ethanol) and 0.4 ml 0.1% (w/v) ferric chloride (prepared in ethanol). The volume was made up to 3.0 ml with absolute ethanol and the mixture was gently swirled and left for 4 minutes for colour development. Following this, 0.2 ml of 0.2 M orthophosphoric acid was added to the mixture and allowed to stand for 30 minutes at room temperature before absorbance of the mixture was measured at 554 nm. The blank was prepared in the same manner except that the absolute ethanol was used instead of the hexane-extract. A standard curve was prepared using α-tocopherol (Sigma, type V) at various concentrations (0-1.4 µg/ml). 0.5 ml of α-tocopherol was added into the solution as described above and amount of α-tocopherol in the leaf sample was calculated based on the standard curve. A total of five replicates were used for each plant species from each of the two (interior and fringe forest) locations.

Determination of Ascorbate:

Ascorbate was extracted from the leaf tissue based on the method of John and Hughes (1983). 0.15 g of fresh sample was ground with pre-chilled mortar and pestle in 2.0 ml of 6% orthophosphoric acid in ice-cold conditions. The ground samples were then centrifuged at 10,000 rpm for 10 minutes at 4°C. The supernatant obtained was obtained carefully titrated with DCPIP until a pink colouration was obtained. The volume of DCPIP used was compared against a standard curve to determine the amount of ascorbic acid in the samples. A total of five replicates were used from each of the two (interior and fringe forest) locations.

RESULTS AND DISCUSSION

Oxidative deterioration of all the eight species sampled, as indicated by concentrations of MDA in their leaf tissues, were found to be significantly different between the interior forest and fringe forest regions (*Fig.1*). The MDA concentration was generally found to be higher in the leaf tissues sampled from the fringe forest which was relatively more disturbed compared to samples taken from the relatively undisturbed interior forest except for *Vitex pinnata* (Leban) and *Gironniera nervosa* (Hampas tebu) which had higher MDA concentration in the interior forest region . Higher levels of oxidative deterioration in the samples taken from the fringe forest indicate that the plants were subjected to higher levels of stress conditions which may partly be attributed by greater exposure to atmospheric pollution and inferior soil conditions (Bowler *et al.* 1992). The highest degree of difference in MDA concentrations between the interior and fringe forest with reference to the ratio of the fringe forest region MDA concentrations to interior forest region MDA concentrations was exhibited by *C. atropurpurea* followed by *B. oppositifolia, G . atroviridis, P. axillaris , A. elasticus, E. diadenum, V. pinnata* and *G. nervosa.*

Concentration of α-tocopherol (*Fig. 2*), a lipid soluble antioxidant was also found to be generally higher in the fringe forest regions compared to the interior forest region except for *V. pinnata* and *G. nervosa* where significant differences were found in *E. diadenum , V. pinnata, C. atropurpurea.* The apparent ability of *V. pinnata* and *G. nervosa* to minimize oxidative deterioration in stress conditions as indicated by the lower levels of MDA concentrations in the fringe forest region may be attributed to their efficient ability in modulating and regulating the endogeneous α-tocopherol to impede the chain reactions of oxidative deterioration. This may thus explain the lower levels of α-tocopherol in both *V. pinnata* and *G. nervosa* sampled from the fringe forest regions. Concentration of ascorbate (*Fig.3*), a water-soluble antioxidant on the other hand, was found to be higher for all species sampled from the fringe forest region compared to samples from the interior region where significant differences between these two forest regions were shown by *A. elasticus* (terap), *E. diadenum* (sesenduk), *V. pinnata* (leban), *B. oppositifolia* (kundang) and *C. atropurpurea* (tulang daing). Ascorbate, a reductant in the Halliwell-Asada pathway, may be more directly regulated by the environmental conditions compared to α-tocopherol and thus more sensitive with respect to the antioxidative response shown by all the species samples.

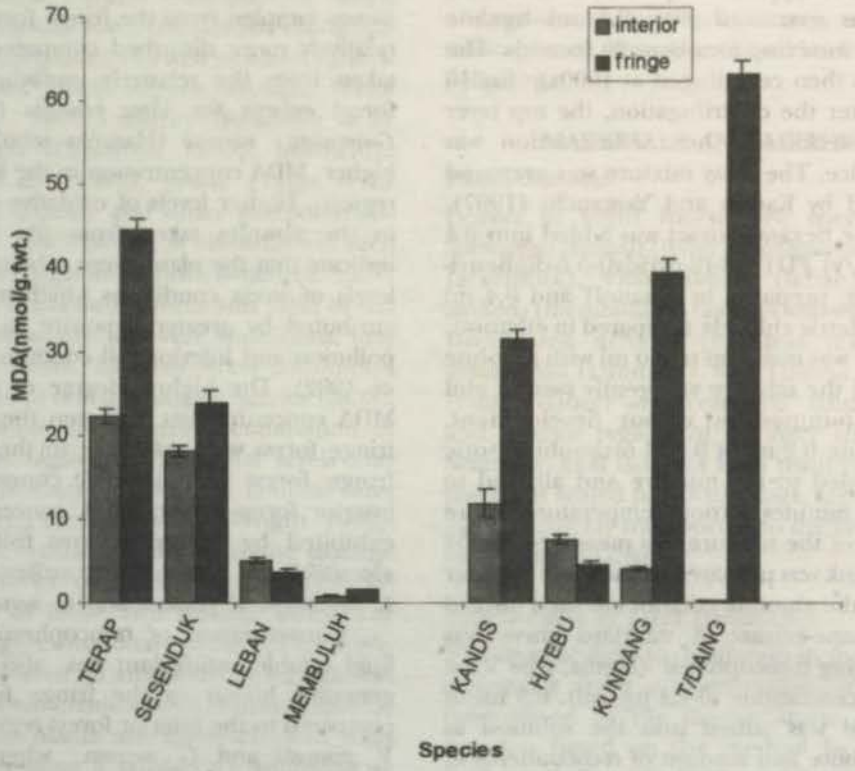

Fig. 1. Malondialdehyde concentration of eight tree species from the interior and fringe forest regions of Ayer Hitam Forest Reserve. Data are means ± se (n=5 replicates)

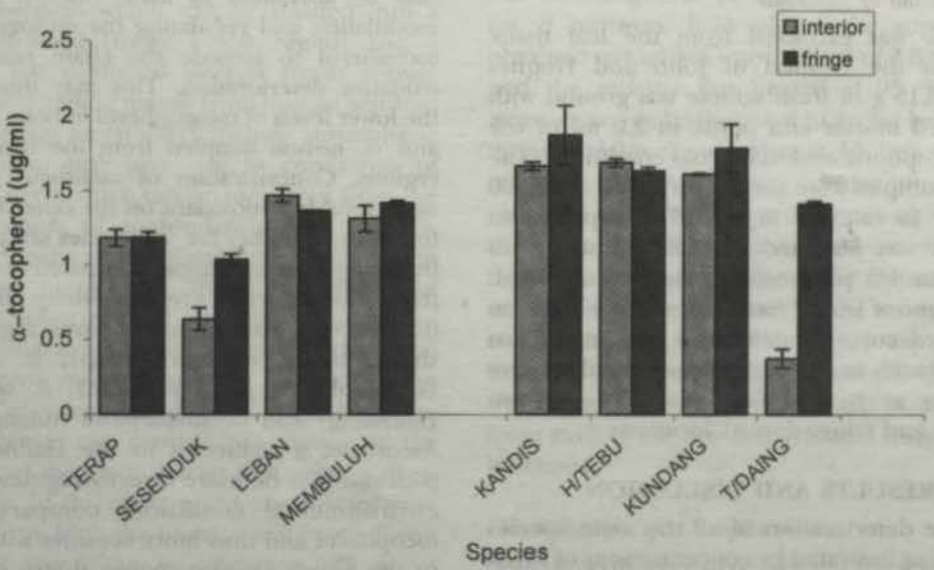

Fig. 2. α-tocopherol concentration of eight tree species from the interior and fringe forest regions of Ayer Hitam Forest Reserve. Data are means ± se (n=5 replicates)

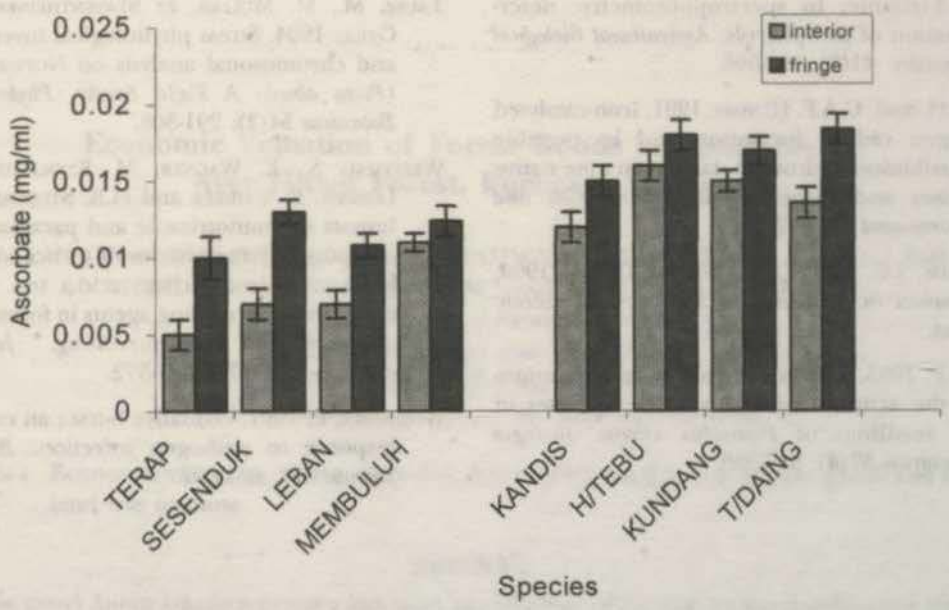

Fig. 3. Ascorbate concentration of eight tree species from the interior and fringe forest regions of Ayer Hitam Forest Reserve. Data are means ± se (n=5 replicates).

CONCLUSION

In agreement with a previous study (Fadzillah and Faridah Hanum 1999), oxidative deterioration has been shown to be a significant antioxidative response and may be a suitable indicator of forest disturbance. In addition, *C. atropurpurea* may be a good and sensitive indicator species in determining stress conditions in the forest regions while *V. pinnata* and *G. nervosa* represent tree species that are efficient in modulating their endogeneous α-tocopherol content to minimize oxidative deterioration in stress conditions.

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Economic Valuation of Forest Goods and Services of Ayer Hitam Forest, Puchong, Selangor

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ABSTRAK

Penukaran tanah hutan kepada kegunaan lain telah menyebabkan kehilangan kepada kepelbagaian biologi dan lain-lain nilai ekonomi kepada komuniti. Bagaimanapun, potensi nilai ekonomi sumber-sumber hutan tidak diambilkira sewajarnya oleh pembuat polisi dan perancang pengguna tanah. Satu kajian penilaian ekonomi sumber hutan dijalankan di Hutan Ayer Hitam (AHFR), Puchong Selangor untuk menentukan nilai ekonominya dan kesannya ke atas perubahan guna tanah. Kajian ini memberi tumpuan kepada penilaian sumber kayu, rekreasi, peranan ke atas komuniti dan pemuliharaan hidupan liar. Keputusan menunjukkan bahawa nilai ekonomi Hutan Simpan Ayer Hitam adalah tinggi dan jika kita tidak mengambilkira nilai tersebut dalam pembangunan guna tanah boleh menunjukkan petanda yang salah kepada pembuat polisi. Perancangan penggunaan tanah pada masa depan hendaklah mengambilkira bukan sahaja pulangan berasaskan kepada pasaran tetapi juga lain-lain faedah alam sekitar.

ABSTRACT

The conversion of forestland to other land uses has resulted in substantial loss of biodiversity and other potential economic values to the community. However, the potential economic values of forest resources have been largely ignored by policy makers and land use planners. An economic valuation of forest resources of Ayer Hitam Forest (AHFR), Puchong, Selangor was carried out to determine its economic value and its impact on land use changes. The study focused on valuation of timber resources, recreation, community roles and wildlife conservation. The results show that the economic value of AHFR is substantial and ignoring this value in land use development would provide a wrong signal to policy makers. Future land use planning should consider not only market-based economic returns but also its non-market and other environmental benefits.

INTRODUCTION

Malaysian tropical forest is well known for providing valuable timber resources to the state governments and the community in terms of direct and indirect monetary and non-monetary benefits. Forests also provide a source of food and genetic resources of many agricultural crops, materials used in medicine, eco-tourism and recreation opportunities, and help in maintaining favourable environmental conditions as well as 'research labs.' In the past, however, the forest has been viewed mainly as a source of timber to feed the wood-based industries, which produce a variety of products for domestic and export consumption. The other equally important components of the forest ecosystem such as environmental services, however, have not attracted much attention until very recently. This is indeed an unfortunate situation knowing the fact that tropical forests are very rich in flora and fauna.

The natural products that come from the forests include latex, steroids, edible oils, rattans, bamboo, spices, pesticides, and dyestuffs while some of the consumer goods made from forest products are coffee, lubricants, glue for postage stamps, golf balls, chewing gums, toothpaste, shampoo, mascara and lipstick. The market in these industrial products is worth billions of dollars per year.

The full potential of the biologically diverse tropical forests has never been completely quantified in economic or monetary terms. While it is relatively simple to determine the economic value of timber because of its readily available market price, it is not as simple to calculate the economic value of recreation, wildlife conservation, medicinal plants species or biological diversity. This could be an important factor for the past neglect on the non-timber components of the forest ecosystem in the decision to convert forest to non-forest uses. The economic potential of these resources has not been very much appreciated. Since the economic value of these resources is difficult to determine, their real potential as income generators has not been fully explored. There is a strong need for studies to be carried out to quantify to the fullest extent the economic value of all forest goods and services. Only then we would have a complete view on the costs and benefits of comparing alternative forestland use options.

This paper discusses the economic value of Ayer Hitam Forest, Puchong, Selangor with emphasis on timber resources, recreation, benefits to community and wildlife conservation. The implications of the study on land use options are discussed in the final section of the paper.

VALUATION OF FOREST GOODS AND SERVICES: THE NEED AND APPROACH

Economists generally depend on market prices to indicate the value of goods and services. For goods and services exchanged in a well-defined market, information on prices and quantities are readily available. This information can be used to estimate the value of certain goods and services by constructing a demand curve. Unfortunately, not all forest goods and services have market prices. This is particularly true for most of the non-timber forest products or services such as water, recreation, wildlife, wild fruits and genes. One characteristic of such goods or services is the occurrence of 'free riders', in which case consumers refuse to express their true willingness-to-pay (wtp), but could obtain utility from the good or service. As such, prices might be distorted leading to inappropriate estimation of the true economic value of the resources. The major role of valuation is, therefore to assign the value to goods and services with distorted or non-existent market prices or to value them in terms of their opportunity cost.

Typically, the benefits derived from forest resources are to be measured in terms of market price or willingness-to-pay of users or consumers for using and experiencing the goods and services. An approximation of users' wtp for certain recreational opportunities, for instance, can be developed from a demand curve, which indicates the quantity of use that users in a market would be willing and able to purchase at each price. Other estimates could be in terms of the expenditures on preventive measures taken by consumers or users to avoid a future loss. Thus, conservation of forest resources could be seen as a form of wtp for current, as well as, future benefits.

Resource economists have yet to agree on a taxonomy of economic values. There are many classifications of values and benefits given in the literature (Barbier 1992, Munasinghe 1993, Pearce 1993). In general, the following category of economic values are used:

(i) Direct use values refer to the productive or consumptive values of ecosystem components or functions. Direct uses may be marketed or non-marketed, with some of the latter activities often being important for the subsistence needs of local communities. An example of a marketed direct use is timber resources, which can be harvested and sold to consumers. The use of medicinal herbs collected from the forest resources by local communities is an example of non-marketed direct use. Marketed uses may be important for both domestic and international markets. In general, the value of marketed goods and services is easier to measure than the value of non-marketed and subsistence direct uses.

(ii) Indirect use values refer to the value of environmental functions that support or protect an economic activity. For instance, a tropical forest protects watersheds and store carbon dioxide. Tropical forests also include many plant species, which in turn may have ecological functions. The values of environmental functions can be derived from the supporting or protecting economic activities that have directly measurable values.

(iii) Option values relate to the amount that an individual or society would be willing to pay to conserve an ecosystem for future uses. For example, preservation of biological diversity can preserve wild genes for future uses such as improvement of a fruit species. Wild fruit and fish may prove to be extremely valuable genetic stocks in the future, because many of these wild plants and fish have genes that can help resist some kind of diseases.

(iv) Existence values refer to society's willingness-to-pay to conserve biological resources for their own sake, regardless of their current or optional uses. For instance, many people reveal their wtp for the existence of biological resources such as wildlife and landscape without participating in the direct use of the wildlife and landscape through recreation.

The method employed to determine each value mentioned above depends on the nature of forest goods and service in question. For the direct use value, the methods available include market-based technique, changes in productivity approach, relocation cost, and damage cost avoided. The contingent valuation approach can be used to value the indirect use, option and existence values. This method requires good understanding of forest goods and services production system. It is not the intention of this paper to discuss each method used in valuing a good or service. A good literature on the methods used can be found in IIED (1994) and Mitchell and Carson (1989).

MATERIALS AND METHODS

Location of the Study Area

The study area is the Ayer Hitam Forest (AHFR), Puchong, Selangor, which is located in a strategic place in a rapidly developing urban community. Some of the development projects that have been completed in the vicinity include an agriculture project, world class sports complex, a multi-million dollar housing project, incineration plant and waste disposal area, and an equestrian park. The forest reserve has also been excised for the highway linking Seri Serdang and Damansara Puchong Highway. The new administration city, Putrajaya, is just a short drive away and so is the capital city of Kuala Lumpur. The forest area, therefore, could provide excellent recreation and eco-tourisn opportunities for urban dwellers.

The forest belongs to the Lowland Dipterocarp forest type. It is classified as a secondary disturbed forest because it has been logged and treated several times since 1930's. Currently, the forest comprises six compartments, namely, compartments 1, 2, 12, 13, 14 and 15. These compartments make up a total area of 1,248 ha. According to the Forestry Department record, the area of AHFR has decreased substantially from the original forest area of about 4,267 ha in 1965. The extent of forest area and the percentage of area loss as compared to the original area are shown in Table 1.

The AHFR is the only remaining lowland forest reserves left in the Klang Valley. It is an excellent demonstration area for students to learn about various aspects of forestry. In addition, the forest area offers research opportunities for scientists interested in the working of a tropical lowland forest ecosystem. It also serves as an important 'green lung' for the urban city of Kuala Lumpur.

Considering the factors mentioned above, a general function of AHFR is to promote the protection of a lowland forest ecosystem that would serve the needs for education, research, and recreation not only for UPM community but also the urban areas (Petaling Jaya, Subang Jaya, Kelang, Kuala Lumpur) and dwellers surrounding the forest reserve (Seri Serdang, Seri Kembangan, Puchong, Kajang and Bangi). Thus, the management objectives of AHFR are as follows:

- to promote systematic and coordinated research into the working of a lowland rainforest ecosystem;
- to provide training areas in forest biology, forest production, forest management,

environment, medicinal plants, microclimate, and other related disciplines; and
- to offer opportunities for forest recreation and eco-tourism for local as well as the surrounding urban communities.

TABLE 1.
Extent of Ayer Hitam Forest, Puchong, Selangor and area loss (1965-1997)

Year	Forest area (ha)	Percentage of area loss (compared to base year 1965)
1965	6267.56	
1980	4006.00	36.08
1983	4006.00	36.08
1993	2198.00	64.90
1994	1964.00	68.66
1997	1082.701	82.72

Source: Annual Report, Selangor State Forestry Department (various years) and District Forest Office Selangor Tengah, Cheras.

Economic Valuation Method

In this study, the economic valuation was carried out for the following goods and services:

- timber resources
- recreation
- local dependence of non-wood resources
- wildlife

It should be noted that the total economic valuation of AHFR is still on-going, and the results presented here are not comprehensive. The economic value of wildlife was based on physical unit, not the economic value per se. The following section describes the methods used and results of economic valuation quantified for each of the goods and services of the Ayer Hitam Forest Reserve.

Valuing Timber Resources

The residual value method was used to estimate stumpage value of AHFR. The value of standing timber is calculated as the difference between the selling value of the products made from it and the stump-to-market processing costs (including margin for profit and risk). Stumpage value per hectare for a compartment was calculated using the following formula:

$$sv_{ij} = v_{ij} * (p_{ij} - c - pm_{ij})$$

where:

sv = stumpage value, (RM/ha)
v = volume, (m^3/ha)
p = price, (RM/m^3)
c = average logging cost, (RM/m^3)
pm = profit margin, (RM/m^3)

i,j are index for species and diameter class, respectively.

pm is calculated as follows:

$$pm_{ij} = (p * PR)/ (1+PR)$$

where PR is profit ratio.

The subscripts i and j indicate that stumpage value (sv_{ij}) varies due to variations in log price (p_{ij}) at each diameter class j. Since average cost is constant, it is not subscripted.

Data on timber volume were obtained from the records of a post-felling inventory conducted by the Faculty of Forestry, UPM. The inventory data were used to estimate timber volume for each species in the compartments by using the one way volume formula. Data on log prices were obtained from previous study by Awang Noor and Mohd. Shahwahid for Negeri Sembilan (Table 2). Data on logging costs were also obtained from the study by Awang Noor and Mohd. Shahwahid (1997). The average logging cost used in the analysis was RM75 per cubic meter. Data collected were analysed to determine the total stumpage value for Compartments 1, 2, 12 13, 14 and 15.

RESULTS AND DISCUSSION

Valuing Timber Resources

The taxonomic composition from the enumeration of trees of 5 cm and above in a one hectare plot in a lowland forest at Ayer Hitam Forest, Selangor is shown in Table 3. Results showed that the plot contains 177 tree species belonging to 92 genera and 44 families.

The various estimates of stumpage value were calculated and presented in Table 4. The results show that the estimated stumpage value is substantial, comparable to other estimates in the hill forest. In fact, all the estimated stumpage values are relatively higher to the estimated stumpage value for other hill dipterocarp forests. This indicates that that the AHFR is fully

TABLE 2.
Log price by species and species group (ex-matau), RM/m^3

Species/ Species group, I	Diameter class, j				
	15-30 (j=1)	30-45 (j=2)	45-50 (j=3)	50-60 (j=3)	60+ (j=4)
Group 1					
Dark red meranti (I=1)	233	332	384	451	472
Light red meranti (I=2)	224	313	358	423	443
White meranti (i=3)140	212	282	333	343	
Yellow meranti (i=4)94	142	187	229	243	
Meranti melantai (I=5)	157	247	331	386	394
Group 2					
Mersawa (I=6)	192	322	442	511	537
Merawan (I=7)	108	143	162	192	200
Gerutu (i=8)	108	143	162	192	200
Group 3					
Oily keruing (i=9)	272	344	412	466	476
Non-oily keruing (I=10)	86	110	134	213	228
Kapur (i=11)	86	110	134	213	228
Group 4					
Balau (i=12)	196	287	381	479	503
Cengal (i=13)	249	376	528	649	697
Giam/resak (i=14)	115	152	174	214	230
Other HHW (i=15)	115	152	174	214	230
Light hard wood (I=16) (Group 5)	107	135	159	189	201
Medium hard wood (i=17) (Group 6)	86	110	134	213	228
Heavy hard wood (i=18) (Group 7)	115	152	174	214	230
Half commercial species (i=19) (Group 8)	108	143	162	192	200
Podo/Agathis (i=20) (Group 9)	108	143	162	192	200

Source : Awang Noor and Mohd. Shahwahid (1997)

regenerated in terms of economic sustainability. The stumpage values for trees above 30 cm dbh and above range between RM5,279 per hectare and RM30,318 per hectare. Another study on economic valuation of tree species in a one hectare plot showed that the stumpage value was about RM26,222. The results from this one hectare plot was higher than the estimated value of the two compartments using the inventory data. This is not surprising because this value include trees 15 cm and above compared to that of the 30 cm and above. The present value of sustainable timber harvest was calculated at 10 percent interest rate and 55 years cutting cycle using the following formula:

$$PV = SV(0) + SV(t)^* \, 1/[(1+1.10)^{55}-1],$$

where SV(0) is stumpage value from current harvest and SV(t) is stumpage value at t=55. Since forestry involves long term gestation period, the present value of sustainable harvest of AHFR

is not much different from the current harvest (range from RM5,307 to RM30,479 per hectare).

TABLE 3
Taxonomic composition of trees at Ayer Hitam Forest Reserve

Family	Genera	Species
Anacardiaceae	4	6
Annonaceae	4	4
Apocynaceae	1	1
Bombacaceae	1	1
Burseraceae	3	14
Celastraceae	1	1
Combretaceae	1	1
Cornaceae	1	1
Crypteroniaceae	1	1
Dipterocarpaceae	1	3
Ebenaceae	1	2
Elaeocarpaceae	1	3
Euphorbiaceae	12	18
Fagaceae	1	1
Flacourtiaceae	3	6
Guttiferae	3	9
Icacinaceae	1	1
Lauraceae	5	12
Leguminosae	1	1
Linaceae	2	2
Melastomataceae	2	2
Meliaceae	3	3
Moraceae	2	6
Myristicaceae	4	14
Myrtaceae	2	19
Myrsinaceae	1	3
Ochnaceae	1	1
Olacaceae	1	1
Oxalidaceae	1	1
Polygalaceae	1	4
Proteaceae	1	1
Rhizophoraceae	2	2
Rubiaceae	6	6
Rutaceae	3	4
Sapindaceae	2	5
Sapotaceae	3	5
Simaroubaceae	1	1
Sonneratiaceae	1	1
Sterculiaceae	2	2
Theaceae	1	1
Thymelaeaceae	1	2
Tiliaceae	1	2
Ulmaceae	1	2
Verbenaceae	1	1
TOTAL 44	92	177

Source: Pius (1995)

Valuing Recreation Benefits

The AHFR is also used by the local population for recreational activities. A study was conducted by Mohd. Shahwahid *et al.* (1998) to determine the recreational value of AHFR. A Zonal Travel Cost (TCM) was used in this study. The objective was to determine a demand function relating the number of visit/population of a zone with average zonal values of travel cost. The data were collected using a structured questionnaire, which contained questions pertaining to socio-economic characteristics of visitors, distance travelled and location of origin, mode of transportation, travel expenditure to the site and frequency of visit. A total of 80 respondents were interviewed over a three week period in March 1997. The respondents from the survey were mainly from the District of Petaling (46.3%), followed by the District of Gombak (20%), the District of Hulu Langat and Kuala Langat (11,.2%), the District of Sepang (7.5%), and the remainder 3.8% were from the District of Klang.

The average expenditures of RM12.36 per visitor made by the respondents in making the trip to experience the recreational services are for transportation, expenditure for foods and recreational services and recreational materials (Table 5).

Demand for recreation of Ayer Hitam Forest Reserve was estimated by estimating the number of visits from each zone and the average travel costs per visit. A demand curve is then fitted to each zone average points. The total consumer surplus for each zone was calculated as the product of the average consumer surplus per visit and the total number of visits. The net social benefit provided by the area being valued is indicated by the sum of the consumer surpluses in all zones. The average consumer surplus per individual visit across all zones was estimated at RM1.23 (Table 6). This estimate is comparable to the values estimated by Awang Noor and Mohd Shahwahid (1997) for six forest recreational areas in Negeri Sembilan with estimated values ranging from RM0.58 to RM2.26, with the average of RM1.49. Benson et al. (1996) obtained a similar result from a study on 20 forest recreational areas in Peninsular Malaysia with the values ranging from RM0.78 to RM3.74, an average of RM2.30. The lower estimates obtained for AHFR could be due to the relative superiority in terms of outdoor attributes of the other sites and lower visit per month. The average monthly recreational users of the AHFR

TABLE 4
Total stumpage value of AHFR, Puchong, Selangor (RM/ha)

Year of assessment	Compartment	Stumpage value (trees > 30 cm) (RM/ha)	Present value (RM/ha) $SV+SV*1/[(1+0.10)^{55}-1]$	Source
1995	1 ha plot	26,222	26,361	Pius (1995)
1998	C1	5,279	5,307	Norsahikin (1998)
1998	C2	9,521	9,572	Norsahikin (1998)
1998	C12	30,318	30,479	Norsahikin (1998)
1998	C13	25,260	25,394	Norsahikin (1998)
1997	C14	17,169	17,260	Johnny (1997)
1997	C15	14,500	14,577	Johnny (1997)

was estimated at 300 users. The annual value of recreation benefits for AHFR was therefore RM4,428. Using a 10% discount rate and assuming a constant visitation rate in the future, the net present value (NPV) of AHFR was estimated at RM44,280. It should be pointed out that the estimated value is site specific and subject to existing conditions. If new facilities and accessibility are improved and developed, the estimated economic value of recreation benefits found in this study would be altered.

Valuing the Benefits to Local Community

A study was carried out to determine the extent of use of AHFR by the indigenous or Orang Asli community (Rusli et al. 1997). The main objectives of the study were to estimate the quantity of timber and non-timber forest produce collected by the Orang Asli as well as the revenue that could have been generated by collecting these produce.

TABLE 5
Travel cost incurred by respondents to Ayer Hitam Forest Reserve

Items	Average expenditure (RM/visitor)	Percentage
Petrol	4.15	33.6
Food	3.55	28.7
Recreational kit	3.63	29.4
Books and magazines	0.52	4.2
Others	0.51	4.1
Total	12.36	100.00

Source: Mohd. Shahwahid *et al.* (1998)

Using a structured questionnaire, interviews were held with each of the household heads of two Orang Asli communities residing at Sungai

TABLE 6
Estimation of value with the zonal travel cost method (TCM) for Ayer Hitam Forest Reserve

Zone	Population (number of family)	Number of family visits	Average number visits per '000 population	Average cost per visit (RM)	Consumer surplus per visit (RM)	Total consumers surplus (RM)
1	54,653	19	0.35	3.85	0.19	3.61
2	633,144	120	0.19	4.10	0.83	99.60
3	129,696	21	0.16	5.00	0.90	18.90
4	542,906	37	0.11	6.07	1.65	61.05
5	410,491	28	0.068	8.11	3.59	100.52
6	406,832	6	0.015	14.00	0	0
Total	2,177,722	231				283.68

Source: Mohd. Shahwahid *et al.* (1998)

Rasau Luar and Sungai Rasau Dalam during the months of November and December, 1996. The main aim of the interview was to gather data and information on the volume of forest produce collected by the Orang Asli. Data on price of various forest products were obtained by surveying market outlets in the vicinity as well as in the city of Kuala Lumpur. The household heads were also asked about the prices of some of the produce in cases where these are not obtainable from the markets.

The results show that, in terms of species collected, the Orang Asli communities are more dependent on the forest reserve for food and fruits than for other purposes like housing construction, handicraft-making and medicine. While all the 24 animal species mentioned by the Orang Asli were hunted for their meat, 48% (10 species) of the plant species are for fruits. Birds and small mammals comprise 75% of the animal species collected.

The revenue that could have been generated and/or saved by collecting the timber and non-timber produce amounted to nearly RM110,000.00 for the year 1996. The revenue generated by plant species was about seven times more than that of animal species. The greatest source of revenue came from housing construction followed by handicraft-making and fruits. The Orang Asli commented that they are less dependent on the forest now than before. According to them, the forest now provides lesser number of useable species of plants and animals than before. Also, the Orang Asli are now economically better off than before and they can depend more on markets than the forest for their daily necessities.

Valuing Wildlife Resources

So far, no studies have been done to determine the economic value of wildlife species at AHFR. The studies, thus far, have only looked at the distribution and composition of bird species in the forest (Mohamed Zakaria 1997). The studies also reported the characteristics of the microhabitats of the various bird species found in the forest area. The results presented here are based on a study conducted only in Compartment 15 (southern part) of the forest reserve.

Preliminary results show that there are altogether 153 species of birds from 38 families in the study area. The three largest families are Timaliidae (Babbler species), Cuculidae (Cuckoo species) and Pycnonotidae (Bulbul species) (Table 7).

The Ayer Hitam Forest Reserve is a secondary forest and yet it is very rich in bird species. Most primary forests contain, on the average about 200 to 220 species of birds. The number of species that has been recorded is 153 and it is predicted that there are at least another 40 species. The diversity of families recorded is also comparable to other primary forest areas. Almost all of the families recorded in other forest areas are also found here.

The study has only covered the southern part of the forest reserve. This particular area has been logged quite extensively. The area is dominated with secondary plant species such as *Macaranga*. This could be the reason why there are abundant bird species associated with secondary forest.

Implications on Land-use

The estimated economic value and other indirect benefits of AHFR are substantial and play important roles for socio-economic development of the area. The point of interest is how the benefits of conserving AHFR would be accrued to different social groups, including state, national, and global community. This requires the need to calculate incremental net benefits between the costs and benefits in the alternative land use options and those of the baseline (forest conservation).

Future land use in the surrounding areas will be determined based on population growth and the need of population for various services and other facilities such as housing, industries, recreation, and so forth. Projection made in the structure plan of Petaling District and parts of Klang District showed that the need of land use for housing is the highest, followed by recreation, community facilities and industries. As such, the pressure of AHFR for alternative land uses is very tremendous. With regards to forestland, it was suggested in the structure plan that the forest reserve should be conserved for its ecological function and watershed protection. Only some parts of the forest should be used for passive recreational purposes such as jogging track, camping ground, and research.

In order to evaluate the economics of forest conservation against other alternative land use options, there is a need to carry out comparative valuation. This is basically the application of benefit cost analysis (BCA), where the net

TABLE 7
List of bird species recorded for each family at Ayer Hitam Forest Reserve

No.	English Name	Scientific Name	Malay Name
ARDEIDAE (2 species)			
1	Little Heron	*Butorides striatus*	Pucong Keladi
2	Cinnamon Bittern	*Ixobrychus cinnamomeus*	Pucong Bendang
ACCIPITRIDAE (3 species)			
3	Black-shouldered Kite	*Elanus caeruleus*	Lang Bahu Hitam
4	Crested Serpent-Eagle	*Spilornis cheela*	Lang Berjambul
5	Japanese Sparrowhawk	*Accipiter gularis*	Lang Sewah
PHASIANIDAE (2 species)			
6	Crested Fireback	*Lophura ignita*	Ayam Pegar
7	Great Argus	*Argusianus argus*	Kuang Raya
RAILLIDAE (1 species)			
8	White-breasted Waterhen	*Amaurornis phoenicurus*	Ruak-ruak
COLUMBIDAE (5 species)			
9	Little Green Pigeon	*Treron olax*	Punai Daun
10	Pink-necked Pigeon	*Treron vernans*	Punai Gading
11	Spotted Dove	*Streptopelia chinensis*	Merbok Balam
12	Peaceful Dove	*Geopelia striata*	Merbok Aman
13	Green-winged Pigeon	*Chalcophaps indica*	Punai Tanah
PSITTACIDAE (2 species)			
14	Long-tailed Parakeet	*Psittacula longicauda*	Bayan Nuri
15	Blue-crowned Hanging Parrot	*Loriculus galgulus*	Bayan Kecil
CUCULIDAE (12 species)			
16	Moustached Hawk-Cuckoo	*Cuculus vagans*	Sewah Tekukur Kecil
17	Hodgson's Hawk-Cuckoo	*Cuculus fugax*	Sewah Hantu
18	Indian Cuckoo	*Cuculus micropterus*	Sewah India
19	Plaintive Cuckoo	*Cacomantis merulinus*	Sewah Mati Anak
20	Drongo Cucukoo	*Surniculus lugubris*	Sewah Sawai
21	Common Koel	*Eudynamys scolopacea*	Sewah Tahu
22	Black-bellied Malkoha	*Phaenicophaeus diardii*	Cenok Perut Hitam
23	Raffles' Malkoha	*Phaenicophaeus chlorophaeus*	Cenok Kerak
24	Red-billed Malkoha	*Phaenicophaeus javanicus*	Cenok Api
25	Chestnut-breasted Malkoha	*Phaenicophaeus curvirostris*	Cenok Birah
26	Greater Coucal	*Centropus sinensis*	But-but Carik Anak
27	Lesser Coucal	*Centropus bengalensis*	But-but Kecil
STRIGIDAE (4 species)			
28	Collared Scops-Owl	*Otus bakkamonea*	Hantu Reban
29	Reddish Scops-Owl	*Otus rufescens*	Hantu Merah
30	Common Scops-Owl	*Otus scops*	Hantu Kuang Kuik
31	Brown Wood-Owl	*Strix leptogrammica*	Hantu Punggor
PODARGIDAE (1 species)			
32	Large Frogmouth	*Batrachostomus auritus*	Segan Besar
CAPRIMULGIDAE (2 species)			
33	Malaysia Eared Nightjar	*Eurostopodus temminckii*	Tukang Malaysia

Table 7 (continued)

34	Large-tailed Nightjar	*Caprimulgus macrurus*	Tukang Kubur
APODIDAE (3 species)			
35	Silver-rumped Swift	*Rhaphidura leucopygialis*	Layang-layang Kecil
36	Fork-tailed Swift	*Apus pacifus*	Layang-layang Ekor Cabang
37	Brown Needletail	*Hirundapus gigantea*	Layang-layang Besar
HEMIPROCNIDAE (2 species)			
38	Whiskered Treeswift	*Hemiprocne comata*	Layang-layang Jambu Kecil
39	Grey-rumped Treeswift	*Hemiprocne longipennis*	Layang-layang Jambu Kelabu
TROGONIDAE (1 species)			
40	Scarlet-rumped Trogon	*Harpactes duvaucelii*	Kesumba Puteri
ALCEDINIDAE (8 species)			
41	Common Kingfisher	*Alcedo atthis*	Pekaka Cit-cit Kecil
42	Blue-eared Kingfisher	*Alcedo meninting*	Pekaka Bintik-bintik
43	Black-backed Kingfisher	*Ceyx erithacus*	Pekaka Rimba
44	Rufous-backed Kingfisher	*Ceyx rufidorsus*	Pekaka Api
45	Stock-billed Kingfisher	*Pelargopsis capensis*	Pekaka Paroh Pendek
46	Black-capped Kingfisher	*Halcyon pileata*	Pekaka Kopiah Hitam
47	White-throated Kingfisher	*Halcyon smyrnensis*	Pekaka Belukar
MEROPIDAE (3 species)			
48	Blue-tailed Bee-Eater	*Merops philippinus*	Berek-berek Carik Dada
49	Blue-throated Bee-Eater	*Merops viridis*	Berek-berek Tadah Hujan
50	Red-bearded Bee-Eater	*Nyctyornis amictus*	Berek-berek Janggut Merah
CORACIIDAE (1 species)			
51	Dollarbird	*Eurystomus orientalis*	Tiong Batu
BUCEROTIDAE (2 species)			
52	White-crowned Hornbill	*Berenicornis comatus*	Enggang Jambul Putih
53	Black Hornbill	*Anthracoceros malayanus*	Enggang Gatal Birah
CAPITONIDAE (6 species)			
54	Gold-whiskered Barbet	*Megalaima chrysopogon*	Takor Jambang Emas
55	Yellow-crowned Barbet	*Megalaima henricii*	Takor Mahkota Kuning
56	Red-throated Barbet	*Megalaima mystacophanos*	Takor Raya
57	Blue-eared Barbet	*Megalaima australis*	Takor Akar
58	Brown Barbet	*Calorhamphus fuliginosus*	Takor Dahan
PICIDAE (9 species)			
59	Rufous Piculet Sasia abnormis	*Belatok Kecil*	
60	Rufous Woodpecker	*Micropternus brachyurus*	Belatok Biji Nangka
61	Checker-throated Woodpecker	*Picus mentalis*	Belatok Ranting
62	Banded Woodpecker	*Picus miniaceus*	Belatok Merah
63	Common Goldenback	*Dinopium javanense*	Belatok Pinang Muda
64	Buff-rumped Woodpecker	*Meiglyptes tristis*	Belatok Awan
65	Buff-necked Woodpecker	*Meiglyptes tukki*	Belatok Tuki-tuki
66	Grey-and-Buff Woodpecker	*Hemicircus concretus*	Belatok Punggoh
67	Maroon Woodpecker	*Blythipicus rubiginosus*	Belatok Punggor
EURYLAIMIDAE (3 species)			
68	Banded Broadbill	*Eurylaimus javanicus*	Takau Rimba
69	Black-and-Yellow Broadbill	*Eurylaimus ochromalus*	Takau Hitam Kuning

Table 7 (continued)

70	Black-and-Red Broadbill	*Cymbirhynchus macrorhynchus*	Takau Rakit
71	Green Broadbill	*Calyptomena viridis*	Takau Selawit
HIRUNDINIDAE (1 species)			
72	Pacific Swallow	*Hirundo tahitica*	Sualo Batu
CAMPHEPAGIDAE (2 species)			
73	Black-winged Flycatcher-Shrike	*Hemipus hirundinaceus*	Rembah Batu
74	Lesser Cuckoo-Shrike	*Coracina fimbriata*	Sewah Kecil
75	Pied Triller	*Lalage nigra*	Sewah Kapas
76	Fiery Minivet	*Pericrocotus igneus*	Mas Tulin
77	Scarlet Minivet	*Pericrocotus flammeus*	Mas Belukar
CHLOROPSEIDAE (4 species)			
78	Green Iora	*Aegithina viridissima*	Kunyit Bakau
79	Common Iora	*Aegithina tiphia*	Kunyit Kacat
80	Lesser Green Leafbird	*Chloropsis cyanopogon*	Daun Kecil
81	Greater Green Leafbird	*Chloropsis sonnerati*	Daun Besar
PYCNONOTIDAE (10 species)			
82	Black-headed Bulbul	*Pycnonotus atriceps*	Merbah Siam
83	Puff-backed Bulbul	*Pycnonotus eutilotus*	Merbah Coklat Berjambul
84	Yellow-vented Bulbul	*Pycnonotus goaivier*	Merbah Kapor
85	Olive-winged Bulbul	*Pycnonotus plumosus*	Merbah Belukar
86	Cream-vented Bulbul	*Pycnonotus simplex*	Merbah Mata Putih
	87Red-eyed Bulbul	*Pycnonotus brunneus*	Merbah Mata Merah
	88Spectacled Bulbul	*Pycnonotus erythropthalmos*	Merbah Kecil
89	Finches Bulbul	*Criniger finschii*	Merbah Rempah
90	Yellow-bellied Bulbul	*Criniger phaeocephalus*	Merbah Perut Kuning
	91HAyery-backed Bulbul	*Hypsipetes criniger*	Merbah Bulu Panjang Tengkok
92	Buff-vented Bulbul	*Hypsipetes charlottae*	Merbah Riang
DICRURIDAE (4 species)			
93	Bronzed Drongo	*Dicrurus aeneus*	Cecawi Keladi
94	Crow-billed Drongo	*Dicrurus annectans*	Cecawi Sawai
95	Lesser Racket-tailed Drongo	*Dicrurus remifer*	Cecawi Hamba Kera
96	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	Cecawi Anting-anting
ORIOLIDAE (2 species)			
97	Black-hooded Oriole	*Oriolus xanthornus*	Dendang Belukar
98	Asian FAyery Bluebird	*Irena puela*	Dendang Gajah
CORVIDAE (3 species)			
99	Crested Jay	*Platylophus galericulatus*	Gagak Jerit
100	Black Magpie	*Platysmurus leucopterus*	Gagak Kambing
101	Large-billed Crow	*Corvus macrorhynchos*	Gagak Paroh Besar
	SITTIDAE (a species)		
102	Velvet-fronted Nuthatch	*Sitta frontalis*	Patok Baldu
TIMALIIDAE (13 species)			
103	Short-tailed Babbler	*Trichastoma malaccense*	Rimba Ekor Pendek
	104Ferruginous Babbler	*Trichastoma bicolor*	Rimba Sampah
105	Abbot's Babbler	*Trichastoma abbotti*	Rimba Riang
106	Sooty-capped Babbler	*Malacopteron affine*	Rimba Tinjau Belukar
107	Scaly-crowned Babbler	*Malacopteron cinereum*	Rimba Tua Kecil

TABLE 7 (continued)

108	Rufous-crowned Babbler	*Malacopteron magnum*	Rimba Tua Besar
109	Chestnut-rumped Babbler	*Stachyris maculata*	Rimba Rembah Besar
110	Chestnut-winged Babbler	*Stachyris erythroptera*	Rimba Merbah Sampah
111	Rufous-fronted Babbler	*Stachyris rufifrons*	Rimba Api
112	Striped-tit Babbler	*Macronus gularis*	Rimba Berjalor
113	Fluffy-backed Tit-Babbler	*Macronus ptilosus*	Rimba Pong-pong
114	Brown Fulvetta	*Alcippe brunneicauda*	Rimba Murai Coklat
115	White-bellied Yuhina	*Yuhina zantholeuca*	Yuhina Perut Putih
TURDIDAE (5 species)			
116	Siberian Blue Robin	*Erithacus cyane*	Murai Siberia
117	Magpie Robin	*Copsychus saularis*	Murai Kampong
118	White-rumped Shama	*Copsychus malabaricus*	Murai Rimba
119	Chestnut-naped Forktail	*Enicurus ruficapilus*	Murai Cegar
120	White-crowned Forktail	*Enicurus leschenaulti*	Murai Cegar Belukar
SYLVIIDAE (4 species)			
121	Yellow-bellied Warbler	*Abroscopus superciliaris*	Cekup Paroh Kuning
122	Arctic Warbler	*Phylloscopus borealis*	Cekup Artik
123	Common Tailorbird	*Orthotomus sutorius*	Perenjak Pisang
124	Dark-necked Tailorbird	*Orthotomus artogulais*	Perenjak Belukar
MUSCICAPIDAE (7 species)			
125	Grey-chested Flycatcher	*Rhinomyias umbratilis*	Sambar Batu
126	Asian Brown Flycatcher	*Muscicapa latirostris*	Sambar Asia
127	Tickell's Blue Flycatcher	*Cyornis tickelliae*	Sambar Kelicap Ranting
128	Pied Fantail	*Rhipidura javanica*	Sambar Murai Gila
129	Black-naped Monarch	*Hypothymis azurea*	Sambar Uban Hitam
130	Maroon-breasted Flycatcher	*Philentoma velatum*	Sambar Ungu
131	Asian Paradise Flycatcher	*Terpsiphone paradisi*	Sambar Ekor Panjang
MOTACILLIDAE (1 species)			
132	Richard's Pipit	*Anthus novaeseelandiae*	Pipit Tanah
LANIIDAE (1 species)			
133	Brown Shrike	*Lanius cristatus*	Tirjup Tanah
STURNIDAE (4 species)			
134	Philippine Glossy Starling	*Aplonis panayensis*	Perling Mata Merah
135	Common Myna	*Acridotheres tristis*	Tiong Gembala Kerbau
136	Jungle Myna	*Acridotheres fuscus*	Tiong Hutan
137	Hill Myna	*Gracula religiosa*	Tiong Mas
NECTARINIIDAE (7 species)			
138	Plain Sunbird	*Anthreptes simplex*	Kelicap Kelabu
139	Purple-naped Sunbird	*Hypogramma hypogrammicum*	Kelicap Rimba
140	Little Spiderhunter	*Arachnothera longirostra*	Kelicap Jantong
141	Long-billed Spiderhunter	*Arachnothera robusta*	Kelicap Jantong Paroh Panjang
142	Yellow-eared Spiderhunter	*Arachnothera chrysogenys*	Kelicap Jantong Telinga Kuning
143	Spectacled Spiderhunter	*Arachnothera flavigaster*	Kelicap Jantong Besar
144	Grey-breasted Spiderhunter	*Arachnothera affinis*	Kelicap Jantong Bukit
DICAEDAE (4 species)			
145	Yellow-breasted Flowerpecker	*Prionochilus maculatus*	Sepah Puteri Raja

TABLE 7 (continued)

146	Crimson-breasted Flowerpecker	*Prionochilus percussus*	Sepah Puteri Pelangi
	147Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	Sepah Puteri Bukit
	148Plain Flowerpecker	*Dicaeum concolor*	Sepah Puteri Bongsu
	PLOCEIDAE (5 species)		
149	Eurasian Tree-Sparrow	*Passer montanus*	Ciak Urasia
150	Baya Weaver	*Ploceus philippinus*	Ciak Tempua
151	White-bellied Munia	*Lonchura leucogastra*	Pipit Padi
152	Chestnut Munia	*Lonchura malacca*	Pipit Rawa
153	White-headed Munia	*Lonchura maja*	Pipit Uban

Source: Mohamed Zakaria (1997)

benefits of any pair of alternative land use options (for instance, forest conservation and housing) should be compared. Under the current situation, the net benefits of forest conservation must exceed the forgone net benefits of housing:

$$NB^C - NB^H > 0,$$

where NB^C is net benefits of forest conservation, NB^H is net benefits of housing (alternative land use option.) In comparing these two options, it is again important to include not only the net direct or production benefits of each option, but also their net external environmental impacts. This can be shown as:

$$(NB^{DC} + NB^{IC}) - (NB^{DH} + NB^{IH}) > 0.$$

The implication of the study is that the estimated economic value can be used to determine the opportunity costs of losing sustainable timber earnings, recreation, wildlife, research, local community dependence on forest, research, environmental education programme, and other environmental benefits (such as carbon sequestration). In this study, however, we were unable to compute the economic loss of forest conversion to other land uses since data are still limited. Future efforts will be made to collect more information not only on economic value of AHFR but also the benefits and costs from other land use options in the surrounding areas.

CONCLUSION

The role of economic valuation is important because it provides information on the benefits of various forest goods and services in a particular forest ecosystem. Throughout we have presented results of some economic values of forest goods and services of AHFR. The values estimated from this study could be used in the economic valuation of alternative forestland use options. The future challenge is to obtain reasonable monetary estimates of non-market benefits, especially external environmental impacts. The estimation of these values should be given due consideration if one considers that forest conservation or protection is an investment for future generations. The economic approach to determining investment in forest conservation requires a comparison of the rate of return from conservation with the rate of return from the alternative use of forestland. Conservation is justified if the net benefits of conservation are greater than the net benefits from alternative land use options. Thus, from the perspective of the society as a whole it is very important to value the benefits and costs net of all economic distortions in the marketplace. Ignoring all potential benefits and costs of forest conservation provides a wrong signal to the policy makers. This might bias against forest conservation and converting forest areas to other land use options will result in opportunity cost to the society.

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Recreational Opportunities For Public Use in Ayer Hitam Forest: Setting the Stage and Park Management Approach

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Keywords: Recreation, opportunity, public, management, Ayer Hitam Forest

ABSTRAK

Kertas kerja ini membincangkan konsep taman hutan untuk kegunaan rekreasi awam dan sumber pendidikan yang boleh disediakan oleh Hutan Simpan Ayer Hitam, Puchong, Selangor. Hutan Simpan ini telah berfungsi sebagai tapak pendidikan dan penyelidikan tetapi perlu bersedia untuk membenarkan orang ramai memasukinya jika dibuka untuk kegunaan rekreasi. Peluang rekreasi yang disediakan mestilah mampu memberi ruang kepada kehendak rekreasi yang mengutamakan pengalaman yang menyeronokkan dan berdasarkan kepada rekreasi pendidikan dengan latarbelakang alam semulajadi. Sebarang bentuk penggunaan rekreasi hendaklah melibatkan impak yang rendah dan pembangunannya adalah berdasarkan kemampuan dan kekangan ekologi hutan simpan berkenaan. Untuk memenuhi keperluan rekreasi dan penjagaannya hutan simpan ini memerlukan amalan pengurusan taman hutan dan kerangka institusi bersepadu. Ini meliputi penyediaan peluang rekreasi kepada orang ramai dan pada masa yang sama memberi penekanan kepada pemeliharaan sumber. Sebagai kesimpulan adalah disarankan agar Hutan Simpan Ayer Hitam dikelas dan diwartakan sebagai 'Hutan Terbuka'.

ABSTRACT

This paper discusses the concept of forest park for public recreational use and educational resource to be provided by Ayer Hitam Forest Reserve in Puchong, Selangor. This reserve has served as a teaching and research site but must be ready to allow people to set foot in. The recreation opportunity to be provided must be able to accommodate recreational needs that prioritised rewarding experience and educational-based recreation opportunity within the natural setting. Any recreational access and utilisation must involve low impact use and its development has to be based on the ecological limitation of the forest reserve. For a benefiting use of the area for recreation and its stewardship, the forest requires the practise of park recreation management and an integrated institutional arrangement. These include provision of recreational opportunities to the public albeit protection of the resources. In conclusion it is recommended that Ayer Hitam Forest Reserve be classified and gazetted as an open forest reserve.

INTRODUCTION

As we enter into a new millennium, the changing role of forest in relation to its multipurpose use must be recognised. Increase use of its resources without causing adverse impact to the environment is desired. Key concern of the forest management embraces social forestry concept of open forest where public is part of a broader environment. People must have the share of the forest and able to access the resources. A forest or park is not to be seen as an island where some people are excluded and only a single type of use is prevalent. Forest conservation programme must include recreation for the public in order to minimise people being sidelined in the pursuant of the benefits.

Forest recreation is widely recognised as an amenity and is essential for the well-being of a society. It plays an important part for a person to enjoy quality life after he is able to fulfil his own

basic needs for survival. Recreational needs can be changing with time as society grew and can be characterised as below (Tillman, 1974):

1. Adventure and active recreational pursuit
2. Relaxation in outdoor or in natural environment
3. Escape and fantasy
4. Recognition and identity
5. Dominance and mastery
6. Social interaction
7. Mental activity (to appreciate, appraise and understand)
8. Creativity
9. Provide services to others
10. Physical activity and fitness
11. Need for new experiences and variation in activities

It is proper to accommodate those needs in a modern dynamic society. More people are putting a higher value on forest where they once belong to it. In any outdoor settings, the behaviour of participants may be influenced by several needs simultaneously such as companionship, family, security, self-esteem, prestige and comfort (Tinsley and Kass 1989; Pearse 1988).

With reference to Ayer Hitam Forest Reserve, this forested area is considered as a spot of particular scarcity based on its location and importance as the last remaining lowland dipterocarp forest to be enjoyed by people in the Klang valley. In addition, this forest reserve is still large, able to maintain its integrity, less disturbed and possesses a luxuriant natural resources by comparison to other neighbouring forested areas.

STUDY AREA

Ayer Hitam Forest Reserve (AHFR) in Puchong is the last remaining forest to be used as a recreational land for the nearby local residents of Puchong, Seri Kembangan, Kinrara and the upcoming townships of Cyberjaya and Putrajaya *(Fig.1)*. The area is more accessible now as previously with the opening of Damansara-Puchong Highway. It is made of many prominent topographical features that are conducive for recreation. The prominent features include the landforms made up of rugged lowland and hills (highest peak is 600 m), rivers, waterfalls, vegetation, wildlife and nearby orang asli community. Man made elements are also found but insignificant for a wider recreational use and as attraction to conduct activities.

Ayer Hitam Forest Reserve is a lowland dipterocarp forest managed under the forest reserve by the Forest Office of Central Selangor. It is located about 45 km from the centre of Kuala Lumpur and 25 km from Universiti Putra Malaysia (UPM). This forest reserve includes compartments 1, 2, 12, 13, 14 and 15 leased to the Faculty of Forestry, UPM for research for 80 years under an agreement between UPM and state government of Selangor. This forest area is a logged over forest in the 1960s and improvement works have been done ever since.

The primary uses of this forest are for research and educational purposes. The terms and condition of agreement spelled out provisions such as the duration and condition of award, control mechanism on use of the area as well as specific restrictions on activities to be carried out in the forest area. Therefore, the AHFR having the rights to use for a long-term period by UPM is important because planning and development work can be implemented systematically.

Current Recreational Activities in Ayer Hitam Forest Reserve

By its very nature, the AHFR should be available for forest recreation. Since many surrounding forested areas are shrinking, people are looking into whatever remains of natural area as their outlet for outdoor recreation. Activities that are related to educational-based recreation are carried out by the Faculty of Forestry, UPM since 1970s and include:

1. Forestry Camp both for Diploma and Degree students
2. Essaython for school children (Form One to Form Three)
3. National Science Camp
4. Corporate Game
5. Family Day

Most of the recreational activities are mainly of the organised types where leadership and instructions are provided. Acivities that are conducted are well prepared and structured. At present few local people are allowed to go into and enjoy the forest. The attractive spots in AHFR frequented by recreationists include the waterfall and the Sungai Rasau that flows through it.

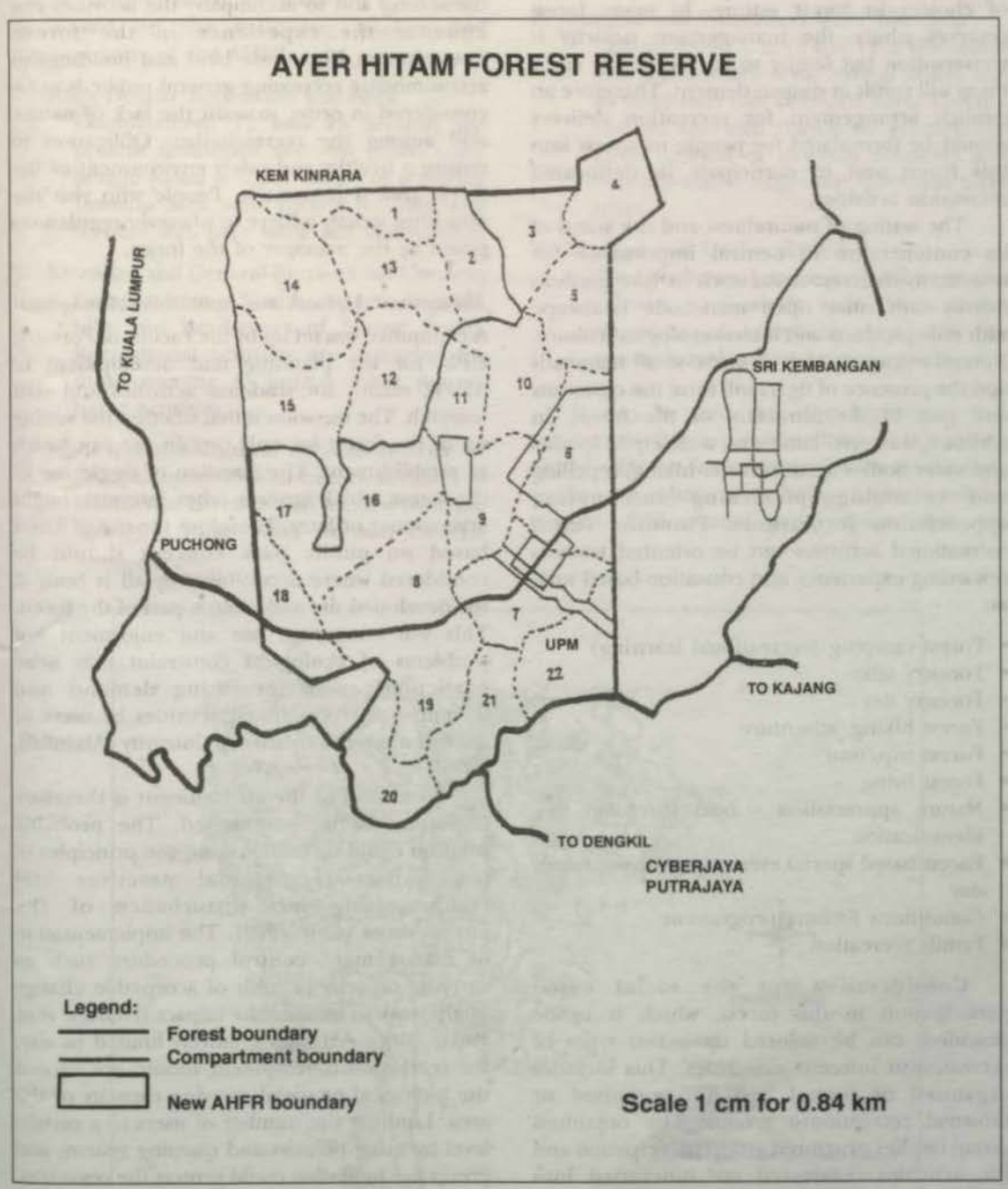

Fig. 1. Location of Air Hitam Forest Reserve from Urban Centres

Potential Recreational Provision and Development

Recreational development and provisions for recreating public must be based on the elements of choices in forest setting. In many forest reserves where the management priority is conservation but failing to let the public enjoy them will result in disgruntlement. Therefore an explicit arrangement for recreation delivery should be formulated for people to access into this forest and to participate in delineated recreation activities.

The setting of naturalness and the status of its contents are of central importance for recreation delivery. Areas such as lake gardens nearby only offer open man-made landscape with stale products and lifeless ecological culture. Natural resources such as birds, small mammals and the presence of tigers will form the curiousity and part of the attraction of the forest. In addition, a rugged landform, a variety of species and water bodies in AHFR offer hiking, repelling and swimming, picnicking and nature appreciation for visitors. Potential forest recreational activities can be oriented towards rewarding experience and education-based such as:

- Forest camping (recreational learning)
- Forestry talks
- Forestry day
- Forest hiking/adventure
- Forest trip/tour
- Forest living
- Nature appreciation – bird watching, tree identification
- Forest based special event – essaython, family day
- Community forestry programme
- Family recreation

Consideration for the social based participation in this forest, which is to be provided, can be tailored upon two types of recreationist interests categories. This includes organised or formal and non-organised or informal recreationist groups. The organised group implies structured group participation and the activities conducted are itineraried into specific recreational activities such as school groups, and uniformed organisation. Meanwhile, the non-organised group is typically made up of visitation by people without any relationship to such organisation and pursuing activities on their own. These include individuals, peers, large groups and families pursuing non-specific activities.

The introduction of facilities to enhance the setting and to accompany the activities can enhance the experience in the forest. Commitment to provide land and buildings to accommodate recreating general public is to be considered in order to assist the lack of nature skill among the recreationists. Obligation to ensure a healthy and safety environment of the forest area is imperative. People who visit the area must strictly adhere to whatever regulations posed by the manager of the forest.

Management Approach and Institutional Arrangement

A committee was set up by the Faculty of Forestry, UPM for the planning and development of AHFR, mainly for students' activities and staff research. The question is that whether the setting up of the forest for only certain use can justify its establishment. The question of single use of the forest, which ignores other interests, might arise sooner or later. Therefore the use of forest based on public park concept should be considered where accessibility by all is both at the developed site and remote part of the forest. This will encourage use and enjoyment but problems of ecological constraint may arise particularly with increasing demand and incompatible recreational activities by users of the forest, which can affect its integrity (Abdullah, 1996).

Protection of the environment is therefore important to be emphasised. The probable solution could be built around the principles of low impact recreational practices and compromising less disturbance of the environment (Cole 1989). The implementation of management control procedure such as carrying capacity or limit of acceptable change might work to balance the impact (Hendee *et al.* 1990). Since AHFR is relatively limited in size, the recreation development should not exceed the biological or social carrying capacity of the area. Limiting the number of users to a certain level by using permits and queuing system, and group size limitation could protect the resources. So it is important to determine the value of the capacity if people are allowed access and stay in the forest.

To overcome this problem, the zonation concept can be applied to manage the resources and other interests such as research (*Fig. 2*).

The dispersal of different types of recreational use, which is compatible with different levels of condition and protection of the specific area, has to be emphasised. An idealised zone could be based on the following background characteristics of the AHFR:

I High Density Recreation Use Area
- Compartment 12 and 15 around the present developed site and gravel road. Sungai Rasau is at the centre of activities. Develop area with visitors facilities and services with park value still maintained.

II Extended and General Recreational Use Area
- Compartment 13 with rugged lowland, hills and headwaters of Sungai Rasau. Recreational activities are extended for those wanting to pursue more nature-based activities.

III Historical and Cultural Recreation Area
- Compartment 15 with historical values of World War II relicts and located near the aborigine village with its own cultural background. Recreational activity that ties with traditional and historical based activities.

IV Natural and Wilderness Strict Use Area
- Compartment 1, 2, 13 and 14 of wilderness and undisturbed area. Sungai Bohol and its headwater can be found here. This is a natural site with minimum interference from internal or external elements and only controlled wilderness recreation takes place.

V Limited and Undisturbed Area
- Can be located in several parts of the reserve particularly away from heavy recreational activities. Available for research and nature learning activities.

It can be said that the legislation and regulations that are outlined for AHFR would not be effective for the conservation particularly at the site where it is being highly used by people. Educational programmes that are

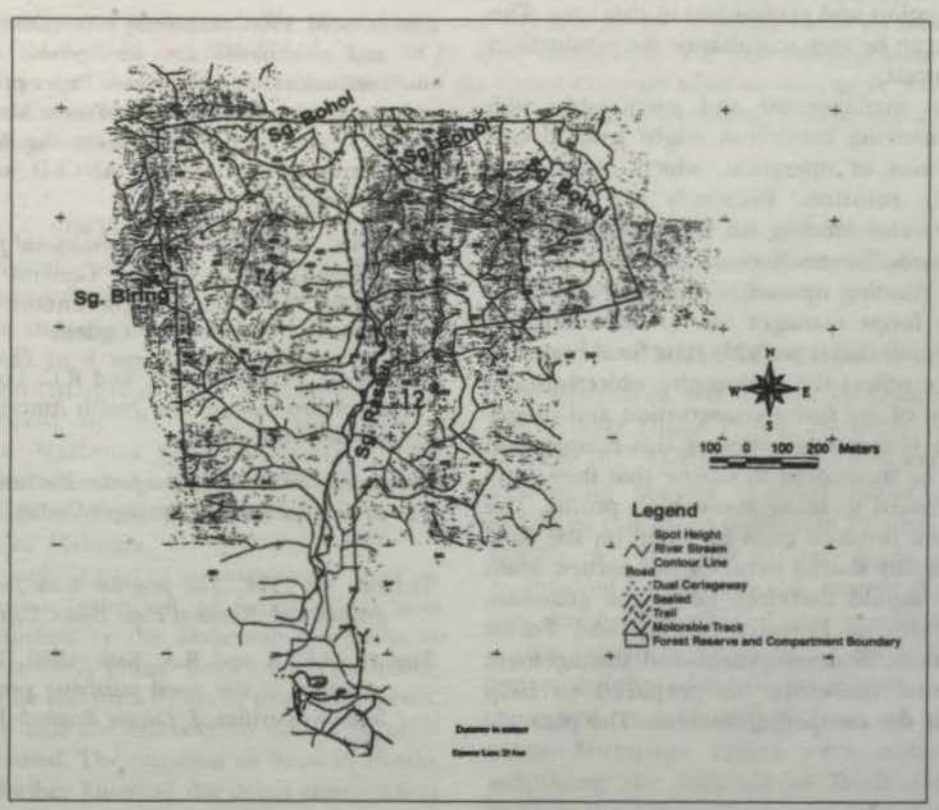

Fig. 2. Natural and man-made features of Ayer Hitam Forest Reserve

spontaneous, formal or informally conducted need to be integrated by the management. Programmes, activities or even modules to be delivered have to be integrated in order to ensure that visitors are able to gain the knowledge and awareness of conservation while recreating.

Conflicting interests will crop up between the naturalists and the public when access is increased. Here, the institutional arrangement should be highlighted among the stakeholders. It can play an important role where participation by all interested parties can contribute to the planning process. A forum or platform for those interested parties should be established for them to voice out ideas. Public at large can form support groups to protect the existence of the forest although there will some impact of recreational use of the forest. Supporting activities can include environmental education group, outdoor recreation - camping group and other groups with environmental interest behind them. Another controversial step that can be considered would involve co-operative endeavour or smart partnership with private operators, who sometimes develop interest in the development for recreation and ecotourism in this area. This attempt can be seen to enhance the productivity of the forest.

Joint management and partnership with other financing institution might lead to cost effectiveness of operation, which could be a workable solution. Presently the financial resources and funding for the management of AHFR is insufficient. Revenue sources and funds to meet running operation is provided by UPM and the forest manager has to make do with limited funds that is available. The fiscal resources therefore reflect the philosophy, objectives and direction of the forest conservation and usage.

The business activities of this cooperation have to be monitored to ensure that they don't go overboard to bring about high profits. The procedure involved must be based on the legal responsibility shared between the parties. Main benefits should therefore go to the guardian, i.e. Faculty of Forestry (UPM) and Forest Department. A development and management plan must therefore be prepared to help reconcile the competing interests. The plan will guide specific facility development and specific actions to meet the management objectives.

CONCLUSION

The general public has turned to forest settings to satisfy much of their recreational needs. AHFR has all the resources to supply those needs. This led to the requirement of a comprehensive approach for the management of the forest reserve. The management should incorporate an open forest the needs. The opportunities to be provided must be based on low impact use of the forest and educational based recreation. The management must encourage compatible development that come with it. Use control and limitation at certain areas should be adhered. Zonation might be workable to address the problems of extensive use of the forest and protection of the fragile resources. Thus, it is necessary for the management of AHFR to be more explicit about the role and stewardship of this forest.

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Economic Valuation of Tree Species Diversity at Ayer Hitam Forest, Selangor, Peninsular Malaysia

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Keywords : Tree species diversity, 1-ha plot, economic valuation, stumpage value, Ayer Hitam Forest

ABSTRAK

Daripada satu kajian di plot 1-ha di Hutan Ayer Hitam, Selangor, sejumlah 177 spesies yang terangkum dalam 92 genus dan 44 famili telah dikira. Ketumpatan dirian ialah 909 pokok setiap ha. Nilai stumpej bagi had tebangan bawah ialah RM 8707.52 dan had tebangan atas ialah RM 17514.12 setiap ha. Jumlah nilai stumpej ialah RM 26221.64 setiap ha. Famili Sapotaceae memberikan nilai stumpej tertinggi dan merupakan separuh dari jumlah nilai stumpej yang diperolehi. Kumpulan komersial nyatoh memberikan 52% manakala kedondong memberikan 25% dari jumlah nilai stumpej.

ABSTRACT

From a study conducted on a 1-ha plot at the Ayer Hitam Forest, Selangor, a total of 177 species in 92 genera and 44 families were enumerated. The stand density was 909 trees per ha. Stumpage values for below cutting limit were RM 8707.52 and RM 17514.12 per ha for upper cutting limit. The total stumpage value was RM 26221.64 per ha. The family Sapotaceae contributed the highest stumpage value accounting for half the total stumpage value obtained. The commercial groups nyatoh and kedondong accounted for 52% and 25% of the total stumpage value, respectively.

INTRODUCTION

The economic potential of species diversity has not been fully investigated (IUCN, 1987). To ensure that the components of biodiversity are utilised in a sustainable manner for the continued progress and socio-economic development of the nation, the revised Malaysian National Forestry Policy 1993 emphasized the importance of conservation and valuation of biological resources to the economy of Malaysia.

This study is part of an on-going project on the economic valuation of forest goods and services funded by the Malaysian Government through its IRPA grant. Before any reasonable value can be put on a forest in monetory terms, we believe that the diversity on the forest must be well studied. The question we hope to answer here is whether knowing the detail composition of tree species can give a better estimate on the economic value of a forest? In doing so we used the stumpage value i.e. the value of standing tree at the stump as a measure of economic value of tree species diversity.

METHODOLOGY

The study area was located in Compartment 6/9 of Ayer Hitam Forest, Puchong, Selangor (3° 4'N 101° 41'E), which was now excised for a housing project (Lestari Perdana). The details of this forest is given in Faridah Hanum (1999). A 1-ha (100 x100m) study plot was established at altitude 50 metres a.s.l. The plot was further divided into contiguous 10m x 10m sub-plots. All trees > 5 cm at diameter breast height (dbh) were tagged, labelled, measured and identified from all the sub-plots. Stumpage values were obtained by modifying the formula of Davis (1966) to indicate the differences in species and diameter class and is shown below:

$S_{ij} = V_{ij} (P_{ij} - C - PM)$ where,

- S_{ij} = Stumpage value for each species and diameter class (RM/m^3)
- V_{ij} = Volume of timber for each species and diameter class (m^3)
- P_{ij} = Log price for each species at mill gate and diameter class (RM/m^3)
- C = Average logging cost per cubic meter (RM/m^3)
- PM = Profit margin (RM/m^3)
- i = an index for each species (i = 1,2,3,....., n)
- j = an index for diameter class (j = 1,2,3,....., k)

The volume formula adopted here was the one used widely by the Selangor State Forestry Department, Malaysia which is as follows:

$V_i = \{P_i \times (dbh)^2 \times h \times F\} / \{4 \times 10000\}$ where:

- V = Volume of timber of each tree (m^3)
- P_i = 22/7
- dbh = diameter at breast height (cm)
- h = merchantable tree height (m)
- F = (0.65) form factor
- i = an index for individual trees (1,2,3,.....n)

The profit margin PM was calculated using the following formula:

$PM = (P_{ij} \times PR) / (1 + PR)$ where,

- PM_{ij} = Profit margin
- P_{ij} = Log price for each species at mill gate and diameter class
- PR = Profit Ratio
- i = an index for each species (i = 1,2,3,.....n)
- j = an index for diameter class (j = 1,2,3,.....k)

The log prices at mill gate were obtained from Maskayu (1996), price reduction factor, average logging and transportation costs from Awang Noor and Mohd. Shahwahid (1995). The total stumpage was finally calculated by summing up all the stumpage values for each species and diameter class in the study area.

RESULTS AND DISCUSSION

There were 177 tree species belonging to 92 genera and 44 families per ha from this forest, a stand density of 909 stems per ha and 67% of trees were under 15 cm at diameter breast height (Faridah Hanum and Pius 1997). Since the availability of present stumpage values on species was limited to trees with diameter at breast heights of 15 cm and above, only 33% of the trees were assigned stumpage values. Table 1 summarizes the stumpage values contributed by the diversity of tree species from various families. Stumpage values for trees below cutting limit (<15 cm dbh) was RM 8707.52 and above cutting limit (> 15 cm dbh) RM 17514.12 per ha, respectively. The total stumpage value for all trees below and above cutting limits was RM 26221.64 per ha (Table 1). Sapotaceae contributed to almost half this total stumpage value, followed by Burseraceae (Table 1). Nyatoh and Kedondong were the two species groups that contributed the most to the total stumpage value, with the former amounting to RM 13681.52 and the latter amounting to RM 6366.13 (Table 2). The percentage distribution of trees by commercial group showed that more than 95% are non-dipterocarps (Table 3). Among the non-dipterocarps, the light hardwood group contributed 25% of the total percentage distribution followed by medium and heavy hardwood which accounted for 23% and 18%, respectively (Table 3). The contribution of dipterocarps to the stumpage value is very small as only 4% (Table 3) were recorded from this plot and they were all below cutting limit amounting to RM 2021.99 as shown earlier in Table 1. Nearly 70% of the total stumpage value was derived from trees in diameter class > 45 cm dbh (Table 4).

The total stumpage value obtained from this study was higher, almost doubled that obtained by Timin (1997) from a similar study in the same compartment which was RM 14,500.36 per ha. The difference in these values can only be explained by the different methods employed in sampling the area. In the present study, a 100% sampling of trees > 5 cm dbh was employed but only 10% sampling was undertaken by Timin (1997). The values obtained from the present study showed a similar trend with those obtained from Ulu Muda Forest Reserve, a hill forest in the northern part of Peninsular Malaysia (Faridah Hanum *et al.* 1999, Awang Noor and Mohd. Shahwahid 1995). A higher species diversity does not necessarily mean a higher economic value of the forest. This was proven in

TABLE 1
Stumpage value by family in 1-ha plot

Family	Stumpage value (RM)		Total stumpage(RM)
	Below cut	Upper cut	
SAPOTACEAE	3070.26	9988.19	13058.45
BURSERACEAE	1084.27	5281.86	6366.13
DIPTEROCARPACEAE	2021.99	-	2021.99
MYRTACEAE	370.97	1416.20	1787.17
MELASTOMATACEAE	64.77	557.40	622.17
FLACOURTIACEAE	543.69	-	543.69
EUPHORBIACEAE	76.31	270.47	346.78
GUTTIFERAE	290.55	-	290.55
STERCULIACEAE	252.20	-	252.20
LAURACEAE	185.49	-	185.49
EBENACEAE	128.65	-	128.65
ANACARDIACEAE	90.24	-	90.24
LEGUMINOSAE	88.11	-	88.11
RUBIACEAE	85.47	-	85.47
MYRISTICACEAE	75.29	-	75.29
SAPINDACEAE	73.21	-	73.21
FAGACEAE	70.97	-	70.97
VERBENACEAE	21.98	-	21.98
RHIZOPHORACEAE	17.17	-	17.17
BOMBACACEAE	16.23	-	16.23
ELAEOCARPACEAE	15.06	-	15.06
THYMELAEACEAE	12.90	-	12.90
MORACEAE	10.69	-	10.69
CORNACEAE	8.89	-	8.89
OLACACEAE	8.32	-	8.32
POLYGALACEAE	6.35	-	6.35
ANNONACEAE	4.91	-	4.91
THEACEAE	4.43	-	4.43
MELIACEAE	4.33	-	4.33
ULMACEAE	3.82	-	3.82
	RM 8,707.52	RM 17,514.12	RM 26,221.64

TABLE 2
Stumpage value by species group in 1-ha plot

Species Group *	Stumpage value (RM)		Total stumpage alue (RM)	Percentage total stumpage value (%)
	Below cut	Upper cut		
NY	3070.26	10611.27	13681.52	52
KDD	1084.27	5281.86	6366.13	25
LRM	2021.99	-	2021.99	8
OMHW	911.46	513.21	1424.67	5
OHHW	843.33	557.40	1400.74	5
OLHW	524.09	550.38	1074.46	4
KS	252.52	-	252.52	1
	8707.52	17514.12	26221.64	100

* NY = Nyatoh; KDD = Kedondong; LRM = Light Red Meranti; OMHW = Other Medium Hardwood; OHHW = Other Hard Hardwood; OLHW = Other Light Hardwood; KS = Kembang Semangkuk

TABLE 3
Percentage distribution of trees by commercial group

Commercial * group	Species** group	Percentage (%)
DIPT	LRM	4
NON-DIPT	KDD	14
NON-DIPT	NY	14
NON-DIPT	OLHW	25
NON-DIPT	OMHW	23
NON-DIPT	OHHW	18
NON-DIPT	KS	2

* DIPT = Dipterocarp; NON-DIPT = Non-Dipterocarp;

** NY = Nyatoh; KDD = Kedondong; LRM = Light Red Meranti;OMHW = Other Medium Hardwood; OHHW = Other Hard Hardwood; OLHW = Other Light Hardwood; KS = Kembang Semangkuk

TABLE 4
Stumpage values by dbh class

Dbh class (cm)	Stumpage value (RM)		Total stumpage value (RM)
	Below cut	Upper cut	
> 60.0	-	10807.44	10807.44
55.9 - 50.0	-	5148.48	5148.48
49.9 - 45.0	778.95	1558.20	2337.15
44.9 – 33.0	5611.35	-	5611.35
32.9 – 25.0	1368.26	-	1368.26
24.9 – 15.0	948.15	-	948.15
	RM 8707.52	RM 17514.12	RM 26221.64

an earlier study in Ulu Muda Forest Reserve where there were only 77 species per ha but the total stumpage value was RM 41445.30 per ha. The next question asked is whether species diversity studies will be necessary to improve the economic value of a forest? Present evidence undoubtedly gives the following answers viz., it will help place the species in the correct commercial group, thus the right pricing which would not over estimate or under estimate the economic value of the forest, it will tell the stocking of the forest, and also shows which dbh classes and commercial species group are contributing the most stumpage.

CONCLUSION

There is no doubt that many a time the forest is under estimated in its economic value because of the constraint taken in sampling and the high costs incurred, amongst others. However, should the government intend to increase its net revenue from the forest, it is recommended that a detail study on the species composition be made.

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Conceptual Design and Implementation of Geographic Information System(GIS) for Hutan Simpan Ayer Hitam, Selangor

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Keywords : Geographical Information System, Decision Support System, forest management planning, spatial analysis

ABSTRAK

Sistem Maklumat Geografi(SMG) memberikan ruang yang besar untuk pembangunan pendekatan yang baru dalam pemprosesan data spatial atau geografik berkomputer seterusnya menambahkan dimensi yang baru dalam pengurusan, penganalisan dan persembahan jumlah maklumat yang besar yang diperlukan untuk menyokong proses membuat keputusan. Satu SMG dicadangkan diguna untuk automasi dan penganalisan data dalam pengurusan sumber hutan di Hutan Simpan Ayer Hitam, Puchong, Selangor. Selain dari operasi-operasi asas pertanyaan attribut dan spatial menggunakan SMG, kaedah modeling spatial dan permukaan juga dapat digunakan untuk menolong perancangan dan pengurusan hutan di Ayer Hitam.

ABSTRACT

Geographic Information System (GIS) has created a large field of opportunity for the development of new approaches to computer processing of spatial or geographically referenced data, hence adding a new dimension to the management, analysis, and presentation of the large volumes of information required in the decision making processes. A GIS is proposed to be used for automation and analysis of data in the management of forest resources at Hutan Simpan Ayer Hitam, Puchong, Selangor. In addition to basic attribute and spatial query operations in the GIS, spatial modeling and surface analysis methods should also be used to assist forest planning and management at Ayer Hitam.

INTRODUCTION

Hutan Simpan Ayer Hitam, Puchong, Selangor plays a major role in teaching and research at the Faculty of Forestry, Universiti Putra Malaysia (UPM). However, a major challenge presented by the forest is the handling and organizing of information about the resource from past and future research. The second challenge is how this information can be analyzed to support decision making. The advent of Geographic Information System (GIS) has created a large field of opportunity for the development of new approaches to computer processing of spatial or geographically referenced data, hence adding a new dimension to the management, analysis, and presentation of the large volumes of information required in the decision making processes (Healey, 1988). Since, information on Hutan Simpan Ayer Hitam are largely spatial in nature, the question arise whether data management and decision making can be improved using GIS as a tool. This paper proposes a GIS for Hutan Simpan Ayer Hitam, Puchong, Selangor for the purpose of data management and decision support. The conceptual design and implementation of the Ayer Hitam GIS will be highlighted in the paper.

Conceptual Design and Implementation of Hutan Simpan Ayer Hitam Geographical Information System (GIS)

Geographical Information System(GIS) is an organized collection of computer hardware, software, geographic data, and personnel

designed to efficiently store, capture, update, manipulate, analyze and display all forms of geographically referenced information, (ESRI, 1990). Its successful implementation at Hutan Simpan Ayer Hitam largely depends on four requirements. The first requirement is automation of the GIS database. It is costly and time consuming to collect and store large quantities of data. The most cost-effective approach is to collect only data required for specific uses. Secondly, all data collected from various sources, either from existing records, ground surveys, remote sensing and others will need to be integrated by means of GIS methods. Thirdly, the Hutan Simpan Ayer Hitam GIS and its database must be organized so as to facilitate ad hoc query and generation of new information. Finally, it must be possible to perform spatial modeling, in support of decision-making.

The GIS database Automation and Application

The exact information types to be acquired in the database must first be identified. Each data type included in the database will comprise of unique map features and their attributes linked by special geographic identifiers. This will enable data retrieval and ad hoc queries be performed on the spatial features. *Fig. 1* illustrates the conceptual GIS database design for Hutan Simpan Ayer Hitam. It consists of five main data layers: 1) the base map 2) topography 3) drainage 4) infrastructure and 5) forest stand.

For design, automation and implementation of the GIS, the software ARC/INFO and ARCVIEW (ESRI Inc., Redland, CA) will be used because of their wide availability on personal computers. The following stages in the GIS database automation and implementation process are illustrated in *Fig. 2.*

1. Digitizing of existing map sources
2. Updating of existing map coverages from aerial photography, satellite remote sensing and field survey;
3. Development of attribute database for each spatial features;
4. Data query, spatial analysis and modeling
5. Automated mapping and display of results from data analysis and modeling

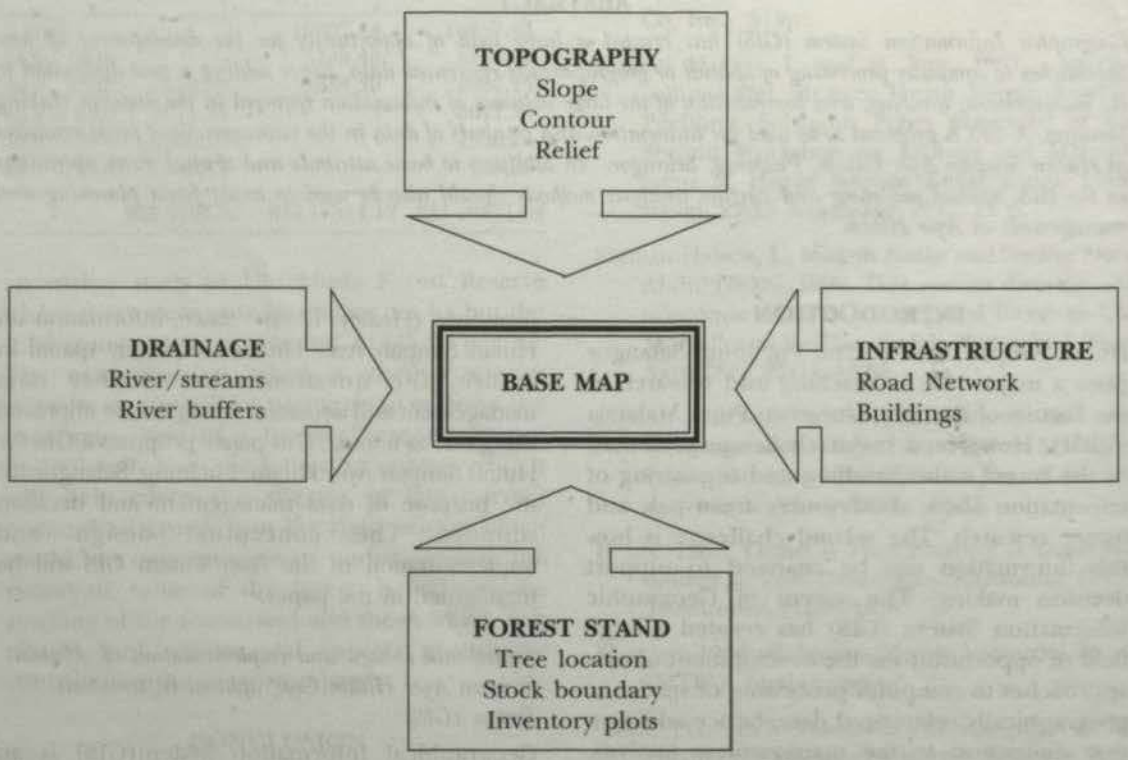

Fig. 1. The conceptual GIS database design for Hutan Simpan Ayer Hitam, Selangor

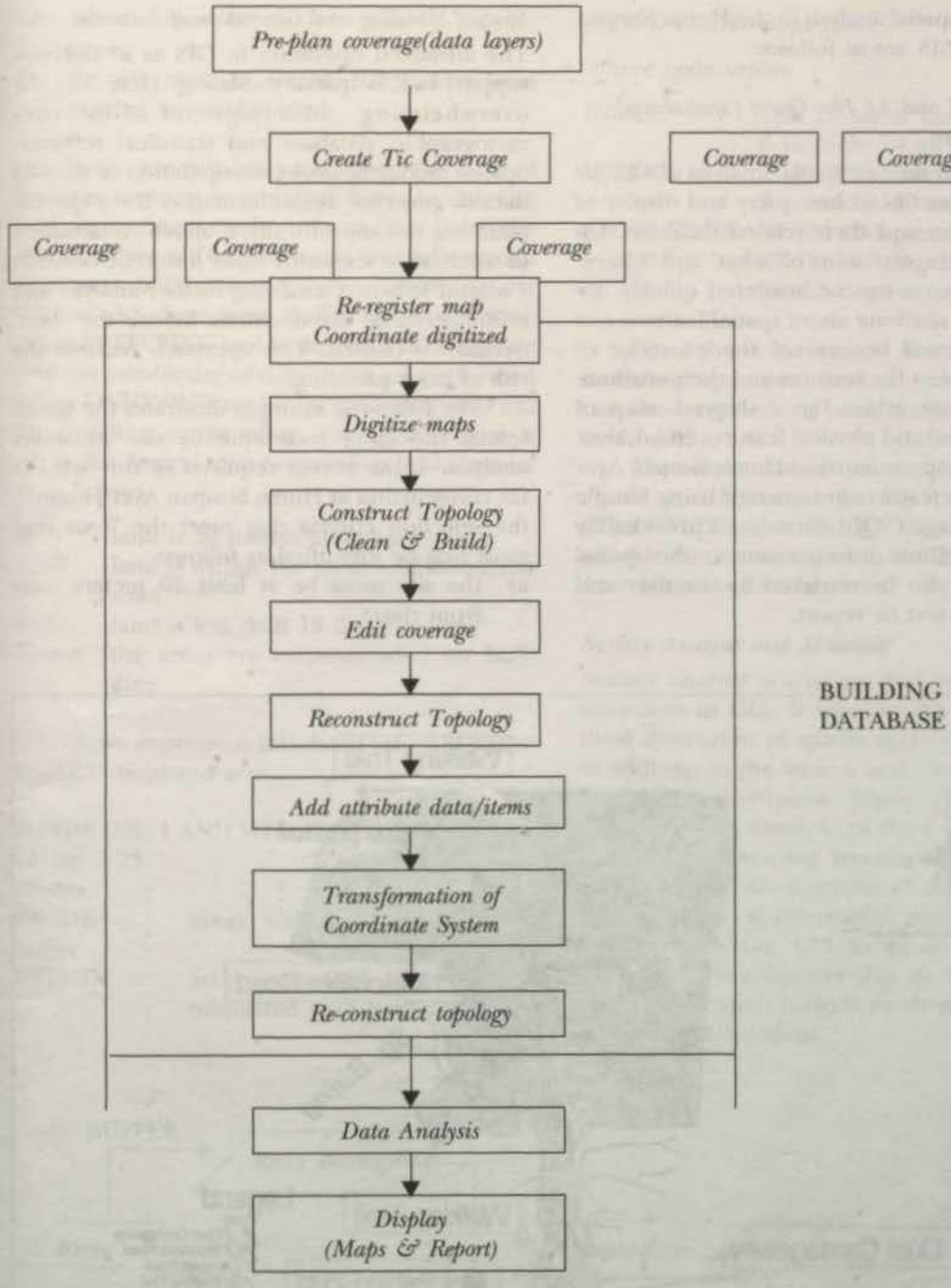

Fig. 2. Combined steps in database automation and Implementation of Hutan Simpan Ayer Hitam, Selangor GIS Using ARC/INFO and ARCVIEW software

Hutan Simpan Ayer Hitam GIS as a Decision Support Tool

The true strength of a GIS lies in its functionality of spatial analysis. The three operations allowed are attribute queries (ad hoc query and retrieval of database), spatial queries and generation of new information (modeling). These operations are in support of decision making processes. In Forestry, GIS has supported decisions in timber harvest planning, timber inventory and stock mapping, fire risk potential, erosion risk assessment and many others (Harem 1998).

Examples of spatial analysis in the Hutan Simpan Ayer Hitam GIS are as follows:

Data Retrieval and Ad Hoc Query (Spatial and attribute queries)

The basic operation in spatial analysis of GIS for decision support is ad hoc query and display of spatial features and their related database. Using the GIS, the questions of 'what' and 'where' the resources are can be answered quickly. Information or attribute about spatial features can also be retrieved because of the existence of linkages between the features and their attribute in the database table. *Fig. 3* shows a map of queried natural and physical features (road, river and forest compartments) in Hutan Simpan Ayer Hitam. These features are queried using Simple Query Language (SQL) commands provided by the GIS. Attribute information on the spatial features can also be retrieved by the user and presented as text or report.

Spatial Modeling and Generation of Scenarios

The advanced operation in GIS as a decision support tool is spatial modeling. Here, lies the overwhelming advantage of GIS over cartographic, database and statistical software. Spatial modeling allows manipulation of the GIS data to generate new information for a specific planning task. Specifically, it allows visualization of alternative scenarios from different decision ('what if'); hence, enabling further analysis and refinements of the decisions before the 'best' decision is chosen. This approach reduces the risk of poor planning.

The following example illustrates the use of spatial modeling technique in site suitability analysis. If the answer required is "the best site for construction at Hutan Simpan Ayer Hitam?", the selection criteria that meet the "best site" must first be identified as follows:

a) the site must be at least 20 meters away from rivers

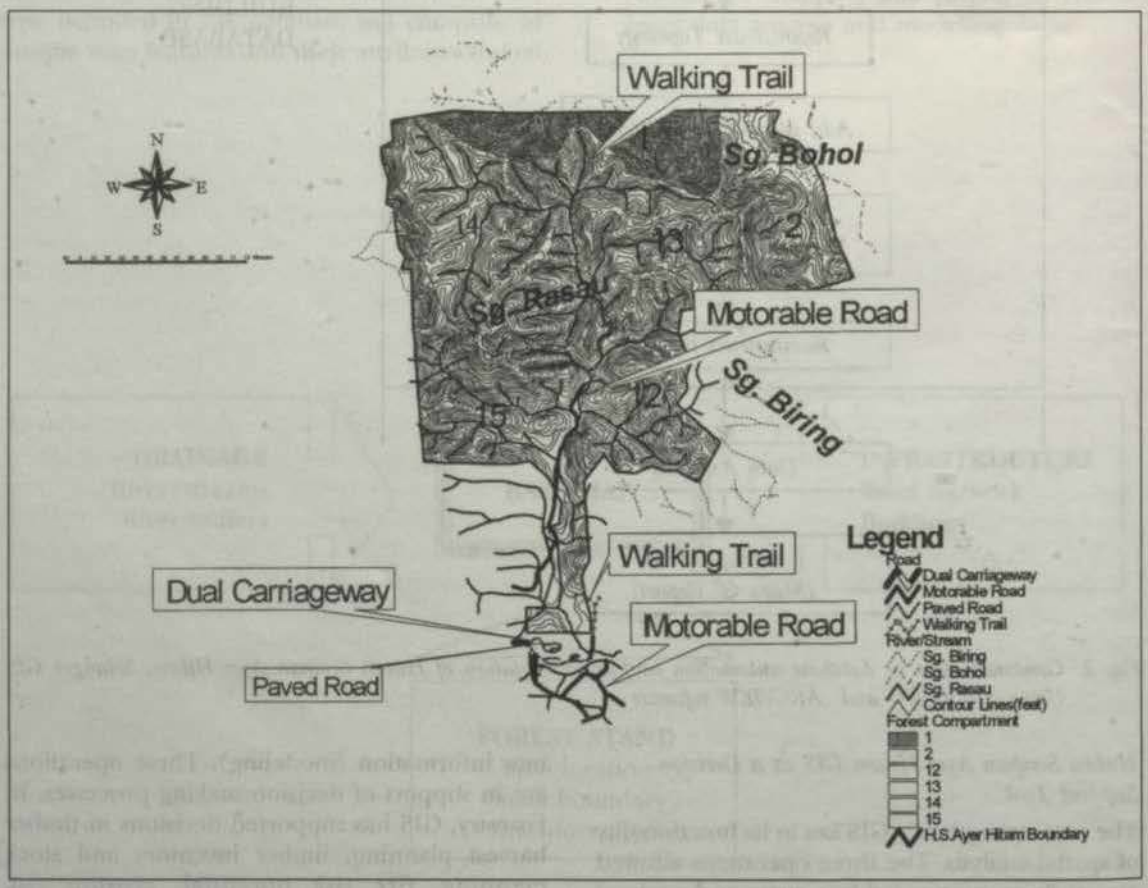

Fig. 3. Map of Natural and Physical Resource in Hutan Simpan Ayer Hitam, Selangor

b) the site must be on less than 15 degrees slope
c) the site must be within 100 meters from existing motorable road

In the site suitability modeling, the method involves creating new digital layers in the GIS and extracting certain information from the database layers. The new layers created are road and river buffers and a layer combining the buffers with slope layer. Buffer creation is done using BUFFERING tool in the ARCVIEW software and the combining of data layers are performed using UNIONING tool. To model suitable site for building construction, the QUERY tool is used. The logical query expression in the model is as follows:

IF land is 20 meters away from rivers
AND land is within 100 meters of motorized road
AND land is less than 15 degrees slope
THEN the areas are recommended for building

The above expression translated into ARCVIEW QUERY command are:

INSIDE .NE. 1 AND WITHIN = 2 AND SLOPE-CODE = 73

Where

INSIDE areas within 20 meters river buffer
WITHIN areas within 100 meter motorized road buffer
SLOPE–CODE slope code

Where code values:

INSIDE 1 (in 20 meter buffers);
0 (outside 20 meter buffer)
WITHIN 2 (in 100 meter buffer);
3 (outside 100 meter buffer)
SLOPE-CODE 73 (0-14.9degrees),
83 (15-24.9 degrees),
84 (25 degrees and greater)

Fig. 4 shows the overall flow of the spatial modeling operation. Statistics of suitable area can also be generated using attribute query tool in the GIS.

The results and output of spatial modeling above is illustrated in *Fig. 5*. Using the STATISTICS tool in the GIS, the extent of areas suitable for construction in the Hutan Simpan Ayer Hitam is 89.4 hectares.

Surface Analysis and Modeling

Surface analysis is a recent and more advanced operation in GIS. It involves the usage of the third dimension of spatial data (the z variable) in addition to the basic x and y variables in the Cartesian coordinate plane (Chou 1997). Elevation is an example of the z variable or 3D attribute representing terrain topography of a study area. In the example of the Ayer Hitam forest, three dimensional surface can be generated in the GIS to enable perspective viewing of the resources *(Fig. 6)*. Other surface analysis operation include earth volume, aspect and relief calculations.

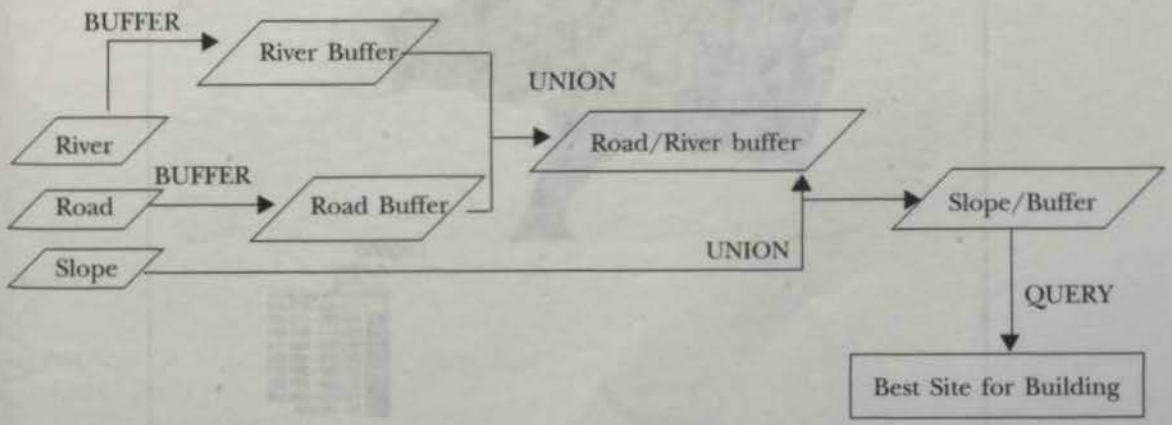

Fig. 4. Flow chart of spatial modeling

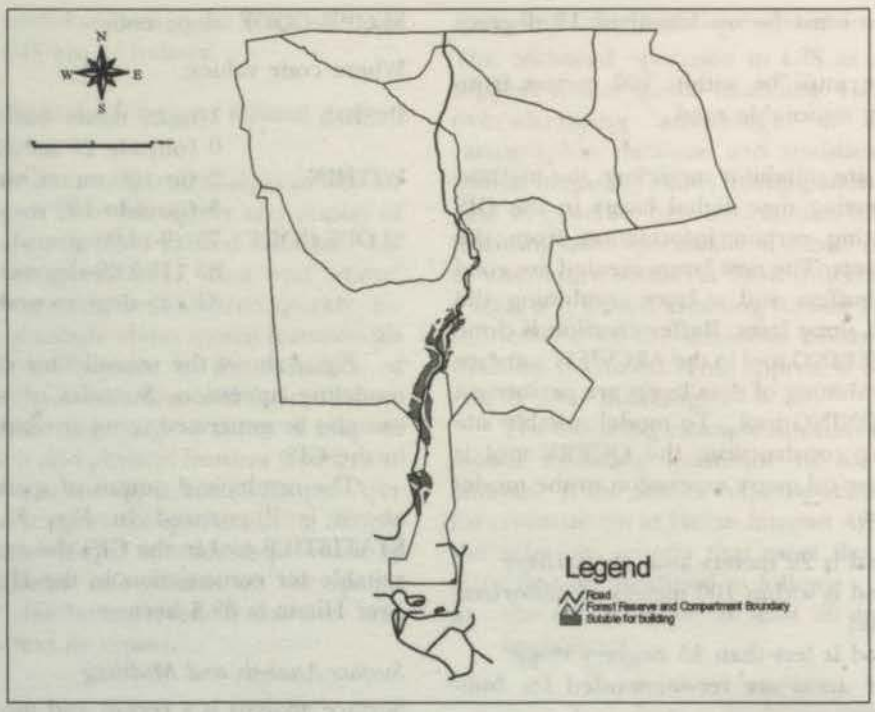

Fig. 5. Map of Area Suitable for Development in Hutan Simpan Ayer Hitam, Selangor

Fig. 6. 3 Dimensional View of Ayer Hitam Forest, Selangor

CONCLUSION

The myriad of operations available in Geographical Information System (GIS) has made the system an important decision support tool in Forestry. Efficient handling and analysis of spatial data provided by GIS enable more efficient planning and management of forest resources. The need for organized data collection, storage and analysis in decision making at Hutan Simpan Ayer Hitam can be met if GIS is developed for the forest area.

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Short Notes on the Vertebrate Fauna of Ayer Hitam Forest Reserve, Puchong, Selangor

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Keywords: Vertebrates, Ayer Hitam Forest Reserve.

ABSTRAK

Rekod dari Muzium Zoologi, Jabatan Biologi, Universiti Putra Malaysia mengandungi senarai vertebrata dari kawasan Hutan Simpan Ayer Hitam yang dikutip dari 1975 hingga 1985. Koleksi dalam muzium ini terdiri dari 14 burung, 10 anura, 5 lacertalia, 3 ophidia dan 8 mamalia. Kutipan lapangan baru-baru ini yang dilakukan oleh pelajar-pelajar biologi, sebagai sebahagian tugasan kursus kepelbagaian vertebrata mendapati 3 spesies kelawar, 2 reptilia, 13 anura dan 10 ikan. Ikan merupakan tambahan kepada senarai vertebrata yang belum pernah dilakukan sebelum ini. Senarai vertebrata dalam laporan ini bukanlah yang lengkap. Beberapa koleksi perlu dilakukan untuk inventori vertebrata di Hutan Simpan Ayer Hitam.

ABSTRACT

Record from the Museum of Zoology, Department of Biology, Universiti Putra Malaysia contains list of vertebrates of Ayer Hitam Forest Researve area collected from 1975 until 1985. The collection in the museum consists of 14 birds, 10 anurans, 5 lacertalians, 3 ophidians and 8 mammals. Recent field collections by students of biology, as part of their assignment of vertebrates diversity revealed 3 species of bats, 2 reptiles, 13 anurans and 10 fishes. Fish is the new addition of the vertebrate lists that was not collected before. The list of vertebrate in this report is by no means exhaustive. More collections are needed to inventorise the vertebrates of Ayer Hitam Forest Reserve.

INTRODUCTION

Ayer Hitam Forest Reserve is a lowland dipterocarp forest situated in the middle of a rapidly developing area, about 20 km south of Kuala Lumpur. Covering an area of about 1248 ha the forest is bordered in the north by Bukit Jalil sport complex and to its south by new Putra Jaya administrative township. The eastern part of the forest is bordered by the proposed new satellite town of Lestari Perdana and to the west by the massive housing and business centres of Puchong. A small stream of about 2.5 km with many tributaries cut across the length of the forest. The stream becomes the riverhead of the Rasau River. Most of the tributaries dried up during drought season.

The forest was formally under the management of the Selangor State Forest Department and was leased to Universiti Putra Malaysia in 1996 for 80 years for the purpose of teaching and research. Prior to its lease to Universiti Putra Malaysia, the forest was already became part of the field training site for students from the Faculty of Forestry and students from the Department of Biology, Faculty of Science and Environmental Science.

During the early years of UPM, several animal collection trips to the forest were conducted to provide materials for classes. The specimens collected were recorded and deposited at the Museum of Zoology, Department of Biology. There was a gap in field activities by the Department of Biology between 1985 and 1998 and only in April 1998 until January 1999 there was a study on the anurans along the Rasau River conducted as part of the students' final year project. At about the same time several field trips were conducted to study the vertebrate diversity of the forest.

This communication reports some of the vertebrates recorded in the museum of the Department of Biology from the collection in the earlier periods of UPM and those collected during the recent field studies by the students.

MATERIALS AND METHODS

The information on the existence of the vertebrates was obtained from a search of the record of the Museum of Zoology, Universiti Putra Malaysia. The record on the vertebrate collection from the forest dated back since 1975. In addition, the current list also contained species collected during the three brief field studies in Ayer Hitam Forest Reserve recently carried out by the biology students as part of their assignments in the Vertebrate Biodiversity course.

Mist nets were mounted about 2 meters above the ground under the forest canopy to trap birds and bats. Rat-traps were set on the ground, using banana as baits to collect small ground mammals. The sites of collection covered only to the eastern part of the forest, along the old logging track that run almost parallel to the river as shown in *Fig. 1.*

Scoop nets were used to collect fishes and tadpoles in the Rasau River. Adult frogs and toads were caught by hand and mostly carried out at night. Some reptiles such as skinks and agamids were observed directly. Identification of the collected vertebrates were based on the references available and also by comparing the specimens with those deposited at the Museum of Zoology, UPM. For conservation purposes, trapped animals, except for taxidermy exercises, were released back to its original collection sites.

RESULTS AND DISCUSSION

Some of the information on the site of collection in the early years of UPM stated only Puchong that included at that time the present UPM Puchong farm and that of proposed Lestari Perdana townships area. Nevertheless the collection are included in the present list.

The vertebrates collected and recorded in the Museum of Zoology between 1975 until 1985 are listed in Table 1.

The three brief field collections by students revealed some of the species collected in the previous collections. Vertebrates collected from these exercises are listed in Table 2.

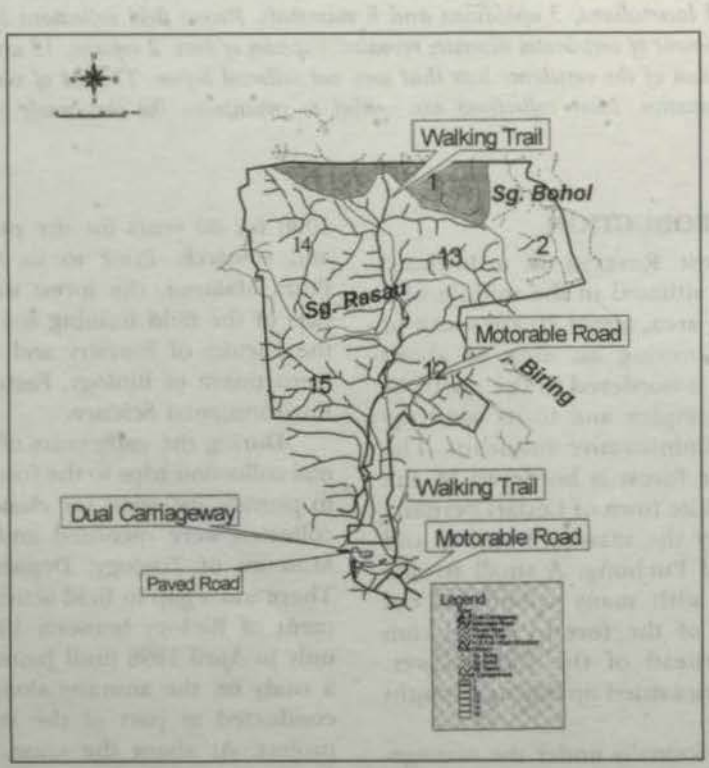

Fig. 1. Map of Natural and Physical Resource in Ayer Hitam Forest Reserve, Puchong

TABLE 1
List of vertebrates collected during the early years of Universiti Putra Malaysia

Species	Common name	Family	Date of collection
Birds:			
Criniger phaeocephalus	White throated bulbul	Pycnonotidae	10 Apr. 1981
Arachnothera longitrosta	Little spider hunter	Nectariniidae	10 &15 Apr. 1981 Kelicap jantung
Orthotomus sutorius	Long-tailed tailor bird Laki padi	Sylviidae	15 Apr. 1981
Hypogramma hyphogramicum	Purple naped sunbird	Nectarinidae	14 Apr. 1981
Trichestomma rostratum		Timallidae	9 Apr. 1981
T. malaccanes			8 Apr. 1981
Copsychus malabaricus	White rumped shama Murai batu	Turdidae	14 Apr. 1981
Trichastoma malabaricus		Timallidae	14 Apr. 1981
T. saularius		..	16 Apr. 1981
Pycnonotus simplex	Cream vented bulbul Murai rimba	Pycnonotidae	14 Apr. 1981
Chalcophaps indica	Emerald dove	Columbidae	16 Apr.1981
Pycnonotus goiaver	Yellow–vented bulbul	Pycnonotidae	15 Apr. 1981
Merbah kapur			
Stachyris erythroptera	Red-winged tree babbler Merbah sampah	Timaliidae	10 Apr. 1981
Macronus ptilosus	Fluffy-backed babbler	Timaliidae	15 April 1981
Anuran:			
Rana limnocharis	Padifield frog	Ranidae	12 Nov. 1975
Polypedates leucomystax	Malayan house frog	Rhacophoridae	21 Nov. 1975
Bufo quadriporcatus	Four-ringed toad	Bufonidae	27 N0v. 1979
Leptobrachium hasseltii	Ground toad	Pelobatidae	26 Feb. 1981
Rana chalconota	Copper cheek frog	Ranidae	13 Aug. 1981
Rana blythi	Malaysian giant frog	Ranidae	13 Aug. 1981
Rana signata	Yellow spotted frog	Ranidae	13 Aug. 1981
Rana malesiana	Malaysian frog	Ranidae	13 Aug. 1984
Rana erythrea	Malayan pond frog	Ranidae	22 Feb. 1984
Occidozyga laevis	Paddyfield puddle frog	Ranidae	22 Feb. 1984
Reptiles:			
Lacertilia:			
Draco volans	Sumpah-sumpah	Agamidae	14 April 1981
Draco quinquefasciatus		..	8 April 1981
Draco fimbriatus		..	10 April 1981
Draco melanopogon		..	10 Apr. 1981
Aphaniotis fuscus			27 Nov. 1979
Ophidia			
Liopeltis baliodeirus		Colubridae	13 Jan. 1975
Achaetulla straiata		..	16 Mar. 1975
Sibynophis melanocephalus		..	15 Oct. 1979
Mammals:			
Ground squirrels:			
Rhinosciurus laticaudatus	Schrew faced ground squirell	Sciuridae	27 Jul.1978

Callosciurus nigrovittatus	Black banded squirrel	Sciuridae	28 Jul.1978
Callosciurus notatus	Plantain squirrel	Sciuridae	Aug. 1985
Rats:			
Rattus muelleri	Mullerís rat	Muridae	4 Jul. 1978
Rattus sabanus	Long tailed giant rat	..	4 Jul.1978
Rattus surifer	Red spiny rat	..	4 Jul.1978
Rattus tiomanicus	Wood rat	..	18 Aug. 1985
Rattus rajah	Brown spiny rat	..	14 Jul.1978

TABLE 2
Vertebrates collected by students during their field trips

Species	Common name	Date of collection	
Mammals:			
Bats			
Rhinolopus trifoliatus	Treefoil horse shoe bat	Pteropodidae	8 Sept. 1997
Cynopterus brachyotis	Malaysian fruit bat	..	8 Sept. 1997
Penthetor lucasii	dusky fruit bat	..	8 Sept. 1997
Reptiles:			
Calotes versicolor	Sumpah sumpah	Agamidae	8 Sept. 1997
Geomyda spinosa	Spiny tortoise	Testudinidae	9 Sept. 1997
Amphibia:			
Rana doriae	Siamese frog	Ranidae	8 Sept. 1997
Polypedates leucomystax	Malayan house frog	Rhacophoridae	8 Sept. 1997
Rana chalconota	Copper cheek frog	Ranidae	8 Sept. 1997
Fishes:			
Channa striatus	Snake head	Ophiocephalidae	8 Sept. 1997
Hemirhampodon pogonognathus	Jolong, Sember	Hemirhampidae	8 Sept. 1997
Rasbora einthoveni	Seluang/susur batang	Cyprinidae	8 Sept. 1997
Puntius binotatus		..	8 Sept. 1997
Anuran:			
Rana doriae	Siamese frog	Ranidae	6 Feb. 1999
Bufo melanostitus	Common toad	Bufonidae	6 Feb. 1999
Bufo asper	Malayan giant toad	..	6 Feb. 1999
Rana malesiana	Malaysian frog	Ranidae.	6 Feb. 1999
Kalophrynus palmatissimus	Rain skicky toad	Microhylidae	6 Feb. 1999
Fish:			
Rasbora heteromorpha	Bada seluang	Cyprinidae	6 Feb. 1999
Rasbora sumatrana	Ikan seluang	..	6 Feb. 1999
Betta pungnax	Belaga,Sepilai	Anabantidae	6 Feb. 1999
Hemirhampodon pogonognathus	Julung-julung	Hemirhampidae	6 Feb. 1999
Channa striatus	Haruan	Ophiocephalidae	6 Feb. 1999
Clarias sp.	Keli	Clariidae	6 Feb. 1999
Channa lucius	Bujuk, Ubi	Ophiocephalidae	13 Mar. 1999

Anuran			
Rana blythi	Malayan giant frog	Ranidae	April 1998 till Feb. 1999
Rana chalconota	Copper cheek frog		..
Rana doirae	Siamese frog		..
Rana hosei	Green tree frog		..
Rana paramacrodon	Coarse frog		..
Rana plicatella	Rhinoceros frog		..
Rana signata	Yellow spotted frog		..

The list of vertebrates in this report may not be exhaustive especially the avian fauna which has been studied more thoroughly by other workers recently. Among the vertebrates, fishes gave a more complete list. Some fishes that are quite rare such as 'bujuk' that prefer to live in streams, lakes and pond is also found in the Rasau River. Among the fishes, *Hamirhampodon pogonognathus* is available in large number and normally remain near the surface. *Rasbora* are small fishes that are also commonly found in the river. They are small fish and the largest caught in Rasau River was about 8.5 cm in length. Even though *Rasbora* form the food for predatory fish, their existence in large number is because there are very few predator fishes found in Rasau River. Some *Rasbora* such as *R. einthoveni* prefers slightly acidic water in swamp. Some how the fish is also found in Sg. Rasau that was not acidic. From a total of 8 species of *Rasbora* recorded in Malaysia, 4 are found in Rasau River.

More collections are needed to inventorize the vertebrates of Ayer Hitam Forest Reserve especially in the interior part of the forest.

ACKNOWLEDGEMENTS

The author is grateful to the Officer in charge of Hutan Simpan Ayer Hitam, Puchong for allowing the field collections. Thanks are due to the lecturer in charge of the Museum of Zoology, Department of Biology for the assistance rendered. This paper is dedicated to the laboratory technicians, especially to the late Mr. Rajoo who had spent time and effort in establishing the Museum of Zoology during the early years of the University.

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The Role and Function of Universiti Kebangsaan Malaysia Permanent Forest Reserve in Research and Education

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Keywords : Bangi Forest Reserve, UKM Permanent Forest Reserve, Langat Basin

ABSTRAK

Hutan Simpan Kekal UKM adalah kawasan berhutan yang masih ada di dalam kampus utama UKM di Bangi, yang merupakan kawasan yang dimajukan di atas hutan yang dahulunya dikenali sebagai Hutan Simpan Bangi. Kawasan seluas 138 ha (340 ekar) ini dikelaskan sebagai hutan yang telah dibalak yang sedang pulih, termasuk kawasan seluas 81 ha telah dikhaskan sebagai kawasan penyelidikan ekologi. HSKUKM telah diwartakan pada tahun 1993 untuk menghalang pembangunan kawasan hijau di bawah pengawasan UKM. Perkara ini telah ditekankan semula di dalam Polisi Kelestarian Hutan UKM yang telah dilancarkan pada tahun 1997. Hutan Simpan Bangi dahulunya adalah merupakan sebahagian dari kawasan berhutan Lembagan Langat yang telah terserpih. Kedudukan hutan ini yang hampir dengan kampus telah dioptimumkan oleh pelajar dan kakitangan UKM untuk penyelidikan mereka. Sejak dari peringkat awal pembangunannya, UKM telah menekankan pembinaan kampus yang menyerupai taman botani di mana para pelajar akan dapat menjadikannya sebagai makmal terbuka. Hasilnya UKM telah menjadi contoh dan sekarang mempunyai koleksi di antara terbaik bagi germplasma tumbuhan perhiasan dan teduhan terutama palma dan paku pakis. Hutan ini penting kerana ia merupakan sinki hijau karbon di Lembagan Langat serta ianya digunakan sebagai makmal biologi dan kelas terbuka bagi pelajar di UKM.

ABSTRACT

The UKM Permanent Forest Reserve is an area within the main campus of UKM in Bangi, developed in an area formerly known as Bangi Forest Reserve (BFR). This 138 ha (340 acres) of recovering logged-over forest, inclusive of some 81 ha of ecological research area was formally gazetted in 1993 as UKM Permanent Forest Reserve to safeguard and prevent further development of this green area. This was further reiterated in the UKM Sustainable Forest Policy which was introduced in 1997. The BFR was part of what was used to be known as Langat Basin Forest area which is now very much fragmented into various pieces of small left-overs. The close vicinity of the forest to the campus has been one of the main reasons for the extensive utilisation of the area for student research projects. Since the early days of its development, the planners of UKM have envisaged holistic concept of having the campus to resemble a botanic garden as a whole to serve as living laboratories for the use of UKM students in education and research. As a result, UKM has set an example and currently hold one of the best germplasm collections of ornamental plants, especially palms and ferns collections in Malaysia. The UKM Permanent Forest Reserve is an important carbon sink green area in the Langat Basin as well as a biological laboratory and open classroom for UKM students.

INTRODUCTION

The Bangi Forest Reserve (BFR) lies between 2° 54' N and 101° 4.5' E in the district of Hulu Langat, Selangor Darul Ehsan, some 35 km south of Kuala Lumpur. This quartzite soft rock-based forest is bordered by the Langat river in the North and Kuala Lumpur-Seremban highway in the South. Topographically the area is moderately flat with several small streams and patches of swamps, at altitude of 40 m to 110 m above sea level. BFR received its status as a forest reserve on 31 December 1906 and was placed under strict jurisdiction of the Selangor Forestry Department. Nevertheless unauthorized exploitation during the post World War II occurred and it was selectively logged during the

Japanese occupation in 1942-1945 (Latiff 1981). It was again logged off for the second time in the late 1960's. The Japanese planted *Palaquium gutta* after the logging was completed as a source for "gutta perca". In addition, native settlements were then allowed and *Hevea brasiliensis* trees were subsequently planted on the fringes of this reserve. Prior to handing of this Reserve to the Universiti Kebangsaan Malaysia (UKM) authorities in the 1970's, it had been the home of the Temuan community aborigines group.

The original 881 ha BFR was classified into 832 ha of regenerating lowland forest, 31 ha of fresh water swamps and 19 ha of rubber and oil palm plantations *(Fig. 1, 2)*. Most of these areas, especially plantation areas and those near the main road, were developed to accommodate infrastructures for the UKM campus facilities. Another 27 ha was later delineated for Malaysian Institute for Nuclear Technology (MINT) (then known as Pusat Penyelidikan Atom Tun Dr Ismail or PUSPATI) and some 200 ha was leased to Palm

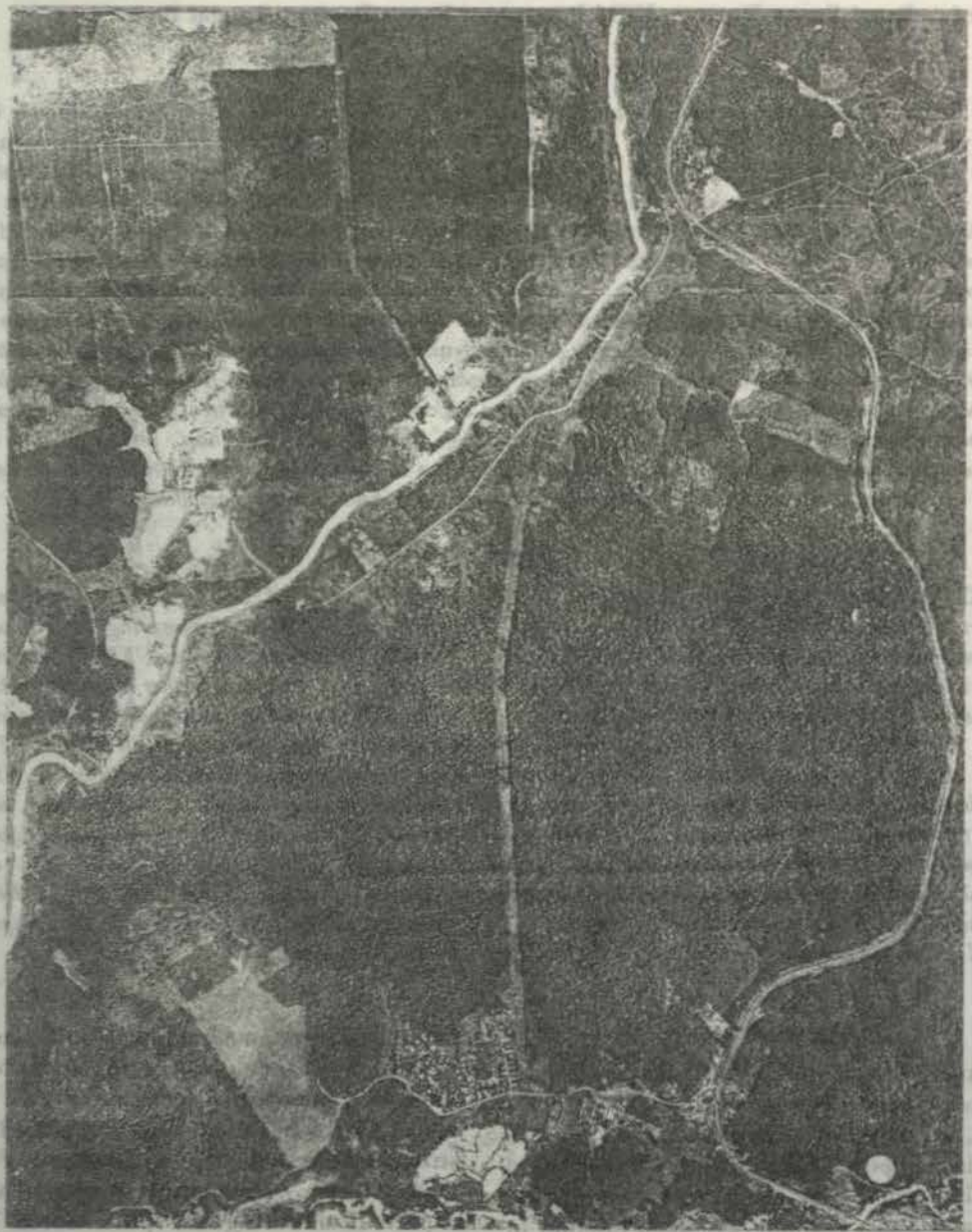

Fig. 1. Aerial photograph of the Bangi Forest Reserve in 1970's

Fig. 2. Map of Bangi Forest Reserve in 1970's showing the ecological reseach area (1). The section 2 and 3 are under very disturbed forests

Oil Research Institute Malaysia (PORIM) for oil palm plantation. By late 1980's only a portion of the original forest (about 105 ha) remain designated by the University as the Ecological Research Area, where many on-going researches were carried out mostly by students of UKM *(Fig. 3)*.

The Establishment of UKM Permanent Forest Reserve

Following illegal encroachment of this area, which further reduced the ecological research area to a dangerously small fragment (said to be about 81 ha), biologists and senior academicians in the campus appealed to the top management

Fig. 3. Current landuse of the UKM area

of UKM management to formally gazette the remaining 138 ha (340 acres) of forested areas in the campus as *UKM Permanent Forest Reserve* to safeguard and prevent further development of this green area. This was achieved in 1993 and further reiterated in the *UKM Sustainable Forest Policy* which was introduced in 1997. This declaration pledges that:

- UKM will continue to practice sustainable development philosophy, and University forests will be kept as gazetted
- University forests will be managed to achieve maximum benefits in research & education
- Future developments will be carried out after assessments on impacts to environment and resources
- Forest extraction will only be allowed after consultation with the Committee
- The Committee will evaluate the impact of development to the forest resources and environment
- Degenerated forest areas will be revived and enriched with a proper silvicultural technique

The BFR was part of what was used to be known as Langat Basin Forest area which is now very much fragmented into various pieces of small left-overs. With the rapid development of Sepang-Putra Jaya area, this forest would probably remain as the only medium-size forest left in the area buffering the Hulu Langat water catchment forest reserves in the north-northeast and Kuala Langat wetlands in the west and Air Hitam buffers in the north *(Figure 4, 5)*.

University Forest as a Research Site

The close vicinity of the forest to the campus has been one of the main reason for the extensive utilisation of this area for student research projects. There are 2 km trail crossing the forest and the two 1-ha permanent ecological research plots are being studied and monitored at specific periods throughout the year.

The abstracts of student theses and dissertations made from studies on this forest and its components were recently compiled and published by Zubaid (1997). A total of 75 theses and dissertations were submitted from 1974 to 1997 for Ph.D (1 dissertation), M.Sc. (6) and B.Sc (68). These student academic reports cover:

- Vertebrate ecology & systematics (23)
- Floristics & plant ecology (22)
- Insect systematics & ecology (18)
- Invertebrate ecology & taxonomy (6)
- Genetic diversity (6)

Currently, there are at least 9 active research programmes being carried out in the UKMPFR. These are:

- Reproductive biology and comparative ecology of small mammals
- Anatomy, cytology, and ultrastructure of cryptogams
- Invertebrate community ecology
- Systematics and ecology of Hymenoptera parasites
- Vertical distribution pattern of insects in lowland forest
- Genetics of *Drosophila* in tropical lowland forest
- Comparative bird community ecology
- Floristic analysis and long-term monitoring of species in fragmented forests
- Ecosystem evaluation and biological assessments on forest fragments

Floristic and Faunal Composition

The flora of this forest is well studied by the staff and students of UKM. It was started in 1974 by Misri Kusnan, studying comparative effectiveness of point-quarters and random pair methods in assessing the tree density, species frequency and importance value attributes in the lowland forests. It was later followed in the 1980's by many others including a general ecological survey (Hashim 1980), palm ecology (Ramli 1981), seedling dynamics of dipterocarp trees (Khairiah 1984), ecophysiology (Voon 1985), reproductive ecology of seed plants (Julius 1987). By the late 1980's, detail enumeration of the plant species and ecosystem assessments were carried out, first by Jamili (1988) for the 66 families (166 genera and 360 species) and later by Syed Muzni (1991) for the rest (23 families with 94 genera and 154 species). Two 1-ha plots were also established and detail floristic composition and forest productivity were reported by Norashidah (1993) and Lajuni (1996). They have reported that in their 2 ha plots, a total of 1827 trees (DBH more than 5 cm) from 235 species representing 142 genera and 49 families were found. Most of them (nearly 70%) are small trees in the Class 1 (5 to 14.9 cm DBH) and only 1 % are in the large timber (Class 7 with DBH over 65 cm) category. Four out of the five largest trees were from the Dipterocarpaceae family. The total above ground biomass is estimated at 318 t per ha. The forest is being dominated by *Shorea acuminata, S. bracteolata, S. leprosula, Dipterocarpus baudii, D. crinitus*

Fig. 4. Lansat image of the Langat Basin as in 1998

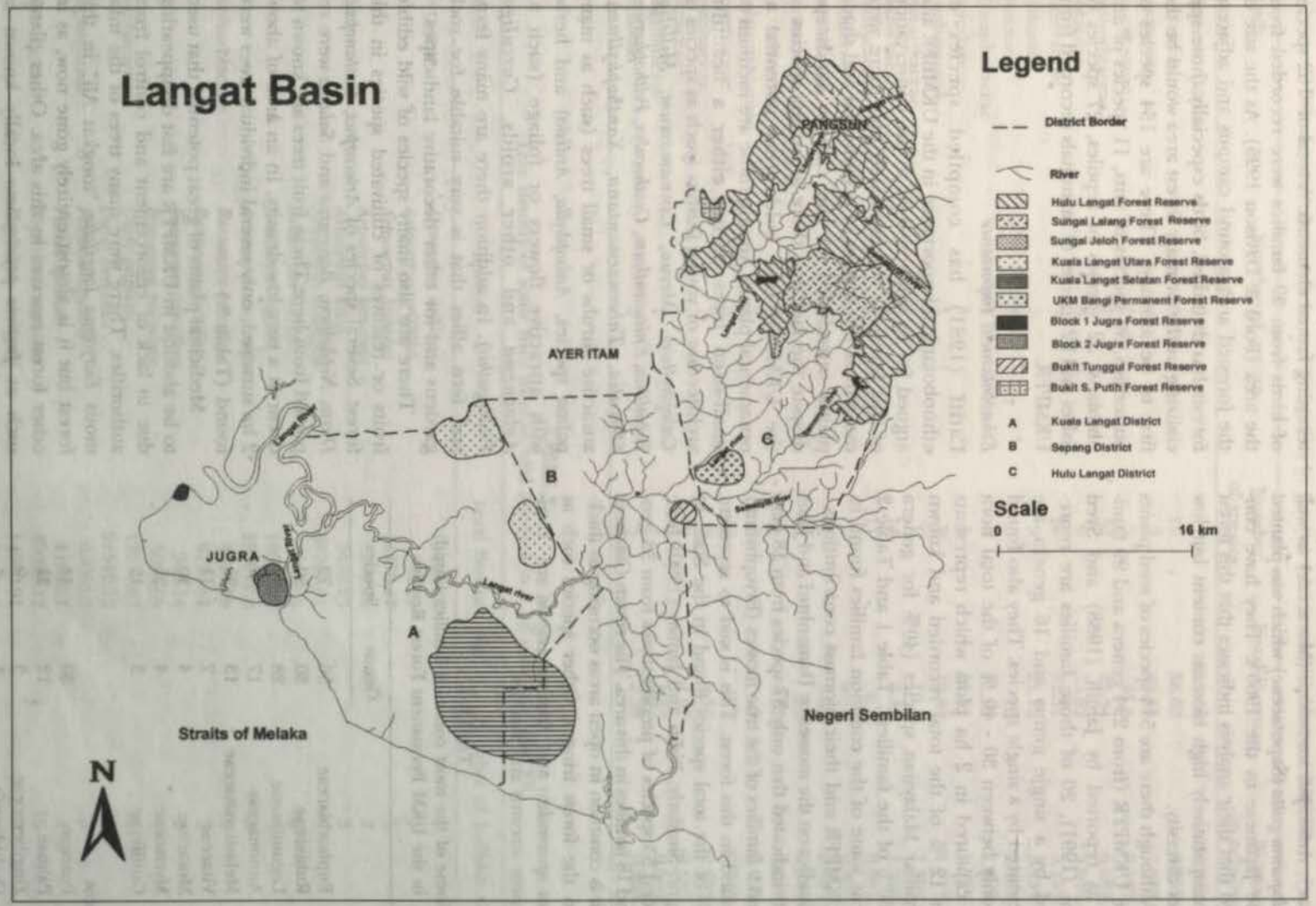

Fig. 5. Forest remnants in the Langat Basin

(Dipterocarpaceae), *Ptychopsis costata* (Euphorbiaceae), *Artocarpus scortechinii* (Moraceae) as well as *Palaquium gutta* (Sapotaceae) which was planted by the Japanese in the 1960's. They have concluded that their analysis indicates that this forest has comparatively high biomass content but low species diversity.

Although there are 514 species of seed plants in the UKMPFR (from 294 genera and 99 families) as reported by Jamili (1988) and Syed Muzni (1991), 20 of those families are represented by a single genus and 16 genera are represented by a single species. They also found that only between 30 - 40 % of the total flora were captured in 2 ha plots which represents about 12 % of the total recorded and known Peninsular Malaysian species (40% for genera and 60% of the families). Table 1 and Table 2 present some of the common families found in the UKMPFR and their biomass contributions.

Studies on the mosses by Damanhuri and Jikos (1990) indicated that only 37 species from 18 genera and 9 families of the true mosses (Bryophytina) are found in this forest. This is said to represent 30.8% of the total species found in the State of Selangor. Similarly, Bidin and Jaman (1990) have recorded 53 species of pteridophytes from 33 genera and 18 families in this area. The resam *Gleichenia linearis* is common in open areas occuring as thickets on the forest fringes. Other species such as *Cyathea squamulata* and *Schizaea wagneri* are common near streams and swamps.

TABLE 1
Some of the most common families found in the UKM Permanent Forest Reserve

		Genus	Species
Dicot			
	Euphorbiaceae	50	72
	Rubiaceae	30	50
	Leguminosae	28	42
	Annonaceae	17	37
	Melastomataceae	13	21
	Vitaceae	7	11
	Moraceae	4	30
	Myrtaceae	4	25
	Guttiferae	3	15
Monocot			
	Poaceae	30	44
	Palmae	12	31
	Zingiberaceae	5	9
	Orchidaceae	5	5
	Pandanaceae	2	5

The Bangi Forest Reserve has quite an interesting faunal elements. A total of 162 species of birds from 39 families were recorded from the area (Ford & Davison 1995). As the size of the forested area around campus and adjacent forests has dwindled, birds especially those specializing in the primary forest area would be the first to be affected. There are 134 species of butterflies, 39 species of ants, 11 species of amphibians, 32 species of reptiles, 27 species of fishes and 52 species of mammals recorded from UKMPFR.

Ethnobotanical Importance

Latiff (1981) has compiled species of ethnobotanical importance in the UKMBFR and argued for its value vis-á-vis to the conservation of this forest. It was estimated that there were more than 100 species of ornamental and shade plants introduced to the campus landscape despite the fact that there are many species in the UKMPFR that hold great potential as ornamental plants. Among those are medium or small-sized trees having either a beautiful architecture or young flushes (such as species of *Calophyllum, Mesua, Cinnamomum, Milletia, Polyalthia, Enicosanthum, Cyathocalyx, Pelthophorum, Sterculia, Tabernaemontana, Xanthophyllum*), attractive shrubs or small trees (such as many palms species, *Anisophylla, Ardisia*) and herbs with attractive flowers or foliage (such as *Aglaonema* and other aroids, *Curculigo, Phyllagathis*). In addition there are many ferns and fern allies that is very suitable for rock gardens and for other decorative landscapes.

There are also many species of wild edible fruits or relatives of cultivated species in this forest. Several species of *Artocarpus, Castanopsis, Durio, Nephelium, Baccaurea* and *Salacca* were reported from here.These fruit trees are known to occur at a very low density. In an area of about 2 ha surveyed, only several individual trees were found (Table 3.)

Medicinal plants of great potential that used to be abound in UKMPFR are fast disappearing due to lack of enforcement and control from authorities. There were many trees of the infamous *Eurycoma longifolia* "tongkat Ali" in this forest but it is almost entirely gone now, as in other forest reserves in this area. Other plants such as *Justicia ptychostoma* locally known as "sebongkok", claimed to be effective for treatment of cold among children is abundant in this

TABLE 2
Biomass contribution from top 25 families in the two 1-ha research plots in UKMPFR

Family	Number of genera	Number of species	Total Biomass	Biomass in percentage
Dipterocarpaceae	2	7	215.66	34.04%
Rubiaceae	10	10	58.63	9.25%
Sapotaceae	4	7	49.45	7.80%
Apocynaceae	2	2	45.5	7.18%
Euphorbiaceae	17	30	42.34	6.68%
Moraceae	3	9	35.82	5.65%
Burseraceae	5	17	32.51	5.13%
Fabaceae	7	9	21.73	3.43%
Clusiaceae	1	3	13	2.05%
Rhizophoraceae	4	4	11.93	1.88%
Sapindaceae	4	5	11.11	1.75%
Bombacaceae	1	2	10.84	1.71%
Anacardiaceae	7	9	10.1	1.59%
Lauraceae	12	14	8.83	1.39%
Myristicaceae	5	11	6.3	0.99%
Guttiferae	2	5	5.72	0.90%
Sterculiaceae	2	4	5.61	0.89%
Myrtaceae	3	15	5.3	0.84%
Flacourtiaceae	5	6	5.07	0.80%
Melastomataceae	2	3	5	0.79%
Celastraceae	3	3	4.7	0.74%
Annonaceae	7	9	4.36	0.69%
Ulmaceae	1	2	4.02	0.63%
Magnoliaceae	1	1	3.53	0.56%
Tiliaceae	2	3	2.28	0.36%

TABLE 3
Tree density of some fruit trees or wild relatives in 2 ha plots in UKMPFR

Family	Species	Total Biomass (Kg)	Number of Individuals
Moraceae	*Artocarpus axillaris*	13429.85	1
	Artocarpus griffithii	98.29	1
	Artocarpus hispidus	11373.47	5
	Artocarpus kemando	280.26	2
	Artocarpus lowii	3438.23	3
	Artocarpus maingayi	38767.01	9
	Artocarpus nitidus	6092.5	6
	Artocarpus rigidus	19627.32	5
	Artocarpus scortechinii	257072.8	43
Euphorbiaceae	*Baccaurea brevipes*	4645.59	14
	Baccaurea kunstleri	9778.87	2
	Baccaurea parviflora	949.14	2
	Baccaurea reticulata	3625.65	4
Bombacaceae	*Durio griffithii*	17077.67	20
	Durio lowianus	91342.12	19
Leguminosae	*Parkia singularis*	43065.2	3
	Parkia speciosa	11088.1	1
Sapindaceae	*Nephelium costatum*	49059.12	16
	Nephelium maingayi	14600.91	1
Sterculiaceae	*Scaphium macropodum*	50186.3	23

forest. So does *Willughbeia firma* (for treatment of headache and fever), *Thottea grandiflora* (dysentery), *Labisia pumila* (after childbirth), *Diospyros wallichii* (yaws), *Macaranga denticulata* (snake-bite) and various species of Annonaceae especially *Goniothalamus malayanus, Goniothalamus curtisii, Uvaria grandiflora, Artabotrys suaveolens, Xylopia malayana* and *Fissistigma fulgens* (after childbirth) which are so abundant in this forest. Other plants of ethnobotanical importance, such as species utilised by natives for general construction, are also recorded in this forest. The nibung (*Oncosperma tigillaria*) and bayas (*O. horrida*) for example are noted for their fine long lasting wood and hardness are growing in areas near swamps. The valuable kayu gaharu (*Aquilaria malaccensis*) noted for its valuable incense wood and resin were used to be there as well.

The residents of Bangi and surrounding area are known to collect many plants from this forest for their own use. Plants that were collected include medicinal plants, rattans, and palas leaves during festive seasons. The high biomass per hectare in Bangi forest can afford to stabilize its surrounding area and perhaps the only green lung remaining. Forest biomass has a direct bearing on its contribution to regulating the environment. A forest with higher biomass have lower albedo, hence it has the ability to regulate climate more effectively. This is especially important in stabilizing the daily temperature, and hydrological regimes (Sham *et al.* 1987; Soepadmo 1984). Studies by Sham (1986 & 1990) also showed that the presence of several trees in a medium size park can influence the temperature of that area. BFR also an important genetic stock for fruit growers around this area. The absence of pollinator fauna in this forest may have serious negative implication on fruit harvest, which can directly hurt the growers economic gain. BPFR is also a good place as a recreation area for nature and outdoor enthusiasts. As times goes by areas around this forest will become more urbanized. This forest can become an important recreation area for residents.

Economic Value of Botanical Resources

In an analysis to calculate the value of botanical resources based on tree standings in the two 1-ha plots in this forest, Mat Salleh *et al.* (1997) estimated that the stumpage value (SV) for UKMPFR is approximately RM 17,000 per ha. About 80% of those value are from the dipterocarps (Table 4, Table 5). The total value for the remaining forest in UKM is projected to worth close to RM 1.4 million based on market price of the timber in that year (1997). This value is comparable to other recovering logged-over forests in this area (Table 6).

Proper evaluation of tropical forests are necessary to make judicious use of the forest (Godoy 1992), and it is best represented if we can capture the total economic value. This total economic value is given by a sum of a number of components,

Total economic value = Direct-Use Value + Indirect-Use Value + Option Value + Existence Value

However, in this study we have only covered partial direct-use value, we did not yet take into consideration other non-timber forest products, for example medicinal plants. At the same time,

TABLE 4
Top 15 commercial families from UKMPFR

Families	Volume	CR	PM	SV	Stands
Dipterocarpaceae	123.09	37778	10848	26930	103
Apocynaceae	27.93	3373	1262	2111	18
Sapotaceae	27.46	2693	1096	1597	32
Anacardiaceae	20.03	1111	603	508	22
Clusiaceae	6.7	778	296	483	35
Rubiaceae	7.88	731	305	426	276
Fabaceae	9.54	765	342	423	50
Burseraceae	14.81	867	457	410	151
Moraceae	11.83	754	379	375	77
Euphorbiaceae	12.76	699	382	317	351
Bombaceae	4.04	311	142	169	39
Celastraceae	2.1	219	87	132	5
Magnoliaceae	1.56	183	69	114	1
Sapindaceae	4.12	234	125	108	57
Lauraceae	2.97	181	93	88	35

TABLE 5
Top 15 commercial species from UKMPFR

Species	Family	CR	PM	SV	Stands
Shorea acuminata	Dipterocarpaceae	12703	3568	9135	24
Shorea leprosula	Dipterocarpaceae	10965	3095	7870	20
Shorea bracteolata	Dipterocarpaceae	6480	1959	4521	15
Dipterocarpus baudii	Dipterocarpaceae	5892	1632	4260	10
Palaquium gutta	Sapotaceae	2489	987	1502	16
Dyera costulata	Apocynaceae	2237	873	1364	17
Shorea parvifolia	Dipterocarpaceae	1287	367	920	10
Alstonia scholaris	Apocynaceae	1135	389	747	1
Gluta sp.	Anacardiaceae	757	279	477	1
Mesua ferrea	Clusiaceae	615	238	376	11
Artocarpus scortechinii	Moraceae	685	356	329	43
Pertusadina eurhyncha	Rubiaceae	486	254	232	37
Dipterocarpus crinitus	Dipterocarpaceae	418	215	203	23
Durio lowianus	Bombaceae	300	133	167	19
Elateriospermum tapos	Euphorbiaceae	310	155	155	27

TABLE 6
Comparative analysis of stumpage value (SV) for several forest reserves in Malaysia

Forest Reserve	Ecosystem	Assessment	SV/ha
Johor: Lenggor	HDF	1994	17644
Kedah: Ulu Muda	HDF	1994	26022
Kelantan: Berangkat	HDF	1989/90	6525
Negeri Sembilan: Angsi	HDF	1995	8674
Negeri Sembilan: Johol	HDF	1995	9233
Negeri Sembilan: Pasoh	HDF	1995	5178
Negeri Sembilan: Serting	HDF	1995	11361
Pahang: Lesong	HDF	1989/90	19793
Sabah: Ulu Bengkoka	HDF	1995	13947
Terengganu: Jengai	HDF	1988/89	15779
Selangor: Raja Muda	Peatswamp	1990	2149
Selangor: Air Hitam (14)*	LDF	1996	17170
UKMPFR	LDF	1993-1996	17276

indirect-use value or functional value as related to ecological function performed by the forests, such as biogeochemical cycling and the regulation of watershed is also not being accounted for, not to mention option value and existence value. If all these values are being added up, UKMPFR would value more than we have given here. A mere RM 1.4 million is only a glimpse of its potential value. Therefore policies should be adjusted for responsible long-term resource management of UKMPFR, so that this vast store of wealth will be sustained if not conserved.

Germplasm Depository

Since the early days of its development, the planners of UKM have envisage the establishment of a campus as a "botanic garden" (Latiff & Ismail 1984). The idea of turning the existing and future infrastructures into a Botanic garden for the University was proposed in 1981 and agreed in principle by the University's Committee for Campus Beautification and Landscape in 1982. This holistic concept was designed to promote the green image of UKM and to serve a living laboratories for the use of UKM students in education and research. As a result, UKM campus has set an example and currently hold one of the best germplasm collections of ornamental plants, especially palms, and ferns collections in Malaysia. The campus hold 97 species of interesting ornamentals and shade trees introduced to the campus (Table 7).

TABLE 7
Ornamental and shade plants introduced to the UKM campus

Botanical name	Local Name	Botanical name	Local Name
Acacia auriculaeformis		*Hibiscus rosa-sinensis*	Bunga raya
Acalpha simensis	Akalifa siam	*Hibiscus tiliaceus*	Bebaru
Acytinophloeus macarthuri	Palma	*Ixora coccinea*	Siantan hutan
Adenanthera pavonina	Saga	*Ixora javanica*	Jarum-jarum
Aglaia odorata	Belangkas	*Jacaranda filicifolia*	Introduced
Aleurites moluccana	Buah keras	*Lagerstroemia flos-reginae*	Bungor besar
Allamanda cathartica		*Lagerstroemia indica*	Bungor Kedah/India
Andira inermis		*Lawsonia inermis*	Inai
Archontophoenix alexandre		*Licuala glabra*	
Areca catechu	Pinang	*Licuala grandis*	
Baccaurea motleyana	Rambai	*Litchi chinensis*	Laici
Bauhinia blakeana	Tapak kuda	*Livistonia chinensis*	
Borassus flabellifer		*Livistonia rotundifolia*	
Brunsfelsia examina		*Mangifera foetida*	Macang
Calliandra surinamensis		*Mangifera odorata*	Kuini
Calophyllum inophyllum	Bintangor laut	*Melaleuca cajupti*	Gelam
Caryota mitis		*Melia indica*	
Cassia biflora		*Mesua ferrea*	Penaga
Cassia fistula	Dulang/ Tengguli	*Milletia atropurpurea*	Tulang dacing
Cassia spectabilis	Introduced	*Mimosops elengi*	Bunga tanjung
Casuarina equisetifolia	Ru	*Mussaenda phillipica*	Introduced
Casuarina sumatrana	Cemara	*Nerium odorum*	Introduced
Cerbera odollam	Pong-pong	*Ochna kirkii*	
Chrysolidocarpus lutescens	Introduced	*Peltophorum pterocarpum*	Jemerlang laut
Cinnamomum iners	kayu manis	*Phoenix dactylifera*	
Cocos nucifera	Kelapa gading	*Phoenix roebelinii*	
Codieum variegatum	Podi	*Phoenix rupicola*	
Congea tomentosa		*Pithecellobium dulce*	Madras Thoru
Corypha utan		*Plumbago capensis*	Ceraka
Cupressus sp.		*Podocarpus polystachyus*	Setada, jati laut
Cyrtostachys renda		*Polyalthia longifolia*	Asoka
Delonix regia	Semarak api	*Pometia pinnata*	Kasai
Diospyros discolor	Buah mentega	*Pongamia pinnata*	Mempari
Durata repens		*Ptychococcus paradoxus*	
Dyera costulata	Jelutong	*Ptychosperma macarthurii*	
Ehretia microphylla	Pokok pagar	*Randia macrantha*	
Elaeis guineensis		*Rhaphis humilis*	
Eugeissona tristis		*Rhapis excelsa*	
Eugenia aromatica	Cengkih	*Roystonea oleracea*	
Eugenia malaccensis	Jambu bol	*Roystonia regia*	"Royal palm"
Euodia ridleyi	Telor belangkas	*Salix babylonica*	Jendalu
Euphoria longan	Longan	*Samanea saman*	Pokok hujan
Euphoria malaiensis	Mata kucing	*Sizygium grandis*	Jambu laut
Fagrea fragrans	Tembusu	*Sterculia foetida*	Kelumpang
Ficus benjamina	Walungin	*Swietenia macrophylla*	Mahogani
Ficus pumila		*Tamarindus indicus*	Asam jawa
Ficus roxburgiana	Kelebok	*Tecomaria capensis*	
Garcinia mangostana	Manggis	*Veitchia merrillii*	
Gardenia carinata	Bunga cina		

(*Source*: Latiff & Ismail 1984, with addition from recent inventory)

The campus also currently has three germplasm collection programs viz. The Fern Garden, the Ginger Germplasm Collection and The UKM Annonaceae Germplasm Depository (UAGD). The Fern Garden or Taman Paku Pakis (a.k.a. Fernarium) was later setup in 1988 in the 13 ha formerly allocated as an arboretum area (Bidin 1990). It was the first such garden to be established in Malaysia and currently being recognised by the Botanic Garden Council Secretariat of the International Union for the Conservation of Nature (IUCN) as one of the premier germplasm collection in the tropics. The Garden has 6 trails and devided into three sections viz. Ethnobotany, Conservation and Exotics. Currently the garden holds nearly 100 species from 46 genera and 25 families. Ginger Germplasm Collection was only started in 1997 and currently hold 80 species from 10 genera of Zingiberaceae and Costaceae. The UKM Annonaceae Germplasm Depository, the newest section, was started last year in 1998 with more than 50 collections of *Goniothalamus* from all over Malaysia, to supplement 30 other species of Annonaceae found in UKMPFR.

Nature Education Forest

In an effort to provide permanent infrastructure for co-curricular activities for students of UKM, the management has decided to designate 24 ha of UKMPFR as Nature Education Forest. It is currently developed and managed by Co-Curriculum Centre of UKM. Some basic infrasructures such as camp site, multi-purpose hall, dining & cooking area, cleaning and shower rooms, tracking nature trails, wall climbing facilities, obstacle course and mountain craft has been built. The facility can accommodate 300 students at a time and being used almost daily not only by UKM students, school children from Klang Valley area, NGOs as well as voluntary organizations.

CONCLUSION

The UKM Permanent Forest Reserve is an important green area in the Langat Basin, both as a biological laboratory and open classroom for university students as well as an environment buffer to the surrounding areas. The forest, although fragmented as it is, still harbours interesting and important biological resources with high biomass constituents. This forest is a big carbon sink with an estimated 44,000 tonnes for the entire area. The high biomass content in this forest enable it to perform an ecosystem regular function as a life system support, such as flood, climate and erosion. This forest remnant, together with other fragmented forests in the Klang Valley, have a considerable value for research, recreation, education and conservation for our future generations. Removal of these remnants would be catastrophic not only to our environment but also to wildlife and other important germplasm resources. Even the seemingly mobile avifauna was known to suffer and diminish as reported to be happening in Singapore and Bogor Botanic Gardens (Ford & Davison 1995).

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River Water Quality Status of Ayer Hitam Forest Selangor, Peninsular Malaysia

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EXTENDED ABSTRACT

Water is a vital element in human life and it is a renewable resource. According to Wan Ruslan (1994), water is essential for physiological existence, very much the same as every other living organism does and for many other purposes such as agricultural, recreational, industrial, hydroelectric power, navigational, propagation of fish and other aquatic life, irrigation, etc.

Generally, water quality means the standards of water body especially river for any beneficial uses. Water quality with a better index value indicates cleaner water body. High water quality is suitable for man and animals consumption compared to the low water quality. Water quality refers to the characteristics of a water supply that will influence its suitability for a specific use, i.e. how well the water quality meets the needs of the consumer. Water quality status indicates the level of pollutant composition and thus relates to human activities (Anhar *et al.*1998; Mohd Kamil *et al.* 1997a; 1997b). Water quality for various types of water body varies with input loads, flow rate and quantity of water (Mohd Kamil 1991; Wan Nor Azmin *et al.*1997). River is one of the important water sources and is classified polluted when there are changes in their chemical and physical characteristics that make it unsuitable for any objective and function (Azizi *et al.* 1997). Pollution standards for each water body usually evaluated by measuring the value of selected water quality parameters. These parameters can be categorized as physical, chemical and biological.

For the purpose of river water quality status assessment, four river water samples were collected from the upstream to the downstream of Sg. Rasau in Ayer Hitam Forest in May 1998. The first location (S1) located in the most upstream area; the second location (S2) located just after the recreational area within the forest; the third location (S3) located just after the small community area outside the forest reserve; and the last location (S4), located at the downstream most of the forest reserve area (*Fig. 1*). There were two categories of water quality parameters measured; in-situ parameters (Dissolved oxygen (DO), Electrical conductivity (Ec), Temperature, and pH) and laboratory parameters (Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammoniacal-Nitrogen (NH_3-N), and Suspended Solids (SS)). The grab sampling method was adopted in sampling the river water and the analysis procedures were based on APHA (1995).

All the data obtained through analysis were used to calculate the water quality index. The sub-index for each parameter was calculated using a series of equations, derived from the rating curve and the following equation as follows (Norhayati 1981):-

WQI= 0.22*SIDO + 0.19*SIBOD + 0.16*SICOD
+ 0.15*SIAN + 0.16*SISS + 0.12*SIPH
SI=Sub- index

Table 1 shows the result of analysis for the selected water quality parameters used in the assessment. Based on the results obtained , the value of the water quality index based on the DOE-WQI was in the range of 89.60 - 99.80 and thus indicates that the water quality status within the vicinity fall under Class I and II where as all the sampling sites fall under Class 1 except for S4 falls under Class II.

The study shows clearly that as the river flows from undisturbed (upstream) to the dis-

TABLE 1
Water quality data

Parameter	S1	S2	S3	S4
DO (mg/l)	7.0	6.0	6.8	7.4
EC (*mS/cm*)	0.03	0.03	0.03	0.04
Temperature (°C)	28.3	27.2	27.3	28.3
pH	5.93	5.51	5.33	6.03
BOD (mg/l)	0.71	0.65	0.84	5.22
COD (mg/l)	13.0	11.0	6.0	17.0
NH_3-N (mg/l)	0.0	0.0	0.16	0.12
Turbidity (NTU)	1	12	14	19
SS (mg/l)	2.0	11.0	14.0	28.0
E. coli (no./100 ml)	0	8	30	200
WQI	99.80	98.11	97.35	89.60
Class	I	I	I	II

turbed environment, the physico-chemical characteristics change and thus degrade the water quality status (*Fig. 2*). The results also reveals that the water body is very sensitive to any changes within the catchment area either through natural processes or anthropogenic sources.

In summary, it reveals that there is a close relationship between the river water quality and the landuse pattern within the vicinity of the sampling stations. Besides development activities, natural factors such as organic matter decomposition may also contribute and hence influence the river water quality in the study area. Efficient water quality management is the first

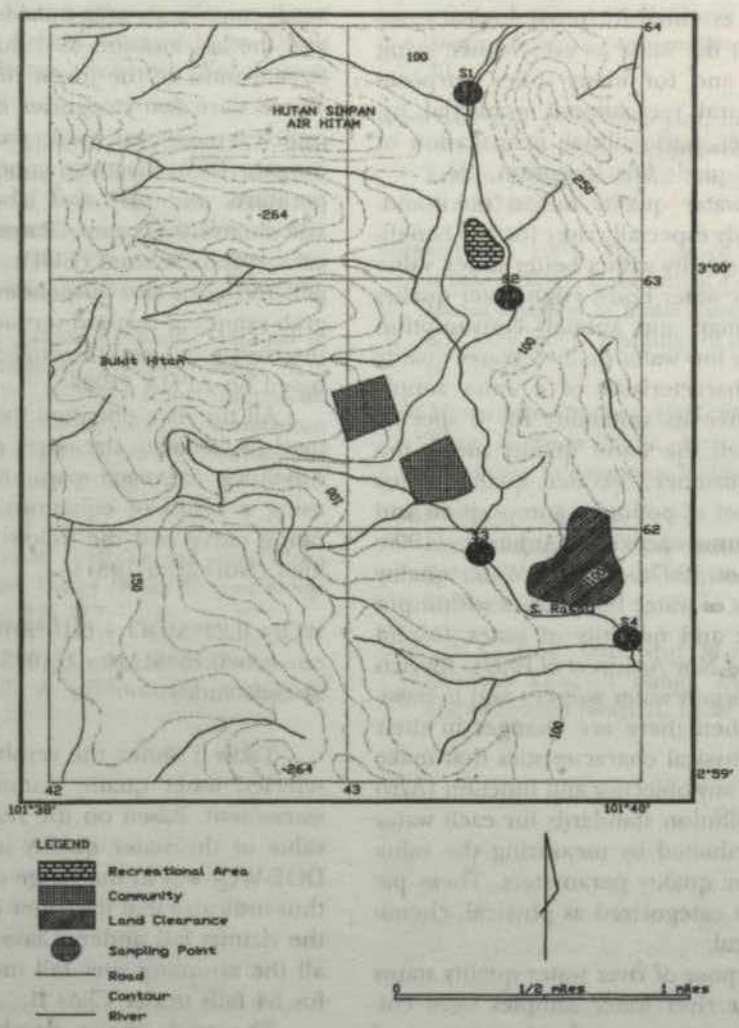

Fig. 1 . Location of sampling sites

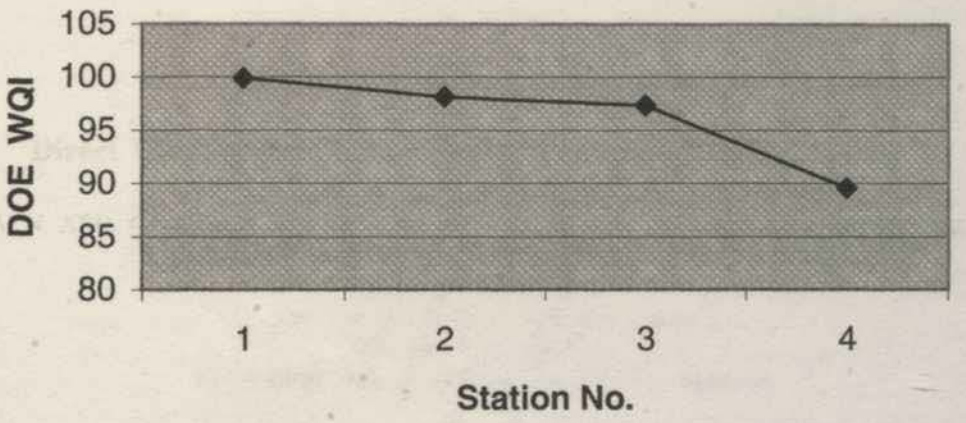

Fig. 2. Water quality profile of the sampling stations

step in ensuring an adequate supply of safe drinking water. While sanitary surveys, monitoring, watershed control, stormwater management and emergency response procedures are some of the essential towards a better and comprehensive water quality management plan.

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Direct Uses of Ayer Hitam Forest Reserve, Puchong, Selangor

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EXTENDED ABSTRACT

Forest land can be categorised into various uses depending on the nature of goods and services provided by the forest. This can be categorised into several uses such as maintenance of environment, provision of opportunity for recreation activities, habitat for wildlife, watershed protection, general conservation including minimization of soil erosion, and the production of wood for various uses. For each category of use, it might be subdivided, or combined to be used in the same area of forest land.

The use of Malaysian tropical rainforest is numerous and is not restricted to only timber production as most people commonly believe. The management of forest resources in Peninsular Malaysia is based on sustainable forest management principles. It means that the forest is managed for timber and non-timber outputs. A particular use of permanent forest reserve is subject to legal provision in accordance to Section 10(1) of the National Forest Act (NFA), 1984, which categorised functional uses of the forest reserve as follows:

- Timber production forest under sustained yield
- Soil protection forest
- Soil reclamation forest
- Flood control forest
- Water catchment forest
- Forest sanctuary for wildlife
- Virgin jungle reserve forest
- Amenity forest
- Education forest
- Research forest
- Forest for federal purposes

The Ayer Hitam Forest Reserve (AHFR) can be classified under either research or education forest as defined in the NFA, 1984. Even though the forest is categorised under one of these functions, many of the uses are used simultaneously in the same forest reserve. Thus, it can be said that the AHFR is a kind of multiple-use forest, whereby many outputs from the forest are used from each forest over time. In this context, the AHFR is either used directly (e.g. forest goods and services derived from the forest by people), or indirectly (e.g. for indirect support and protection provided by the forest's natural functions and regulatory environmental services).

The nature of direct uses of AHFR was examined through the collection of primary and secondary data. Primary data were obtained through surveys conducted on the direct users of AHFR. These include the indigenous people residing the forest, recreation users, and staff of Faculty of Forestry, UPM. The secondary data collection was gathered through examining records of direct users of AHFR available from the Faculty of Forestry, UPM. These data were then summarised to obtain qualitative indicators on the direct users of AHFR. In some cases, the quantitative estimates of direct users were tabulated to calculate percentages.

The current direct uses of AHFR can be broadly divided into three categories: research, education, and other uses.

Research

The AHFR is used directly by staff and students of UPM for scientific research. The majority of research conducted at AHFR is carried out primarily by final year degree students for their

theses. The research projects are not confined to forestry students only, but from other disciplines as well. The focus of the research is mainly on biology, ecology, environment, and wildlife. Research projects are also conducted by academic staff, mainly from the Faculty of Forestry, UPM. Other research projects are also conducted by staff from the Faculty of Science and Environmental Studies. The main outputs of the research projects are B.Sc. theses, research reports, and papers in journals and seminars. Among the research projects conducted at AHFR include the following:

- Distribution of small mammals
- Studies on the root biomass and root growth
- Tree species diversity and composition
- Inventory of medicinal plants
- Biomass studies of forest trees
- Valuation of stumpage
- Valuation of recreation benefits
- Pattern of insect herbivory
- Ethnobotanical survey
- Valuation on the use of AHFR by local indigenous community
- Small mammal species composition
- Bird species composition in intermediate and high land areas
- Genetic diversity of selected tree species
- Characterisation of soil temperature in forest gaps
- Bat species composition
- Remotely sensed indicator of bird habitat heterogeneity
- Microclimatic conditions
- Environmental aspects

Education

The AHFR also plays a very important role in education. The direct use of AHFR for education include forestry camp by forestry students of the Faculty of Forestry (diploma and degree), field laboratories, students' practical training, environmental education programmes (essay and national science camp), other nature-based activities such as team building, nature camping, and organised visits.

In the diploma and degree forestry curricula, the students are required to attend a forestry camp during the first-year semester break for two weeks. At present, the most important contribution of AHFR is that it provides a suitable place for students to carry out their forestry camp because of its close proximity to UPM campus. The students have to stay in the forest and conduct daily activities with the supervision from faculty members. The forest is also used for field laboratory in related courses such as dendrology, ecology, mensuration, silviculture, botany, environmental science and biology.

The direct uses of AHFR for environmental education programme include essaython and national science camp. The essaython programme was introduced in 1994, and it is based on writing with activity concept. The target group of this programme is secondary school children in Malaysia. The participants are selected by the State Education Department to represent each state. The total number of participants is 56, comprising students from different schools. The programme is jointly sponsored by the Ministry of Education and ESSO Productions. It is normally held in November during school holidays. The conduct of essay writing competition is to provide students with 'real situation' by participating in activities designed during the 10-day programme. The participants are required to stay in the forest for the whole duration of the programme. The general objective of essaython programme is to inculcate awareness and appreciation on the importance of environmental conservation. Specifically, the essayton programme aims to:

- Provide a greater sense of love and care for the environment
- Increase the ability of observation and writing skills
- Increase interest in science and technology

Another environmental education programme conducted by the Faculty of Forestry is the National Science Camp introduced in 1994. The aim of the programme is in-line with the Science Encouragement Programmes implemented by the Ministry of Education. Its ultimate aim is to instill enthusiasm among students in science subjects and encourage students to take-up science related disciplines when they pursue higher degrees. The programme is conducted with the cooperation from the Ministry of Education. The specific objectives of the programme are to show the students:

- that science is not a difficult subject if the learning of it is done the right way,
- that science is not a dull but an interesting subject,

- that it is crucial to learn and understand science since our daily activities involve science, and therefore, it contributes towards the quality of life to humankind.

The National Science Camp is usually held twice a year during the school holidays. Each camp lasted for about one week. There are two target groups: students from primary and secondary schools, and teachers from primary schools. The participants (students and teachers) represented all states in Malaysia. Each state is required to send five students including a teacher.

Another important direct use of AHFR is unstructured nature-based activities which include visits, camping activities, and gatherings. There have been 77 reported activities of this nature, which last between one and four days. The number of participants also varies, ranging from 4 to 150 participants. The participants are mostly UPM students. Other participants include UPM staff, school children, members from NGO and youth associations.

Other Uses

Among other direct uses of AHFR include recreation and use by indigenous people. The AHFR is also used by the local population for recreational activities. Mohd. Shahwahid *et al.* (1998) conducted a study to determine the economic value of recreation benefits of AHFR. Based on interviews of 80 respondents, they found that the majority of the recreation users were mainly from the District of Petaling (46.3%), followed by the District of Gombak (20%), District of Hulu Langat and Kuala Langat (11.2%), District of Sepang (7.5%), and the remainder 3.8% were from the District of Klang. They also found that the average expenditures of RM12.36 per visitor made by the respondents in making the trip to experience the recreational services are for transportation, expenditure for foods and recreational services/materials.

The use of AHFR by the indigenous people or Orang Asli was reported by Rusli *et al.* (1997). There are two indigenous villages located within and adjacent to the AHFR: Sungai Rasau Luar and Sungai Rasau Dalam, Puchong, Selangor. The quantity of timber and non-timber forest products collected by the indigenous people as well as the revenue that could have been generated by collecting these products were gathered through personal interviews with heads of household. The results showed that the indigenous people are more dependent on the forest reserve for food and fruits than for other purposes like housing construction, handicraft-making and medicine. The results also indicated that 24 animal species were hunted for their meat and 48% (10 species) of the plant species are for fruits. Birds and small mammals comprise 75% of the animal species collected. In terms of revenue, the results showed that the indigenous people collected about RM110,000.00 for the year 1996. The revenue generated by plant species was about seven times more than that of animal species. The greatest source of revenue came from housing construction followed by handicraft-making and fruits. Table 1 shows some of the forest products collected by the indigenous people.

In conclusion, the direct uses of AHFR are numerous, where the main uses are for research and education. While other uses such as environmental protection are not directly used by local people, it plays a significant role in maintaining the green lung for the urban environment in the Klang Valley. The potential role of AHFR for eco-tourism and other nature-based activities in the future is very great. The AHFR should be conserved not only for research and education but also for long term benefits to the community at large.

TABLE 1
Forest products collected by indigenous people

Product category	Products
Handicraft materials	Bamboo, mengkuang, bertam, rattan, bertam leaves
Medicinal plants	Akar bertam, Tengkuk biawak, Kacip fatimah, Serapat, Tongkat ali, Ubi jaga
Food	Jering, kerdas, petai, bamboo shoot, bayas shoot, bertam shoot, nibung shoot, rattan shoot

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Diversity of Ground-Dwelling Insects in Ayer Hitam Forest Reserve

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INTRODUCTION

Insects are the most abundant animals on earth and two-thirds of these insects inhabit the tropical rain forests. In Peninsular Malaysia, majority of these insects occupy the lowland forests. These forests provide habitats for thousands insect species that are functionally important to the forest ecosystems. In recent years, however, the rates of deforestation in the lowland forests are rather alarming. The destruction of natural habitats and their conversion to other uses pose the single greatest threat to insect communities in the forests. In view of the changing ecosystem of Ayer Hitam Forest Reserve and its surrounding, a study on the diversity of ground-dwelling selected insect communities in the forest was conducted. Heretofore, very few information was available on insects of the forest except those of Maeto *et al.* 1995 and Sajap *et al.* 1997.

MATERIALS AND METHODS

The study was conducted at Ayer Hitam Forest Reserve, Puchong, Selangor, about 20 km south-east of Universiti Putra Malaysia, Serdang campus. Ground-dwelling insects were collected using pitfall traps. Each trap consisted of a plastic cup, 11.5 cm deep and 9.5 cm wide, containing water, few drops of detergent and a small amount of sorbic acid. Three plots, about 500 m apart from each plot, were established along a transect line into the forest. Within each plot, 24 pitfall traps were placed in a group of six within a subplot. The traps were installed twice a month for a period of three months and each trapping period lasted for one week. Samples collected from each pitfall trap were sorted into orders.

RESULTS AND DISCUSSION

The ground-dwelling insects that were collected using pit fall traps are shown in Table 1. The total number of individuals were different between each plot with the middle plot had the highest number of individuals. As expected Hymenoptera dominated all other orders in all the plots. The diversity of the ground-dwelling insects apparently increased from the fringes towards the centre of the forest. This was indicated by the Shanon indices of 2.08, 2.14 and 2.40 at the fringe, middle and centre of the forest, respectively. This trend could be possibly due to the higher plant diversity in the centre than that of the forest fringes. In addition to the differences between plots, the community of ground-dwelling insects varied with the time of sampling (Table 2). The total number of individuals increased by three times, from 406 in August to 1472 in October. The diversity of the insects also increased correspondingly from 2.08 in August to 2.43 in October. The increase in abundance and diversity of insects in the month of October could be attributed to the onset of rainy seasons in the west-central part of Peninsular Malaysia.

In conclusion, Air Hitam Forest Reserve must be conserved. The forest currently acts as a refuge for many animals including insects that are adversely affected by losses of habitat area due to forest destruction and fragmentation.

TABLE 1
Insects collected in pitfall traps placed at three plots

Order	Plot 1	Plot 2	Plot 3	Total
Hymenoptera	404	627	335	1366
Isoptera	36	113	121	207
Collembola	34	103	84	221
Coleoptera	62	64	52	178
Diptera	27	48	47	122
Orthoptera	25	23	36	4
Thysanura	4	9	11	24
Homoptera	5	5	5	15
Hemiptera	4	2	5	11
Lepidoptera	1	0	1	2
Neuroptera	1	0	0	1
Total	603	994	697	2294
Shannon Index	2.08	2.14	2.39	

TABLE 2
Insects collected in pitfall traps in three months

Order	Aug	Sep	Oct	Total
Hymenoptera	236	314	816	1366
Isoptera	74	40	156	270
Collembola	11	5	205	221
Coleoptera	67	22	89	178
Diptera	4	14	104	122
Orthoptera	6	12	66	84
Thysanura	3	4	17	24
Homoptera	3	2	10	15
Hemiptera	2	2	7	11
Lepidoptera	0	1	1	2
Neuroptera	0	0	1	1
Total	406	416	1472	2294
Shannon Index	2.08	2.11	2.42	

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Managing Research Forests - a Preliminary Proposal

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EXTENDED ABSTRACT

According to the National Forestry Act, 1984, the state government can dedicate some parts of the permanent reserved forest as "research forest." For the time being, no definition of research forests is provided in the Act. As such, it is up to the state authority to decide which portion of the reserved forest can be set aside for research purposes and for whatever length of time. It is always the case that it is the researcher who helps to identify the forest areas that are suitable for his/her research project. As research activities intensify while the size of permanent reserved forest area keeps on decreasing, there is a need to carefully plan the establishment of research forests and proper systems of management be applied to manage such forests. This paper attempts to offer some suggestions for the establishment and management of research forests.

What are Research Forests?

An easy definition of a research forest is "a part of the permanent reserved forest set aside for the purpose of forestry research as provided by section 10 (1) of the National Forestry Act, 1984." This definition can be a legal definition but it does not help the forest manager in trying to establish and maintain a research forest. Therefore, there is need for an operational definition of a research forest, one that can reflect the basic attributes or characteristics of such a forest. After listening to the deliberation of the first day of the seminar, an operational definition of a research forest is suggested as:

> "forest areas of appropriate sizes in the permanent reserved forest that are set aside, either permanently or for some specific time period, for the conduct of research activities in forestry and related field of studies."

Two aspects of the definition that deserve some discussion are the size and permanency of research forests. Do these aspects matter in the establishment of research forests?

The size of a research forest is more critical for some types of research than the others. For example, the size of forest area that needs to be reserved to study the ecology of some wildlife species in their natural habitat can be very large. On the other hand, a sample plot to study the floristic composition of hill forests may not be that large. State governments may not be willing to reserve permanently or even for some long period of time large tracts of virgin forest for the purpose of research because this means revenue forgone. The size of a research forest is critical to a researcher as much as to the state government.

The security (or permanency) of a research forest is a more critical issue. Researchers will not want to invest time and money into a research project if there is no guarantee that the project will complete its full cycle. Again, the state government will not agree to the proposal to freeze permanently some pristine forest areas for research purposes particularly when they badly need the revenue that can be obtained from such forests. A balance has to be agreed between the two opposing interests and many factors can enter into the process of striking that balance.

Types of Forestry Research

A very basic factor that influences the establishment of a research forest is the nature of the research project itself. A research project can be classified in many ways using various criteria. Using time as a criterion, for example, some projects can be classified as long-term while the others as short-term. Based on impacts to the

forest ecosystem, some projects can be classified as destructive while the others are non-destructive. In terms of coverage, as mentioned earlier, some projects require large forest area while the others may not require such large areas.

According to Dato' Zulmukshar's keynote speech yesterday, it is not likely that the state governments will entertain many requests from researchers to set aside forest areas permanently for research. Therefore, the number of permanent research forests is likely to be kept at a minimal and should be reserved for the purpose of conducting long-term non-destructive research projects. Other research projects can be carried out in the parts of the permanent reserved forests.

Management of Long-term Research Forests

If forest areas are to be set aside for long-term research, then a proper management system must be instituted to manage such areas. There are several key components of such a system, the most important one being the research priority policy. This policy together with the other components of the system should be spelled out in the management plan of the research forest. The research priority policy determines what kinds of research that can be carried out in the research forests and where. These projects should contribute to the attainment of the objectives for which the research forests are established. Implicit in the research priority policy is the formation of research screening committee who is responsible for ensuring that only appropriate research projects are allowed in the research forests. Also, proper research application procedures must be in place and monitored by the committee.

A suggested framework for the research forest management plan is as follows:

Mission statement
Goals and objectives
Research policy and priority
Descriptions of the forest
The plan (sub-objectives, zones)
Organizational structure/staffing
Record-keeping and communication
Protection
Interaction with other uses
Implementation and control

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Eco-Design Concepts: Application in Ayer Hitam Forest Reserve

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EXTENDED ABSTRACT

In the interest of development, human has interfered with the natural environment within nature. As a result of the interference, two environments have evolved which are the human-made environment, and nature environment. In the Ayer Hitam Forest Reserve for example, human activities have resulted in the evolvement of secondary forest that consists of these two environments. The flora that have naturally regenerated and fauna that have naturally survived constitute today's definition of nature environment, whereas the infrastructure that have been setup within nature and the importation of foreign flora and fauna species are human-made environment. Ayer Hitam Forest has long experienced the impact of development activities. It is inevitable that development will continue to occur as human have equate prosperity with development which in a one way or another will encroached on nature's privacy. The task for the conservationists is to exhibit the importance of nature and its contributions to human environment. When the importance and the contributions of nature are enjoyed and appreciated by human, then will only the conservation of nature be protected or prolonged. In development activities, the environmentally responsible human has to balance the development and conservation of the nature. In other words, if development is to coexist with nature, human has to implement the concepts of Eco-design.

Eco-design is a way of designing within nature in an environmentally responsible way. In general, Eco-design is made up of two different categories of design. These are the passive and active designs. In passive design, the aim is to utilise nature to the designer's advantage. This design concept includes maximisation of daylighting, natural ventilation, solar generated energy source, recycling, and natural methods of bio-waste management. In an active design, the use of nature is reduced; however, it can be considered in an Eco-design development by reducing its impact on nature environment. In the development plan of a nature site, three considerations have to be given prior thought. These are either to leave nature alone, or develop with minimal impact within nature, or sacrifice selective area within nature. The choices have to relate well to the sensitivity and functions of the resources.

As for Ayer Hitam Forest Reserve, considerations will be heavily based upon its importance as the only lowland dipterocarp forest in the state of Selangor. As with many other forest reserves, this forest functions as a reserve, research and development forest, recreation forest, and undeniably a source of food and income to the Temuan community.

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Environmental Education in Ayer Hitam Forest

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EXTENDED ABSTRACT

Introduction

Public have been informed on the importance of forests. Protected forests are usually rich in their diversity of flora and fauna, serve as a source of fresh water, contain valuable products such as timber or wood, wildlife, nature and medicinal product as well as having cultural values. They are also natural laboratories for education purposes, climate and ecological balance, etc. The public's understanding about the forest is still inadequate. A lot of things can be learned from the forests besides their services to human life. A lot of people appreciate the importance of forests but they do not fully understand the forests thus they always forget or are not confident to advise the appropriate authorities when forest disturbances take place. They accept them as part of the development that they need to undergo without considering the long term impact on their local environment or surrounding areas.

Enhancement of public knowledge on forests can be done through many activities namely environmental education. Environmental education is not a new discipline but a new dimension in the education system (Palmer and Neal 1994). All levels of society should be involved in environmental education programmes.

Ayer Hitam Forest is one of the places that can be a venue for environmental education for Klang Valley and nearby areas. This forest reserve can be used by school children, youth, teachers or senior citizen to have greater understanding of the forest and its function to human life beside recreation activities. This paper is to describe briefly the activities on environmental education in Ayer Hitam Forest.

What is Environmental Education?

UNESCO-UNEP (1994) has identified the following definitions for environmental education:

According to Nevada Conference of the International Union for the Conservation of Nature and National Resources in 1970, environmental education is the process of recognising values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness among man, his culture and his biophysical surroundings. Environmental education also entails practice in decision-making and self-formulating of code of behaviour about issues concerning environmental quality.

Organisation of American States Conference on Education and Environment in the Americas, 1971, defined environmental education as the activity that involves teaching about values judgement and the ability to think clearly about complex problems – about the environment – which are as political, economical, and philosophical as they are technical.

In the United States Public Law 91-516, the Environmental Education Act states environmental education as the educational process dealing with man's relationship with his natural and man-made surroundings, and including the relation of population, pollution, resources allocation and depletion, conservation, transportation, technology and urban and rural planning to the total human environment.

From the above definitions, it is clear that people have different opinions on the environmental education leading to conservation and protection of the forests. In the Malaysian context environmental education should be more

organised in order to develop uniformity in the understanding of the environmental education, appreciation, attitudes and responsibilities of the public on the conservation and protection of the forest.

Why do We Need Environmental Education?

Environmental education is to develop a clear awareness of social, political and ecological interdependence in urban and rural areas and economic concern on the environment, to make every person acquire the knowledge, values, attitudes, commitments and skills needed to protect and improve the environment and to create new patterns of behaviour of individuals, groups, and society as a whole towards the environment.

Public need knowledge on the environment to understand about the environment and try to develop the understanding of incidences such as flash floods, land slides, water shortage, climate changes, changes of water quality, increase of temperature, new diseases, imbalance in the ecosystem, biodiversity loss and pollution.

Through environmental education, the public will be more knowledgeable and confident to give views before they are faced with an environmental crisis, or motivated towards finding the solutions to the environmental problems.

Example of Environmental Education Activities in Ayer Hitam Forest

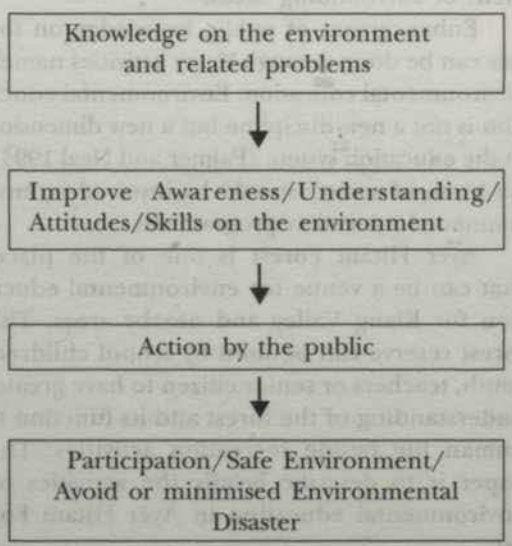
Environmental Awareness Programme is very important to develop public awareness and understanding of the processes and functions of the ecosystem. By using special modules, participants are taught to understand the role of forests and the importance of conservation or protection. Man-environment interrelationship covering different aspects of natural and socio-cultural environments are important to be introduced to the public. Among the participants involved in the Environmental Awareness Programme in Ayer Hitam Forest are adult public from different backgrounds, teachers (training the trainers) and school children. Examples of Environmental Education Modules for Trainers are ecological foundation, conception of awareness (culture, religion, economic, political, etc.), investigation and evaluation, and environmental action skills.

Ayer Hitam Forest can also be a natural laboratory for a school children. A special module can be designed based on the school curriculum to make teaching of sciences easier and more interesting to the students. This includes physical and life sciences. The module should also consider the teaching methodologies, activities, experiments and evaluation techniques. Teachers/supervisors need to have sufficient grounding in science especially in ecology.

Why Ayer Hitam Forest?

Ayer Hitam Forest is unique because it is the only forest left in the Klang Valley besides the 10.6 ha Bukit Nenas Forest Reserve. Its location is strategic in the Multimedia Super Corridor (MSC) and is surrounded by rapid development areas. Its location in the Klang Valley and MSC can serve many people locally and as well as tourists. Ayer Hitam Forest is surrounded by high density population and heavy anthropogenic activities. Ayer Hitam Forest is reported to accommodate a high diversity of flora and fauna and has important aesthetic, economic, medicinal and other socio-environmental values. Since its location is unique and being the only forest in the area, it deserves to be protected and used not only for biodiversity concerns and research but also for education and tourism. In education, the forest can serve as a natural laboratory. The forest can also be used for extension services such as environmental camp and motivation/ team building programme.

CONCLUSION



Ayer Hitam Forest can be a centre for public environmental education, natural laboratory for school children in the Klang Valley, and tourist attraction place. With these activities, Ayer Hitam Forest can serve the public directly and develop self generating funding besides protecting the forest.

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A short communication, not exceeding two printed pages, is intended for rapid publication.

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Manuscripts should be typewritten on A4 paper, double spaced, and of letter quality with 4cm margins on all sides.

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Up to a maximum of 10 keywords are required and they should be placed directly below the abstract.

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Illustrations including diagrams and graphs will be referred to as 'figures' and photographs as 'plates' in the text and numbered consecutively in Arabic numerals. All photographs (glossy black and white prints) should be supplied with appropriate scales.

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Monographs
Turner, H.N. and S.S.Y. Yong. 1969. Quantitative Genetics in Sheep Breeding. Ithaca: Cornell University Press.

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Ho, Y.W. and A. Nawawi. 1991. Effect of carbon and nitrogen sources on growth of *Ganoderma boninense* from oil palm. *Journal of Plant Protection in the Tropics* **8**: 37-43

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