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Tree Species Diversity and Economic Value of a Watershed Forest in Ulu Muda Forest Reserve, Kedah

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ABSTRAK

Data kepelbagaian tumbuhan adalah asas di dalam pengurusan hutan secara berkekalan bagi satu kawasan hutan. Kajian dijalankan di kawasan hutan tadahan air, Hutan Simpan Ulu Muda, Kedah dengan objektif untuk mengenalpasti kepelbagaian spesies pokok dan nilai ekonominya berdasarkan nilai stumpej. Keputusan menunjukkan terdapat 1072 pokok dengan 92 spesies dalam 72 genera dan 34 famili di dalam 1.2 hektar atau 893 pokok dan 77 spesies per hektar. Spesies yang paling banyak didapati adalah Polyalthia rumphii sementara famili yang paling besar di dalam bilangan tunggul adalah Annonaceae, Euphorbiaceae dan Myrtaceae. Kira-kira 3.25% daripada 2830 species pokok di Semenanjung Malaysia didapati di kawasan ini. Nilai stumpej kepelbagaian pokok di hutan ini adalah RM 41,445.30 per hektar. Nilai stumpej bagi pokok di bawah had tebangan bawah adalah RM 1,863.98 per hektar, sementara di atas had tebangan pula adalah RM 39,581.32 per hektar. Pokok dalam kelas diameter ≥60 cm dbh menyumbang hampir 80% daripada jumlah keseluruhan nilai stumpej.

ABSTRACT

Data on plant diversity are fundamental in the sustainable management of a forest. A study was conducted for a watershed forest, Ulu muda Forest Reserve, Kedah, with the objectives of determining tree species diversity and its economic value based on stumpage value. Results showed that there are 1072 trees with 92 species in 72 genera and 34 families in 1.2 hectare or 893 trees and 77 species per hectare. The most abundant species is Polyalthia rumphii while the largest families in terms of stem number are Annonaceae, Euphorbiaceae and Myrtaceae. About 3.25% of 2830 tree species in Peninsular Malaysia are found in this area. The stumpage value of tree species diversity of this forest is RM 41,445.30 per hectare. The stumpage value of trees below cutting limit is RM 1,863.98 per hectare while that of upper cutting limit is RM 39,581.32 per hectare. Trees of diameter class ≥60cm dbh contributed nearly 80% of the total stumpage value.

INTRODUCTION

More often, the tropical forests have been logged without giving due recognition on the details of the flora and fauna. The potential uses of non-timber species are seldom taken into account in forest management. Studies on the economic value of forests goods and services have also been limited. This is mainly due to two reasons. Firstly, many of the benefits derived from the forests are difficult to value in monetary terms, and secondly, benefits often accrue many years after costs have been incurred (Upton, 1994). As a result of the preceeding problems, much of the decision making process in forest management has ignored the species diversity and its role as well as undervalued its potential benefits. Assessment of the biodiversity and the value of forest resources can be one of the ways to influence government decision and policy makers in the conservation of biological diversity in the country. To achieve this, the diversity of species and its value must be well studied so that

it can be taken into account in managing forest resources sustainably (Miskon, 1997).

This paper presents results from tree diversity studies and the economic value of a watershed forest at Ulu Muda Forest Reserve, Kedah.

MATERIALS AND METHODS

Site description

The study area was located at Compartment 27, Ulu Muda Forest Reserve, Baling, Kedah. With an area of 419 hectares, this watershed forest is due to be logged. It is close to the Thailand border with slopes ranging from 20% - 45% and is fairly accessible by four wheel drive vehicles through Kg. Weng, which is approximately 17 km from the base camp.The soil types of Ulu Muda Forest Reserve, Baling, Kedah is classified as Baling, Tai Tak, Serdang, Bungor and Kuala Brang Series (DOA, 1994). The Baling and Tai Tak series are yellowish brown finely textured, well drained and moderately deep soil. The climate in the area is characterized by high rainfall and temperature. The temperature is uniformly high throughout the year. The rainfall distribution pattern varies with an average annual rainfall of about 2750 mm per year. A bimodal distribution of rainfall occurs with a major peak in October and minor peak in July.

Methodology

Three plots each measuring 100 m x 40m were established at valley-bottom, mid-slope and ridge-top at altitudes 480m, 570m and 680m above sea level, respectively. Each of the plot was further divided into 40 contiguous 10 m x 10 m sub-plots. All trees of 5 cm diameter at breast height (dbh) and above were tagged, measured and identified. Voucher specimens were also made and deposited in the Herbarium, Faculty of Forestry UPM.

The residual value technique was used to calculate stumpage value of an individual tree, which is given by the following formula:

$$Sv_{ij} = V_{ij} + (P_{ij} - C - PM_{ij})$$

where :

SV = stumpage value (RM),
V = volume, (m^3),
P = price of log ((RM/m^3),
C = average logging Cost (RM/m^3),
PM = profit margin (RM/m^3), and i is index for species and j is index for diameter class.

The profit margin (PM) is calculated as follows:

$$PM^{ij} = \frac{P_{ij} * PR}{(1 + PR)}$$

where PR is profit ratio .

Timber volume of an individual tree was estimated using the formula presently used by the Forestry Department Peninsular Malaysia:

$$V = \frac{[\ (22/7)\ *DBH2*\ L*f]}{40000}$$

where:

V = timber volume (m^3),
DBH = diameter at breast height (cm),
L = merchantable height (m), and
f = form factor.

The average merchantable height for various dbh classes currently adopted by the Forestry Department Peninsular Malaysia is as follows:

DBH Class (m)	Merchantable height (m)
15-30	5
30-60	10
60-70	15
>75	20

The average log price used is shown in Table 1. Since log price vary by dbh class, price reduction factors were used to adjust log prices by dbh class (Table 2). For instance, a reduction of 0.3 for dbh 30 to 45 cm indicates that price per cubic meter is only 70 percent of the full value.

The logging cost was based on a previous study by Awang Noor and Mohd. Shahwahid (1995), which was taken at RM 74.00 per cubic metre. A 30 percent profit margin was used in the analysis.

RESULTS

Taxonomic Composition

There were 92 species in 72 genera and 34 families for trees ≥ 5 cm dbh on 1.2 ha or on an average 77 species per ha. Table 3 shows the taxonomic composition and abundance of trees ≥ 5 cm dbh. The five largest families in terms of stem number are Annonanceae, followed by Euphorbiaceae, Myrtaceae, Sapindaceae and Polygalaceae. The families Annonaceae and Euphorbiaceae are found to be the most diverse families in terms of taxa both being represented

TABLE 1
Average Log price (RM/m3

Species/Commercial group	DBH class (cm)				
	15-29.9 RM/m^3	30-44.9 RM/m^3	45-49.9 RM/m^3	50-55 RM/m^3	> 55 RM/m^3
Shore curtisii	566.50	721.00	875.50	1004.25	1030.00
Shorea spp. (Balau)	346.50	441.00	535.50	614.25	630.00
Shorea spp. (Red Balau)	330.00	420.00	510.00	585.00	600.00
Instia palembanica	335.50	427.00	518.50	594.75	610.00
Other Hardwood	165.00	210.00	255.00	292.50	300.00
Dipterocarpus (Keruing)	280.50	357.00	433.50	497.25	510.00
Koompassia malaccensis	255.75	325.50	395.25	453.38	465.00
Dryobalanops aromatica	258.50	329.00	399.50	458.25	470.00
Heritiera spp. (Mengkulang)	272.25	346.50	420.75	482.63	495.00
Koompassia excelsa	236.50	301.00	365.50	419.25	430.00
Other Medium Hardwood	162.25	206.50	250.75	287.63	295.00
Dark Red Meranti	354.75	451.50	548.25	628.88	645.00
Light red Meranti	269.50	343.00	416.50	477.75	490.00
Red Meranti	288.75	367.50	446.25	511.88	525.00
Yellow Meranti	209.00	266.00	323.00	370.50	380.00
White meranti	211.75	269.50	327.25	375.38	385.00
Anisoptera spp. (Mersawa)	324.50	413.00	501.50	575.25	590.00
Sindora spp. (Sepetir)	214.50	273.00	331.50	380.25	390.00
Dyera costulata	239.25	304.50	369.75	424.13	435.00
Shorea pauciflora	354.75	451.50	548.25	628.88	645.00
Shorea assamica	211.75	269.50	327.25	375.38	385.00
Palaqium spp. (Nyatoh)	368.50	469.00	569.50	477.75	490.00
Other Light Hardwood	162.25	206.50	250.75	287.63	295.00

Source : MASKAYU (1996)

TABLE 2
Price reduction factor

DBH Class (cm)	Reduction Factor
15-30	0.45
30-45	0.30
45-50	0.15
50-55	0.025
55 and above	0.00

Source : Awang Noor (pers. comm.)

by 7 genera and 9 species each (Table 3). 13 families or nearly 50 percent of the total number of families are represented by only a single species each. The most abundant species across all dbh classes are *Polyalthia rumphii, Pometia pinnata, Monocarpia marginali* and *Xanthophyllum* obscurum (Table 4). Only five dipterocarp species are found, viz. *Shorea curtisii, S. parvifolia, S. pauciflora, S. assamica* and *Vatica maingayi* are found in this forest.

Stand Density and Distribution by Diameter Classes

A total of 1072 trees > 5 cm dbh were enumerated from 1.2 ha or 893 trees per hectare (Table 3). Trees > 30 cm dbh constituted only 10.5% of the total number of trees. Based on the species composition across all dbh classes, it was found that the number of dipterocarp species is low comprising 0.7 % of the total number of trees > 30 cm dbh. Only 14 stems of dipterocarp were found on the ridge-top where six trees fall within the dbh class (> 75 cm and above), two trees within dbh class (60-74.9 cm), one tree within dbh class (30 - 44.9 cm) and five trees within dbh (15-29.9 cm). The estimated basal area of this forest was 31.74 m^3 per ha for trees > 5 cm dbh. 68.8% of this basal area was contributed by

TABLE 3
Taxonomic composition and abundance of trees 5 cm dbh and above in 1.2 ha plot at Ulu Muda Forest Reserve, Kedah.

Family	No. Genus	No. Species	No. of Stem
Annonaceae	7	9	218
Euphorbiaceae	7	9	146
Myrtaceae	1	3	116
Sapindaceae	4	5	100
Polygalaceae	1	3	56
Lauraceae	3	3	46
Meliaceae	1	6	44
Myristicaceae	1	2	40
Leguminosae	7	7	39
Olacaceae	3	3	37
Myrsinaceae	1	1	33
Dipterocarpaceae	2	5	25
Tiliaceae	2	2	22
Burseraceae	3	3	19
Melastomataceae	1	2	17
Sapotaceae	4	4	16
Ebenaceae	1	2	16
Anacardiaceae	4	3	14
Guttiferae	1	2	13
Moraceae	3	2	11
Simaroubaceae	2	1	9
Fagaceae	2	1	8
Lecythidaceae	1	1	8
Flacourtiaceae	1	2	4
Thymelaeaceae	1	2	3
Sterculiaceae	2	1	3
Ulmaceae	2	1	2
Apocynaceae	1	1	
Bombacaceae	1	1	
Combretaceae	1	1	
Elaeocarpaceae	1	1	
Hypericaceae	1	1	
Rhizophoraceae	1	1	
Rubiaceae	1	1	
Total	72	92	107

trees in diameter class (5.0 - 14.9cm) indicating this forest consists of many smaller diameter trees (Table 5).

Stumpage Value

The total stumpage value for all trees > 15 cm dbh was RM 41,445.30 per ha. The stumpage values for above cutting limit RM 1,863.98 per ha. Details on the stumpage values are shown in Table 6. The total stumpage value obtained from this study is higher when compared to a similar study under the Selective Management System (SMS) in the same compartment (RM 24,981.00 per ha), where trees to be harvested are based on minimum diameter cutting limits (50 cm for dipterocarps and 45 cm for non-dipterocarp group) (Awang Noor & Mohd. Shahwahid 1995).

DISCUSSION

The species composition at Ulu Muda Forest Reserve is lower when compared to that of Ayer Hitam Forest Reserve with 177 species per ha (Faridah Hanum et al. 1997) and Bangi Forest Reserve with 167 species (Latiff 1997) for trees > 5 cm dbh. This forest is dominant in Non-Dipterocarp species which is mainly contributed by trees in the (5-14.9) cm diameter class. However, most of the stumpage value obtained from this study was contributed by only 4.3% of the total number of trees present per ha which fall into diameter classes > 45 cm dbh. Although this forest is poorer in terms of species composition and dominant with smaller diameter trees, the economic value of the diversity of tree species it houses is higher when compared to that of Ayer Hitam Forest which was richer in tree species. The total stumpage value obtained is almost double the value obtained by the conventional pre-felling inventories in the same study area (Awang Noor and Mohd. Shahwahid 1995). This difference in stumpage can only be explained in the different inventory method where in the latter case, a 10 % pre-felling inventory sampling was employed. The present stumpage analysis value analysis however sampled all trees > 15 cm dbh. The loss of revenue to the State government usually caused by the undervaluation of forest resources in forest concessions can actually be overcome if Forestry Department insists on a 100% pre-felling inventory for all trees >15 cm dbh.

CONCLUSIONS

Most valuation carried out in our forests tend to focus exclusively on timber resources and have largely ignored the market benefits of others resulting in smaller net revenue. The valuation of forest mainly for its contribution to timber revenue very often underestimates the non-timber forest revenue. We believe that before any forest can be put in monetary term, a detail study on the plant diversity of any 1 ha of the forest must be carried out. This way, it is hoped that optimum benefits from our forests can be obtained.

TABLE 4
Percentage of trees 5cm dbh and above (Species are arranged in order of abundance, only 25 most frequent species are shown)

Species	Family	No. Stem	Percentage
Polyalthia rumphii (Bl.) Merr	Annonaceae	11	1.0
Pometia pinnata Forst.	Sapindaceae	9	0.8
Monocarpia marginalis (Scheff.) J. Sinclair	Annonaceae	8	0.7
Xanthophylum obscurum Benn.	Polygalaceae	8	0.7
Shorea curtisii Dyer ex King	Dipterocarpaceae	7	0.7
Syzygium attenuata (Miq) Koord. & Val	Myrtaceae	6	0.6
Litsea grandis Hook.f.	Lauraceae	6	0.6
Guioa squamosa Radlk.	Sapindaceae	5	0.5
Irvingia malayana Oliv.	Simaroubaceae	4	0.4
Mangifera foetida Lour.	Anacardiaceae	4	0.4
Strombosia maingayi (Mast) Whitmore	Olacaceae	4	0.4
Ardisia vaughanii Ridley	Myrsinaceae	3	0.3
Paranephelium xestophyllum Miq.	Sapindaceae	3	0.3
Canarium denticulatum Blume	Burseraceae	2	0.2
Cynometra malaccensis Meeuwen	Leguminosae	2	0.2
Ficus laevis Blume	Moraceae	2	0.2
Koompassia excelsa (Becc.) Taubert	Leguminosae	2	0.2
Lithocarpus rassa (Miq.) Rehd.	Fagaceae	2	0.2
Santiria oblongifolia Blume	Burseraceae	2	0.2
Xerospermum noronhianum Blume	Sapindaceae	2	0.2
Aglaia exima Miq.	Meliaceae		0.1
Aglaia hiernii King	Meliaceae		0.1
Aporusa confusa Gage	Euphorbiaceae		0.1
Aquilaria malaccensis Lamk.	Thymelaeaceae		0.1
Baccaurea maingayi Hk.f.	Euphorbiaceae		0.1

TABLE 5
Distribution of trees by diameter class (cm) at breast height.

Dbh class (cm)	No. of Stem	Percentage
5.0-14.9	738	68.8
15.0-29.0	222	20.7
30.0-44.9	65	6.1
45.0-59.9	27	2.5
60.0-74.9	9	0.8
>75	11	1.0

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TABLE 6
Stumpage value by diameter class.

Dbh class (cm)	Stumpage value (RM)		Total stumpage value (RM)
	Below cutting limit	Above cutting limit 1	
15-29.9	336.55	-	366.55
30-44.9	1900.23	-	1900.23
45-59.9	-	3451.84	3451.84
60-74.9	-	4795.74	4795.74
>75	-	39250.00	39250.00
Total (RM)	2236.78	47497.58	49734.36
Average per hectare (RM/ha)	1863.98	39581.32	41445.30

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