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Economic Valuation of Timber Resources in Ayer Hitam Forest Reserve, Puchong, Selangor

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ABSTRACT

Timber value has significant effects on sustainable forest management in developing countries. Empirical evidence has shown that timber value depends on many factors including physical conditions of the forest area, characteristics and composition of species, market condition, logging methods and government policy. This study aimed to estimate the economic value or stumpage value of timber resources at the compartment level in six compartments of Ayer Hitam Forest Reserve (AHFR), Puchong, Selangor. The estimation of stumpage value was done using a residual-value technique based on pre-felling (pre-F) inventory data, log price and assumed logging cost. The results show that stumpage values varied by compartment and diameter class. Most of the compartments had a substantial stumpage value, ranging from RM34,514 to RM66.875 per ha for trees 15 cm and above. The total estimated stumpage value for the whole AHFR was RM64,175,904.00. On average, about 49% of this value was stumpage value for trees 50 cm and above. The estimated values ranged from RM9,775 to RM35,606 per ha. From the results of the study, it can be conlcuded that AHFR is a high-value forest and that the total stumpage value is comparable with those of other dipterocarp forest areas in Malaysia.

INTRODUCTION

Forests are well known for providing timber as stumpage. The value of the timber resource is thus an important element in any forest valuation exercise. Stumpage refers to live timber, "standing on the stump" or standing trees in the forest, whether dead or alive or in unprocessed form (not cut into logs) found in the forest (Klemperer, 1996; Davis and Johnson, 2000). From the economic perspective, stumpage value is often termed as the "economic rent", i.e. the return to the owner from timber harvesting. It indicates the maximum willingness-to-pay by a buyer for the standing timber and hence approximates the price which would prevail in a competitive stumpage market (Gray 1983; Grut *et al.*, 1991). Timber valuation is the procedure for finding an investor's valuation of the timber, while appraisal is the procedure for finding a market value of timber. More specifically, stumpage appraisal is a method of evaluating the residual value of standing timber. Thus, the terms stumpage valuation and stumpage appraisal are interchangeable.

The purpose of stumpage appraisal is to estimate the value of the standing timber available for cutting at a particular time and on a particular area (Leushner, 1984; Davis and Johnson, 2000). It preceeds the seller and the buyer negotiations to arrive at an agreed price. Appraisal or valuation is important in the establishment of a market price estimate which may serve as a reservation or floor price. In most cases, the offered price by the buyer would be rejected if it is below the reservation or floor price. In practice, the value of stumpage is not easy to estimate as it depends on log prices and logging costs that vary considerably with species,

grade and locations. The stumpage value of higher-priced species or grades can be several times that of lower-priced species or grades and in some cases stumpage value can be even zero or negative (Grut *et al.*, 1991).

The objective of the paper is to present an estimate of stumpage values of timber resources at the compartment level in Ayer Hitam Forest Reserve (AHFR), Puchong, Selangor. The results of the analysis using the residual-value technique suggests that AHFR is a high-value forest and that the total stumpage value is comparable with those of other dipterocarp forest areas in Malaysia.

METHODS

Study Area

The case study area is Air Hitam Forest Reserve (AHFR), Puchong, Selangor, which is located in a strategic place as it neighbours a rapidly developing urban community. Some of the development projects that have been completed in the vicinity include an agriculture project, a world-class sports complex, a multi-million dollar housing project, an incineration plant and waste disposal area, and an equine park. The forest reserve has also been converted for the highway linking Seri Serdang and Lebuh Raya Damansara Puchong (LDP). The new administration city, Putra Jaya, is just a few kilometers away and so is the capital city of Kuala Lumpur. The forest area, therefore, could provide excellent recreation and ecotourism opportunities for urban dwellers.

The forest is a production forest belonging to the forest type Lowland Dipterocarp Forest. It is classified as a secondary disturbed forest because it has been logged and treated several times since the 1930s (Paiman and Amat Ramsa, n.d.). Currently, the forest comprises six compartments, namely, compartments 1, 2, 12, 13, 14 and 15. These compartments make up a total area of 1248 ha. According to the Forestry Department record, the area of AHFR has decreased substantially from the original forest area of about 4266.23 ha in 1965. The extents of forest area and the percentages of area loss as compared with the original area are shown in Table 1.

General Approach to Value Timber Resource

The general approach in this study was to select the most recently logged areas that show variations in terms of forest types, accessibility, distance to sawmill, forest productivity and terrain condition. Data on pre-felling were combined with data on log prices and logging costs to calculate stumpage value. The study focused on forest areas allocated with those only under administered fees (i.e. fixed royalty and premium).

Methods of Stumpage Valuation

Various methods can be used to estimate the stumpage value from a logging compartment. There are generally two methods of stumpage valuation (Duerr, 1993; Klemperer, 1996; Davis and Jonhson, 2000): (i) market evidence (direct method or transaction evidence method), and

TABLE 1
Extents of Air Hitam Forest Reserve, Puchong, Selangor and area losses (1965-1997)

Year	Forest area (ha)	Percentage of area loss (compared to base year 1965)
1965	4266.23	
1980	4006.00	6.1
1983	4006.00	6.1
1993	2198.00	48.5
1994	1964.00	54.0
1997	1262.33[1]	70.4

[1] The total area reported by the Selangor State Forestry Department is less than the area given to UPM (1248 ha) may due to ground survey error.

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

(ii) analytical method. The market evidence method is done by setting the stumpage value of subject stand through comparison with the prices of stumpage received for stumpage recently sold from stands with similar characteristics as the subject stand. There are two problems related to this method: (a) location, and (b) species composition. An adjustment is needed if the valuer wants a reliable estimate. This can be done in two ways: (a) regression analysis - to estimate the appraised value by examining hundreds of actual sales and to fit a regression equation to these sales data which relate some factors that cause differences in the sale price, (b) another technique known as regionalized harvest value tables or comparable sales - the state can be divided into several timber value areas and within each area, all timber sales are reported and empirical tabulations of market stumpage prices by forest type and logging cost are made; the transaction data are then smoothed and processed into a standard set of tables showing the average current market price of stumpage for each timber value area.

The widely used technique in determining the stumpage value is the analytical method, which requires detailed analysis of logging and timber harvesting, processing, and marketing of forest products from a particular logging compartment. This method consists of two techniques: (a) investment method — this calculates the capital, logging and processing costs for a given product derived from log (timber intended for sale as sawlog or veneer log). It also requires the calculation of margin for profit and risk. Using this method, the net present value (NPV) of its most likely future cash flow is estimated. However, the method has been largely ignored because of the difficulty in getting accurate information on investment and working capital, changes in technology over time, and variation of timber harvesting operation under different environments.

In this study, the most feasible method that can be applied is the residual value or conversion approach. 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). Parameters required to calculate stumpage include selling price, timber volume, conversion cost, and profit margin. This method starts with estimating the market prices of the end product made from standing timber. The market price is the first point of sale where the product is sold freely in the competitive market. From the market price, the stumpage value is residually determined by subtracting all costs involved in processing and harvesting, including profit margin.

The following formula was used to calculate the stumpage value for each species and diameter class:

$$SV_{i,j} = (P_{i,j} - C - PM_{i,j}) * V_{i,j}$$

where:

SV = stumpage value, (RM/ha or RM)
P = log price (RM/m^3)
C = logging cost (RM/m^3)
PM = profit margin (RM/m^3 or RM/ha)
V = volume (m^3/ha or m^3)
i is index of the species, j is the index of the diameter class

According to Davis and Johnson (2000), the difference between the product selling price and the sum of the total logging costs is known as conversion return (CR). This value is allocated between the owner of the resource (i.e. government) and concessionaire. In other words, the government's share is the stumpage payment and the determination of percentage share of stumpage payment depends on the bargaining power in the market place. Based on the above formula, the conversion return (CR) can be determined as follows:

$$CR_{i,j} = (P_{i,j} - C) * V_{i,j}.$$

The margin for profit and risk (PM) can be calculated using four ratios: the overturn ratio, the profit ratio, the selling value ratio, and the operating ratio (Leushner, 1984). Profit ratio is frequently used in the calculation because it permits direct calculation of the margin for profit and risk from an assumed profit ratio and a given log price without first defining stumpage. Thus, the profit margin can be written as:

$PM_{ij} = [(P_{i,j} * PR) / (1+PR)] * V_{i,j}$, where PR is the profit ratio.

Total conversion return (CR) in a given compartment:

Total CR

$$= \sum_{i=1}^{n}\sum_{j=1}^{k} CR_{i,j} = \sum_{i=1}^{n}\sum_{j=1}^{k}\left[\left(P_{i,j} - C\right) * V_{i,j}\right.$$

The total stumpage value in a given compartment is calculated as:

Total SV

$$= \sum_{i=1}^{n}\sum_{j=1}^{k} SV_{i,j} = \sum_{i=1}^{n}\sum_{j=1}^{k}\left[\left(P_{i,j} - C - PM_{i,j}\right) * V_{i,j}\right.$$

Data on timber volume were computed based on a post-felling inventory conducted by the Faculty of Forestry, UPM. The compartments involved in the study included compartments 1, 2, 12 13, 14 and 15. The inventory data were used to estimate timber volume for each species in the compartments by using the local volume table developed by Awang Noor and Mohd Radhi (2002). The local volume table was developed for the lowland forest in Bentong, Pahang and it seems that this local volume table is more appropriate and unbiased compared with the volume estimated using the pre-F volume formula. The formula is as follows:

$$Vi = 0.000362954 * DBH_i^{2.2988}$$

Data on log prices were obtained from MASKAYU, the official bulletin of the Malaysian Timber Industry Board. The ex-matau average log prices sold by timber operators (in Malaysian ringgit) per cubic meter were reported for individual species and species groups. These prices are provided in Table 2.

TABLE 2
Log prices by species and diameter class, Peninsular Malaysia (September, 2003)
(Ex matau, RM/m^3)

Group	Spesies	DBH Class (cm)				
		15-30	30-45	45-50	50-60	> 60
Heavy hardwood (HHW)	Chengal	738	861	984	1107	1230
	Balau	468	546	624	702	780
	Red balau	378	441	504	567	630
	Merbau	474	553	632	711	790
	Mixed HHW	252	294	336	378	420
Medium hardwood (MHW)	Keruing	366	427	488	549	610
	Kempas	330	385	440	495	550
	Kapur	354	413	472	531	590
	Mengkulang	330	385	440	495	550
	Tualang	264	308	352	396	440
	Mixed MHW	240	280	320	360	400
Light hardwood (LHW)	Dark red meranti	444	518	592	666	740
	Light red meranti	426	497	568	639	710
	Red meranti	378	441	504	567	630
	Yellow meranti	294	343	392	441	490
	White meranti	282	329	376	423	470
	Mersawa	420	490	560	630	700
	Nyatoh	432	504	576	648	720
	Sepetir	282	329	376	423	470
	Jelutong	360	420	480	540	600
	Ramin	480	560	640	720	800
	Mixed LHW	240	280	320	360	400

Note: Prices were calculated using price factor: 15-20 dbh: 0.6; 30-45 dbh: 0.7; 45-50 dbh: 0.8; 50-60 dbh: 0.9. The base log price was diameter class of 60 dbh.
Source: MASKAYU (September, 2003)

TABLE 3
Average logging costs of sustainable forest management (RM/m³)

Activity	Average cost (RM/m³)	Percentage
Compartment boundary demarcation	1.24	0.65
Proposed road alignment	1.17	0.61
Tree marking and mapping	9.27	4.84
Road construction	33.57	17.54
Felling and bucking	8.28	4.33
Skidding	35.86	18.74
Log loading	3.31	1.73
Short distance haulage	12.69	6.63
Monitoring and control (supervision/inspection)	3.15	1.65
Other expenditures	14.42	7.54
Taxation	67.18	35.10
Closing report	0.94	0.49
Additional training on MC&I compliance	0.29	0.15
Total	191.37	100

Note: For the purpose of calculating timber value, the average logging cost was taken as RM120 per cubic metre. Tax payment was excluded.
Source: Ahmad Fauzi *et al.* (2002)

Data on logging costs were based on a previous ITTO study by Ahmad Fauzi *et al.* (2002). The logging costs included fixed and variable costs. Fixed costs included such items as road construction, machinery, maintenance cost, salary for logging supervisor (monthly salary) and so on. Variable costs included such items as labour and fuel. The average logging costs reported from previous studies are presented in Table 3. In this study, the average logging cost of RM120 per cubic meter was used in the analysis. This logging cost excluded timber fees or tax paid to the government (royalty, premium and cess).

The profit ratio used in this valuation exercise was obtained from previous studies conducted by Awang Noor *et al.* (1992). A 30 percent profit ratio was used in the analysis. This value is reasonable in view of the fact that logging is considered a high risk business.

Data collected were analysed to determine the total stumpage values for compartments 1, 2, 12 13, 14 and 15.

RESULTS AND DISCUSSION

Characteristics of Timber Resources in AHFR

The average numbers of trees by diameter class and species groups for all compartments are presented in Table 4. The numbers of trees per hectare for trees greater than 15 cm dbh ranged from 131 to 236 and the volumes ranged from 157.64 to 254.37 m³ per hectare (Table 5). The number of trees in different dbh classes dropped rapidly with the increase of dbh classes and followed the inverse-J relationship. A similar pattern was also observed for the timber volume. The numbers of trees of 15 cm dbh and above were 236 trees/ha (C1), 131 trees/ha (C2), 199 trees/ha (C12), 140 trees/ha (C13), 151 trees/ha (C14) and 183 trees/ha (C15). In all compartments, the proportion of non-dipterocaps was higher compared with that of the dipterocarps, ranging from 62 to 84 percent or by a factor of 3.8. In compartment 2, the proportion of non-dipterocarps was the highest, accounting for 84 percent of the total number of trees.

The timber volumes of trees of 15 cm dbh and above were 254.37 m³/ha (C1), 157.64 m³/ha (C2), 228.42 m³/ha (C12), 203.68 m³/ha (C13), 194.18 m³/ha (C14) and 171.46 m3/ha (C15) (Table 5). The proportion of timber volume for the non-dipterocarps in all compartments was also higher than that of the dipterocarps, ranging from 57 to 82 percent. The highest timber volume of dipterocarps was recorded in compartment 14 (C14), accounting for 43 percent of the timber volume.

TABLE 4
Numbers of trees by diameter class and species group in each compartment of Ayer Hitam Forest Reserve, Puchong, Selangor

Dbh class (cm)	Compartment																	
	C1			C2			C12			C13			C14			C15		
	D	ND	Total	D	ND	Total	D	ND	Total	D	ND	Total	D	ND	Total	D	ND	Total
15-30	16	102	118	5	65	70	12	85	97	13	51	64	27	51	79	12	95	106
30-45	11	63	74	10	32	42	17	50	67	10	32	43	16	28	44	9	41	50
45-50	5	11	16	2	9	10	4	9	14	4	7	11	5	4	9	2	7	9
50-55	2	3	5	2	3	5	2	6	8	3	5	8	3	4	7	2	4	6
55-60	5	2	7	1	1	2	2	2	4	1	4	5	3	1	4	1	2	4
60-65	3	4	7	0	1	2	2	3	5	1	3	4	2	2	4	1	2	3
65-70	3	0	3	1	0	1	0	1	1	1	1	2	1	1	2	1	0	1
70-75	0	1	1	0	1	1	0	0	0	0	1	1	1	0	1	0	1	1
75-80	1	2	3	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1
80-85	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
85-90	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
90+	0	2	2	0	0	0	0	1	1	0	1	1	0	1	1	0	1	1
Total	46	190	236	21	110	131	40	160	199	35	105	140	58	93	151	30	153	183

Note: D = Dipterocarps ND = Non-dipterocarps

TABLE 5
Volumes of trees by diameter class and species group in each compartment of Ayer Hitam Forest Reserve, Puchong, Selangor (m^3/ha)

Dbh class (cm)	Compartment																	
	C1			C2			C12			C13			C14			C15		
	D	ND	Total	D	ND	Total	D	ND	Total	D	ND	Total	D	ND	Total	D	ND	Total
15-30	6.07	34.31	40.38	1.68	65.10	66.79	5.41	29.94	35.35	6.63	24.00	30.63	13.87	25.39	39.26	4.32	33.12	37.44
30-45	12.16	67.60	79.75	10.45	32.55	43.00	18.02	51.81	69.83	14.60	44.20	58.80	22.00	37.47	59.47	10.65	44.18	54.83
45-50	9.59	20.29	29.88	2.75	15.30	18.05	7.74	17.30	25.04	7.96	16.51	24.48	10.31	9.56	19.87	4.56	12.06	16.61
50-55	4.65	7.35	11.99	5.33	6.09	11.41	4.86	14.13	18.99	8.56	14.41	22.96	8.02	10.40	18.42	4.83	9.85	14.68
55-60	14.00	5.48	19.48	2.97	2.83	5.80	5.09	6.52	11.61	4.16	11.46	15.61	9.21	3.92	13.13	3.91	6.56	10.47
60-65	10.43	13.24	23.67	0.85	4.29	5.14	6.82	9.51	16.34	5.68	10.17	15.85	8.32	6.12	14.43	3.08	5.79	8.87
65-70	11.56	0.00	11.56	2.04	0.00	2.04	0.69	3.80	4.49	5.71	4.29	10.00	4.13	5.04	9.17	3.37	1.89	5.26
70-75	0.00	4.49	4.49	0.00	2.32	2.32	0.80	1.54	2.35	1.73	4.14	5.87	3.31	1.39	4.70	2.31	3.23	5.55
75-80	5.27	10.89	16.16	0.00	0.00	0.00	0.87	6.01	6.88	0.92	0.00	0.92	0.57	1.67	2.24	0.75	2.27	3.01
80-85	0.00	0.00	0.00	1.58	1.50	3.09	0.00	0.97	0.97	1.09	2.25	3.34	1.90	1.93	3.83	0.42	2.10	2.52
85-90	0.00	0.00	0.00	0.00	0.00	0.00	3.36	3.31	6.66	2.36	2.50	4.86	0.71	0.00	0.71	0.48	1.52	1.99
90+	0.00	16.99	16.99	0.00	0.00	0.00	18.57	11.35	29.92	3.21	7.16	10.37	1.56	7.39	8.95	3.71	6.51	10.22
Total	73.74	180.63	254.37	27.65	129.99	157.64	72.24	156.19	228.42	62.59	141.09	203.68	83.90	110.28	194.18	42.38	129.08	171.46

Note: D = Dipterocarps ND = Non-dipterocarps

Results of Stumpage Value

The distributions of stumpage values for trees 15 cm and above by diameter class for each compartment are presented in Table 6. As can be seen from the table, the estimated stumpage values with regard to the diameter class varied considerably in each compartment. The estimates of stumpage values for compartments 1, 2, 12 13, 14 and 15 were RM66,875 per ha, RM34,514 per ha, RM60,554 per ha, RM53,918 per ha, RM49,562 per ha and RM43,113 per ha respectively. The average estimated stumpage value per ha for trees 15 cm and above in all compartments was RM51,423. Based on trees 50 cm and above, the estimated stumpage values for compartments 1, 2, 12 13, 14 and 15 were RM35,606 per ha, RM9,775 per ha, RM33,467 per ha, RM30,086 per ha, RM25,372 per ha and RM21,051 per ha respectively (Table 7). The average estimated stumpage value for all compartments was RM25,893 per ha. Based on trees 15 cm dbh and above, the total stumpage (stock) value of timber resources in the whole AHFR (1248 ha) was estimated at RM64,175,904.00.

Table 6 also presents our estimates of the components, conversion return, harvesting cost, profit margin and stumpage value on a per hectare basis, for all trees 15 cm dbh and above by diameter class. This table shows the allocations between the government and the concessionaire if AHFR is to be harvested through clear felling at the assumed parameters. As explained before, the conversion return (CR) indicates the allocations between the owner of resource (i.e. government) and concessionaire. In this case, the return to the government, is all revenue minus all harvesting costs. The estimated conversion returns ranged from RM70,278 to RM127,939 per ha. The concessionaire needs also to receive some return for their time and effort, reward for enterpreneurship and other risks and uncertainties. This is the profit margin, and the amounts varied considerably in each compartment ranging from RM16,219 to RM29,524 per ha. This was based on 30% profit ratio. If the profit ratio is reduced, then the amount of profit margin would be reduced and consequently, the stumpage value would be increased. The stumpage values as indicated in Table 6 are in fact the residuals after the profit margins have been substracted from the conversion return. It should be pointed out that the estimates of conversion return, harvesting cost, profit margin and stumpage value depended on the assumptions used in the analysis. Had we used different logging costs, log prices and profit ratios, the variations in stumpage value between sites would have differed greatly.

The distributions of stumpage values by diameter class also varied considerably in each compartment. It can be observed that the estimated stumpage values were concentrated in the 30 to 75 cm dbh class. The proportion of stumpage values within these diameter classes ranged from 64 to 78%. This is because a major proportion of timber volume is within this diameter class and this phenomenon is quite obvious for the dipterocarp forest.

When compared with the stumpage values estimated from previous studies, the stumpage values estimated in this study site are relatively high and in most cases greater than those for the other forest areas (Table 8).

It is also possible to calculate the stumpage value of timber if the forest is managed based on a sustained yield basis at 30-year cutting cycle. This is done by calculating the current stumpage value plus the perpetual regular stumpage value at the end of every 30-year cutting cycle. This is known as land expectation value (LEV) and the formula is as follows:

$$LEV = SV+SV*\left[\frac{1}{(1+r)^{30}-1}\right],$$ where SV is the stumpage value and r is discount factor. The second term is known as present value of a perpetual periodic series (Klemperer, 1996). This equation gives the present value of timber from the first harvest, and those in 30 years and every 30 years thereafter in perpetuity. This is an important concept in forestry, since in the context of sustainable forest management (SFM), timber harvest and other associated costs occur at a fixed cutting cycle. Using a range of 5 to 15% discount rate, the results of LEV for trees above the cutting limit (i.e. trees > 50 cm dbh) are presented in Table 9. From the table, the LEV indicates the maximum willingness to sell the forest by the state government to earn the specified interest rate. The results indicate that the long-term sustainable management of AHFR is economically feasible. The LEV values are higher at the lower discount rate (5%), on average RM33,688.

TABLE 6
Estimates of conversion return, harvesting cost, profit margin and stumpage value by diameter class for each compartment, Ayer Hitam Forest Reserve, Puchong, Selangor (RM/ha)

a. Compartment 1

DBH class	Conversion return	Harvesting cost	Profit margin	Stumpage value
15-30	15,109	5,007	3,487	6,616
30-45	34,815	9,889	8,034	16,891
45-50	14,907	3,705	3,440	7,762
50-55	6,730	1,487	1,553	3,690
55-60	10,934	2,416	2,523	5,995
60-65	14,761	2,935	3,406	8,420
65-70	7,209	1,433	1,664	4,112
70-75	2,800	557	646	1,597
75-80	10,078	2,004	2,326	5,748
80-85	-	-	-	-
85-90	-	-	-	-
90+	10,596	2,107	2,445	6,044
Total	127,939	1,540	29,524	66,875

b. Compartment 2

DBH class	Conversion return	Harvesting cost	Profit margin	Stumpage value
15-30	24,992	8,282	5,767	10,942
30-45	18,771	5,332	4,332	9,108
45-50	9,005	2,238	2,078	4,689
50-55	6,404	1,415	1,478	3,511
55-60	3,255	719	751	1,785
60-65	3,205	637	740	1,828
65-70	1,272	253	294	726
70-75	1,447	288	334	825
75-80	-	-	-	-
80-85	1,927	383	445	1,099
85-90	-	-	-	-
90+	-	-	-	-
Total	70,278	19,547	16,219	34,514

c. Compartment 12

DBH class	Conversion return	Harvesting cost	Profit margin	Stumpage value
15-30	13,227	4,383	3,052	5,791
30-45	30,484	8,659	7,035	14,790
45-50	12,493	3,105	2,883	6,505
50-55	10,659	2,355	2,460	5,844
55-60	6,516	1,440	1,504	3,573
60-65	10,190	2,026	2,352	5,812
65-70	2,800	557	646	1,597
70-75	1,466	291	338	836
75-80	4,291	853	990	2,447
80-85	605	120	140	345
85-90	4,153	826	958	2,369
90+	18,659	3,710	4,306	10,643
Total	115,543	28,325	26,664	60,554

d. Compartment 13

DBH class	Conversion return	Harvesting cost	Profit margin	Stumpage value
15-30	11,461	3,798	2,645	5,018
30-45	25,669	7,291	5,924	12,454
45-50	12,213	3,036	2,818	6,359
50-55	12,887	2,847	2,974	7,066
55-60	8,761	1,936	2,022	4,804
60-65	9,885	1,965	2,281	5,638
65-70	6,236	1,240	1,439	3,557
70-75	3,661	728	845	2,088
75-80	574	114	132	327
80-85	2,083	414	481	1,188
85-90	3,031	603	699	1,729
90+	6,467	1,286	1,492	3,689
Total	102,928	25,258	23,752	53,918

e. Compartment 14

DBH class	Conversion return	Harvesting cost	Profit margin	Stumpage value
15-30	14,690	4,868	3,390	6,432
30-45	25,961	7,374	5,991	12,596
45-50	9,913	2,464	2,288	5,162
50-55	10,339	2,284	2,386	5,669
55-60	7,370	1,628	1,701	4,041
60-65	8,999	1,789	2,077	5,133
65-70	5,719	1,137	1,320	3,262
70-75	2,931	583	676	1,672
75-80	1,397	278	322	797
80-85	2,389	475	551	1,362
85-90	443	88	102	253
90+	5,582	1,110	1,288	3,184
Total	95,733	24,078	22,092	49,562

f. Compartment 15

DBH class	Conversion return	Harvesting cost	Profit margin	Stumpage value
15-30	14,009	4,643	3,233	6,134
30-45	23,936	6,799	5,524	11,613
45-50	8,287	2,060	1,912	4,315
50-55	8,239	1,820	1,901	4,518
55-60	5,877	1,298	1,356	3,222
60-65	5,532	1,100	1,277	3,155
65-70	3,280	652	757	1,871
70-75	3,461	688	799	1,974
75-80	1,877	373	433	1,071
80-85	1,572	312	363	896
85-90	1,241	247	286	708
90+	6,374	1,267	1,471	3,635
Total	83,685	21,259	19,312	43,113

TABLE 7
Summary of stumpage values by compartment and tree size of AHFR, Puchong, Selangor

Compt.	Trees < 50 cm dbh		Trees > 50 cm dbh		Total stumpage value (RM/ha)	Total percent (%)
	Stumpage value (RM/ha)	Percentage (%)	Stumpage value (RM/ha)	Percentage (%)		
1	31,269	47	35,606	53	66,875	100
2	24,739	72	9,775	28	34,514	100
12	27,087	45	33,467	55	60,554	100
13	23,832	44	30,086	56	53,918	100
14	24,190	49	25,372	51	49,562	100
15	22,062	51	21,051	49	43,113	100
Average	25,530	51	25,893	49	51,423	100

TABLE 8
Comparison of the estimated stumpage values of Ayer Hitam Forest Reserve, Puchong, Selangor with those of other forest areas in Malaysia (trees > 30 cm dbh)

State/Forest Reserve	Compartment/ Logging area	Year	Stumpage value (RM/ha)	Source
Pahang, Lesong FR	C86/87	1989	14,351	Awang Noor et al. (1992)
	C88/89	1989	25,235	"
Pahang, Bencah FR	C15	1989	11,200	"
	C16	1989	9,128	"
Pahang, Berkelah FR	C43	1999	5,012	Nur Hajar (1999)
	C31	1999	9,485	"
	C50	1999	12,106	"
Pahang, Tekai	C76	2000	7,078	Awang Noor and Mohd. Shahwahid (2003)
Tembeling FR	C77	2000	13,992	"
Pahang, Lesong FR	Block G	2000	13,886	"
	Block H	2000	15,823	"
	Block C	2000	11,027	"
Kelantan, Balah FR	Block 91	1996	23,632	Che Roslan (1996)
	Block 93	1996	28,267	"
	Block 95	1996	26,271	"
Terengganu,	C86	1989	17,172	Awang Noor et al. (1992)
Jengai FR	C87	1989	14,385	"
Kelantan	C13	1989	5,883	Awang Noor et al. (1992)
Berangkat FR	C14	1989	7,166	"
Kedah, Muda FR	C26	1994	27,332	Awang Noor and Mohd. Shahwahid (1995)
	C27	1994	26,710	"
	C29	1994	24,023	"
Johor, Lenggor FR	C221	1994	15,155	Dominic (1995)
	C225	1994	23,038	"
	C226	1994	14,740	"
Negeri Sembilan,	Angsi FR	1995	8,674	Awang Noor and Mohd. Shahwahid (1997)
Angsi FR				
Negeri Sembilan, Serting FR	C18	1995	13,031	"
Negeri Sembilan, Serting FR	C49	1995	9,691	"
Negeri Sembilan, Johol FR	Johol FR	1995	9,233	"

cont.

table cont.

Negeri Sembilan, Pasoh FR	C71	1995	6,137	"
Negeri Sembilan, Pasoh FR	C72	1995	4,218	"
Sabah, Kalabakan FR	Selected compartment	2003	11,041	Hussin (2003)
Sabah, Ulu Padas FR	Coupe 1	2003	11,633	Hussin (2003)
	Coupe 2	6,424		
Sabah, Deramakot FR	C40 (FMU 19)	2003		Lehuji (2003)
	Block 1		6,760	
	Block 2		5,226	
Selangor (1997)	10-20 years after logging	1995	9,532	Awang Noor and Mohd. Shahwahid
Selangor	21-30 years after logging	1995	9,715	"
Selangor	> 31 years after logging	1995	10,775	"
Selangor, Ayer Hitam FR	1 ha plot	1995	26,362	Pius (1995)
Selangor, Ayer Hitam FR	C1	2007	60,259	This study
Selangor, Ayer Hitam FR	C2	2007	23,572	This study
Selangor, Ayer Hitam FR	C12	2007	54,763	This study
Selangor, Ayer Hitam FR	C13	2007	48,900	This study
Selangor, Ayer Hitam FR	C14	2007	43,130	This study
Selangor, Ayer Hitam FR	C15	2007	36,979	This study

TABLE 9
Land expectation values of AHFR, Puchong, Selangor (RM/ha)

Compt.	Stumpage value (trees > 50 cm dbh) (RM/ha)	Discount rate				
		5%	8%	10%	12%	15%
		Land expectation value (RM/ha) $SV + SV^* \left[\frac{1}{(1+r)^{30}-1}\right]$				
1	35,606	46,324	39,535	37,771	36,835	36,152
2	9,775	12,718	10,854	10,369	10,113	9,925
12	33,467	43,542	37,160	35,502	34,623	33,980
13	30,086	39,143	33,406	31,915	31,125	30,547
14	25,372	33,010	28,172	26,914	26,248	25,761
15	21,051	27,388	23,374	22,331	21,778	21,374
Average	25,893	33,688	28,750	27,467	26,787	26,290

Note: r is discount rate.

CONCLUSION

This study shows that AHFR is substantially high in timber resources and its stumpage value is comparable with those of other dipterocarp forests in Malaysia even though it is a logged-over forest. The estimated stumpage values based on trees 15 cm dbh and above ranged from RM34,514 to RM66,875 per ha and the average estimated stumpage value was RM51,423. Based on trees 50 cm and above, the estimated stumpage values ranged from RM9,775 to RM35,606 per ha. Based on trees 15 cm dbh and above, the total stumpage (stock) value of timber resources in the whole AHFR (1248 ha) was estimated at RM64,175,904.00. The estimated stumpage values were concentrated in the

middle-size tree classes (30 to 75 cm dbh). The proportion of stumpage value within these diameter classes ranged from 64 to 78%. Even though the total stumpage value is substantial, this represents the stock value of the AHFR. Conversion of AHFR would provide a significant value to the government and concessionaire, but it must also consider the opportunity cost of converting this forest to other uses such as housing. A trade-off analysis is necessary such that resource allocations among competing uses can be compared, not just taking into account the benefits and costs of the proposed development project. This requires a different approach in evaluating forest land-use options and all benefits and costs, direct and indirect, must be taken into account. The result of this analysis is one of the aspects in this exercise.

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The Importance of Ayer Hitam Forest Reserve (AHFR), Puchong, Selangor, to the Temuan Ethnic Subgroup

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ABSTRACT

The indigenous people, or Orang Asli, have a prominent role to play in efforts to sustain the management of forest resources in Malaysia. Their direct use of and close association with the forests for generations have made them important for consideration when formulating and implementing forestry policies. Unlike that of other forest reserves, surrounding development has influenced the size of the Ayer Hitam Forest Reserve (AHFR). In fact, not only has the size of the forest reserve been affected, but also continuous rigorous socio-economic development has resulted in the resettlement of one of the Temuan communities from Kg. Sg. Rasau Hulu to Taman Orang Asli Saujana Puchong. Two Temuan ethnic subgroup communities, namely those currently living in Kg. Sg. Rasau Hilir and Taman Orang Asli Saujana Puchong, are located less than 3 km away from AHFR. The two Temuan ethnic subgroup communities also are believed to have occupied the AHFR for the last 400 years. With increasing pressure for further development of this prime forest reserve, the need is crucial to evaluate not only the goods and services but also the Orang Asli as direct users of forest resources.

INTRODUCTION

Literature reviews have indicated that the forests are an important component of the indigenous people's (like the Orang Asli's) way of life worldwide. Studies related to the Orang Asli also have shown that resources, especially non-timber forest produce (NTFPs), extracted from the forest are crucial as a source of both food and income to maintain their lives. To certain groups or ethnic subgroups of Orang Asli, even though they are surrounded by development, their need to be in the forest is something that cannot be denied. Their strong sense of belonging to the forest is beyond description and can be understood only by the Orang Asli themselves. Also, because of their strong relationship with the forest, their presence needs to be acknowledged and felt by all of us – foresters, forest planners or managers, and most important of all, policy-makers.

The Orang Asli's relationship with the forest demands our attention, especially now when their population number is said to be growing substantially. Using figures from the Department of Statistics Malaysia, Nicholas (2000) stated that the population of Orang Asli grew at an average rate of 1.9 to 4.3% annually between 1947 and 1992. A similar average growth rate was observed between 1990 and 1992. In an earlier study, Nicholas (1997) said that about 42,000 (40%) of the 105,000 Orang Asli population in 1997 lived close to or within forested areas, which indicates their direct association with the forest. The percentage of Orang Asli living close to or within forested areas is our major concern. In other words, the higher the percentage of Orang Asli who are dependent on forest resources, the more we, as resource managers and policy-makers, have to incorporate their needs and interests when drafting and implementing forest management plans.

Besides acknowledging the strong bond of the Orang Asli with the forests, we as custodians of the forests also must include inputs from other stakeholders who may have a direct interest in the said forests. The idea of including views from other stakeholders does not mean the wider community is trying to dictate to the forestry profession what they should or should not do, but rather that the complementary roles

of others in forest management are being acknowledged (Buchy and Hoverman, 2000). Buchy and Hoverman's idea of incorporating the complementary roles of other stakeholders right at the beginning, i.e. from the planning stage through the implementation process, has been advocated by others, as well.

The importance of forests in terms of trade to the Orang Asli has been well documented by many authors (Wang, 1958; Lamb, 1964; Wheatley, 1964; Dunn, 1975; Lim, 1991a; 1991b). However, a majority of these researchers did not quantify the values of forest collections made in relation to the Orang Asli's dependence on those forest resources. Hence, to claim that the Orang Asli are dependent on forest resources, namely NTFPs, for their livelihood, is difficult, especially when one is speaking of the degree of the so-called dependency.

The Ayer Hitam Forest Reserve (AHFR), Puchong, also is said to be important to the Orang Asli, specifically, the ethnic subgroup called Temuan. A majority of the communities living near the forest area are aware of this. Unfortunately, a well-known fact is insufficient to indicate the close relationship of the Temuan with AHFR without the support of hard evidence from the scientific community. To put it differently, the importance of AHFR to the Temuan needs to be quantified scientifically. This paper discusses the importance of AHFR to the Temuan in terms of values of NTFPs hunted and collected, such as animals, fish and medicinal plants. Views of the AHFR's condition, past and present, in terms of the availability of NTFPs that they used to collect, their way of life and being relocated to new homes, also are discussed.

REVIEW OF LITERATURE

Literature on the importance of AHFR to the Temuan ethnic subgroup is rather scanty. The only available literature on the value of AHFR to the Orang Asli is by Rusli *et al.* (1997), as quoted in Awang *et al.* (1999). Rusli *et al.* estimated that the value of timber and non–timber collected by the Orang Asli was worth RM110,000 in 1996. Without detailing what exactly the Orang Asli collected, Rusli *et al.* further stated that birds and small mammals comprised 75% of the animals collected; 24 species were hunted for meat and 48% of the plants were collected for their fruit. According to Awang *et al.* (1999), the case study by Rusli *et al.* (1997) also reve aled that, at the time the survey was conducted, AHFR supplied fewer usable species of plants and animals than before. The interviews of household heads were conducted for two months, namely November and December 1996.

Obviously, without further details about what the Temuan collected, it is difficult to gauge the importance of the types of collections, be they of animals, plants, fruits, or other NTFPs. Besides giving more insight into and better appreciation of the importance of AHFR to the Temuan, information gathered from the study also will help policy-makers formulate a more compatible management plan for AHFR. The need to gain knowledge about the importance of AHFR to the indigenous people, i.e. Temuan, as one of the priority areas for research was decided in the stakeholder analysis conducted jointly by the Forest Research Institute Malaysia (FRIM) and Universiti Putra Malaysia (UPM) between 16 and 17 October 2003. The stakeholders present at the workshop thought that more comprehensive information was needed on the indigenous people, as well as on other aspects such as timber, potential recreational value, carbon sequestration, medicinal plants, fruits and other non-timber values. Stakeholders who attended the workshop strongly believed that knowing all the attributes of AHFR through stakeholder analysis would assist policy-makers in making not only effective but also participatory forest management decisions (Norini *et al.*, 2004).

Before going into the materials and methods used in the study, let us examine the cognitive map, sometimes also referred to as a facilitative device – an outcome of an interview with the headman or Tok Batin of the Orang Asli during the stakeholder analysis workshop (*Fig. 1*). *Fig. 1* clearly indicates that the mind of the indigenous people is not as simple as we might have thought. For instance, when asked what exactly they did when they went into the forests, they informed the interviewer that they collected plants (mostly medicinal plants), hunted animals (e.g. deer mouse, deer and wild boar), and caught fish. More will be said of *Fig. 1* in the section on results and discussion.

MATERIALS AND METHODS

Similar to other socio-economic studies, information was gathered in this study through interaction with Temuan heads of households, using a structured questionnaire. Basically, the

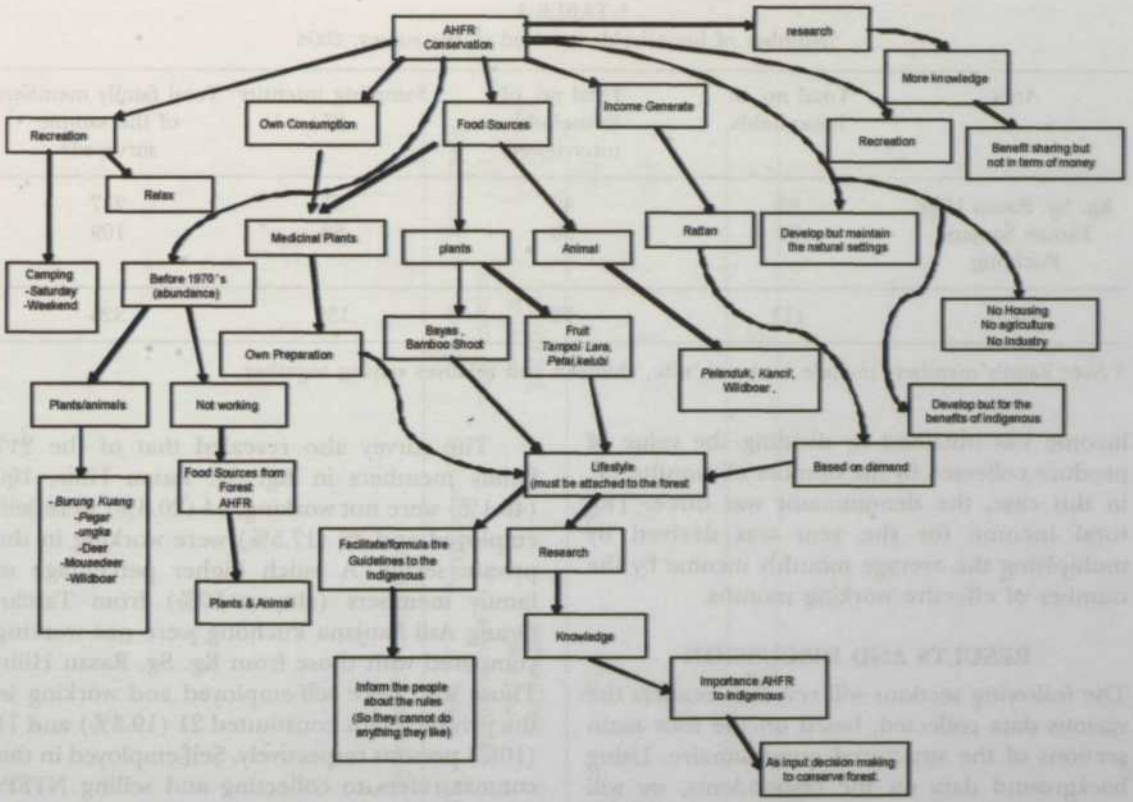

Fig .1: Part of the facilitative device showing view of an Orang Asli of AHFR
Note: Words in italic are local names
Source: Norini *et al.* (2004)

questionnaire was divided into four main sections: (a) background of respondent; (b) status of land and properties owned; (c) perceptions of development, i.e. from the perspective on AHFR's condition, life-style before and after relocation, income, and availability of NTFPs; and (d) values of NTFPs collected from AHFR.

The survey on the Temuan was conducted in June 2004. Two main groups of Temuan were involved in the survey. They were living in Kg. Sg. Rasau Hilir and Taman Orang Asli Saujana Puchong. The group in Taman Orang Asli Saujana Puchong had moved from Kg. Sg. Rasau Hulu, located reasonably close to AHFR. The former group, Kg. Sg. Rasau Hilir, comprised 83 households whereas the latter, Taman Orang Asli Saujana Puchong comprised only 34 households. Of the 83 households at Kg. Sg. Rasau Hilir, 42 (51%) were interviewed. On the other hand, 30 of the 34 (88%) households from Taman Orang Asli Saujana Puchong, were interviewed (Table 1).

Valuing of Animals, Medicinal Plants, and Fish

Values of NTFPs, such as animals, medicinal plants and fish, could be estimated should detailed data become available. A much better representation of NTFP values also would be obtained if researchers could collect time-series data or be involved with the activities of the Orang Asli. To follow the Orang Asli into the forest and record the values of the NTFPs they collect is one way of obtaining reasonable estimates. Because the data that were collected depended highly on the memories of householders engaged in such activities and because of budgetary constraints, detailed data were not collected. Therefore, in this study, valuation of NTFP such as animals, medicinal plants and fish was based entirely on an average of three months' collection. The units (for animals collected) or weights (for fish, fruits/ vegetables and medicinal plants collected) were then translated into values by multiplying the amount by the average unit price. Average

TABLE 1
Number of households involved in the survey, 2004

Area	Total no. of households	Total no. of households interviewed	Sampling intensity (%)	Total family members of the sample surveyed*
Kg. Sg. Rasau Hilir	83	42	51	217
Taman Saujana Puchong	34	30	88	109
Total	117	72	139	326

* *Note:* Family members include husband, wife, children and relatives staying together.

income was obtained by dividing the value of produce collected by the number of months, i.e. in this case, the denominator was three. The total income for the year was derived by multiplying the average monthly income by the number of effective working months.

RESULTS AND DISCUSSION

The following sections will reveal to readers the various data collected, based on the four main sections of the structured questionnaire. Using background data on the respondents, we will then try to relate that information to the NTFPs collected by the Temuan from AHFR.

Background Data

Information collected on the background of the Temuan indicated that a majority of the 209 family members (more than 28%) in Kg. Sg. Rasau Hilir were between 21 and 30 years old. A figure of 209 instead of 217 family members was quoted because one of the heads of households could not recall the different ages of his eight family members. On the other hand, of the 109 family members in Taman Orang Asli Saujana Puchong, 34 (31%) were also in the age group of between 21 and 30 years.

With regard to educational level, 89 (42.6%) of the family members of the total population living in Kg. Sg. Rasau Hilir did not have any formal education, whereas about 91 (43.5%) and 29 (13.9%) members had primary and secondary school education respectively. A majority of family members from Taman Orang Asli Saujana Puchong had no education (46.8%), whereas about 37.6, 14.7, and 9.2% (one individual) had primary schooling, secondary schooling and college exposure respectively.

The survey also revealed that of the 217 family members in Kg. Sg. Rasau Hilir, 100 (46.1%) were not working, 44 (20.3%) were self-employed and 38 (17.5%) were working in the private sector. A much higher percentage of family members (almost 50%) from Taman Orang Asli Saujana Puchong were not working compared with those from Kg. Sg. Rasau Hilir. Those who were self-employed and working in the private sector constituted 21 (19.3%) and 11 (10%) persons respectively. Self-employed in this context refers to collecting and selling NTFPs from AHFR.

Table 2 indicates that a majority of the total household members interviewed in Kg. Sg. Rasau Hilir (37.9%) earned less than RM300 per month. In Taman Orang Asli Saujana Puchong, the percentage of household members earning less than RM300 per month was 31.6%.

Little can be said about the levels of income earned by the two Temuan groups. The much higher percentage of household members earning less than RM300 per month was not related to the percentage of each group's population who were not working (46.1% from Kg. Sg. Rasau Hilir and 50% from Taman Orang Asli Saujana Puchong). The percentages of household members in both areas that were self-employed also did not differ much.

Status of Land and Properties Owned

A total of 42 householders responded to the question regarding status of the land where they currently were living. A quick observation indicated that about 30 householders in Kg. Sg. Rasau Hilir owned the land where they were living, whereas 10 householders informed the interviewers that the land had been passed to

TABLE 2
Pattern of household income, by top three categories

Area	Total family members of the sample surveyed	Total no. of wage earners	No. of wage earners earning < RM300	Percentage (%)	No. of wage earners earning RM300-400	Percentage (%)	No. of wage earners earning RM401-500	Percentage (%)
Kg. Sg. Rasau Hilir	217	87	33	37.9	20	23.0	13	14.9
Taman Saujana Puchong	109	38	12	31.6	3	7.9	8	21.1
Total	326	125	45		23		21	

them by their parents and grandparents. The other two householders indicated that they were occupying government land. Of those householders living in Taman Orang Asli Saujana Puchong, 24 said they owed the land, whereas another 6 were squatting on government land.

Of the total population from the two groups of Temuan, 42 and 15 householders from Kg. Sg. Rasau Hilir and Taman Orang Asli Saujana Puchong respectively responded to the next question. Of the 42 householders from Kg. Sg. Rasau Hilir, 22 said that they had motorcycles and 4 said the cars they drove were their own. In comparison, only 12 householders in Taman Orang Asli Saujana Puchong said that they owned motorcycles as a mode of transportation.

Perceptions of Development

Data collected from the area revealed that eight householders reported that they lost their land and homes to the government because of development. According to the householders from the two groups, the lands taken by the government usually were replaced with new ones or the owners were compensated for them. Householders in Kg. Sg. Rasau Hilir indicated compensation figures of between RM12,000 and RM75,000 if their lands were taken over by the government. A much higher rate, between RM16,000 and RM200,000, was paid to those from Taman Orang Asli Saujana Puchong once their lands were taken over by the government for development purposes.

When asked about the condition of the forest following development, householders from Taman Orang Asli Saujana Puchong said that, as far as resources were concerned, AHFR seemed to have fewer fish and animals, even though there was no restriction on their entering the forest (Table 3). The water quality also was said to have been affected by the development. At this juncture, perhaps it would help if some indicators such as numbers were used to demonstrate the degree of change. Householders living in Kg. Sg. Rasau Hilir expressed similar feelings of concern regarding the condition of selected aspects before and after development. The number of householders who said they were not "comfortable" increased after development (Table 3).

Overall, 40 of the 42 householders interviewed in Kg. Sg. Rasau Hilir were satisfied with their way of life. This comprised about 48.2% of the total households in that area. These Temuan groups were still living in their original state, i.e. they had not been touched by development. It was also noted that 21 or 70% of the householders from Taman Orang Asli Saujana Puchong stated that they were happy with their new homes, whereas another 5 (16%) and 4 (13%) still preferred the old life-style and complained about earning less income because of the distance they had to travel to collect NTFPs from AHFR.

Overall, there was a general feeling that AHFR should be preserved because it is a source of both food and income to the Temuan ethnic subgroup (*Fig. 2*). Besides, both groups also said that they frequently needed to go into the forest for recreation, to hunt for animals, and to do other related activities of interest.

Values of Non-Timber Forest Produce (NTFPs)

(i) Yearly Values of Animals Collected

Analysis of the data from AHFR revealed that about 17 popular animals currently were hunted either for food or to be sold to prospective buyers (Table 4). For calculation purposes, all NTFPs collected were given a value, regardless of whether they were consumed or sold.

Of the 17 animal species, deer and python seemed to be the most popular. When translated into values, their average worth was between RM10,000 and RM12,000 per year (number of effective months was assumed to be 10 months). As far as price per unit is concerned, one can see that the range for certain animals is substantial. Nonetheless, for calculation purposes, an average price had to be used, even though a range of prices would certainly help improve the total values collected. All in all, the Orang Asli collected a total of RM43,817 from selling the various types of animals (Table 4).

(ii) Yearly Values of Fish Collected

It looks like fishing was not as attractive as hunting animals. The total yearly collection, according to the survey, was slightly more than RM1,200 (Table 5). This figure corresponds to an earlier statement made by the Temuan regarding the number of fish caught before and after development.

(iii) Yearly Values of Medicinal Plants Collected

It is clear from Tables 6 and 7 that collecting medicinal plants and fruits/vegetables was equally important to both the Temuan groups.

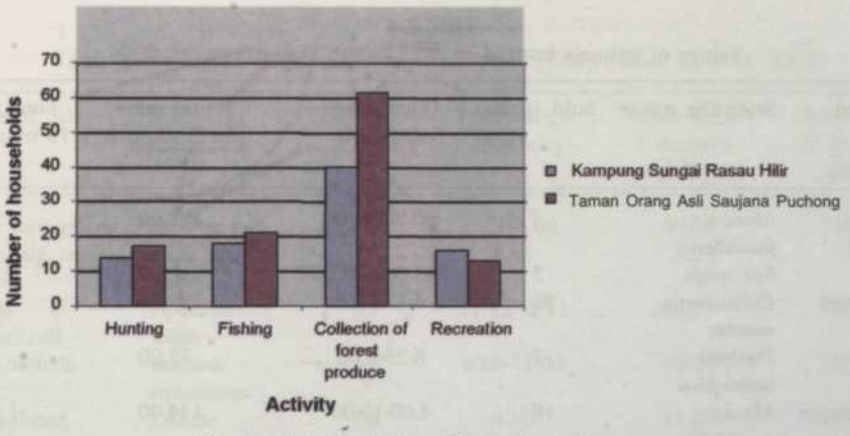

Fig. 2: Activities in Ayer Hitam Forest Reserve

TABLE 3
Conditions of selected aspects before and after development in Taman Orang Asli Saujana Puchong

Item	Condition	No. of households responding	
		Before development	After development
Housing	Comfortable	18	10
	Uncomfortable	11	18
	No change	1	2
Forest resources	Plenty	29	
	Decrease		27
	No difference		2
River	Clean	17	4
	Dirty	1	16
	Shallow		1
	Deep	1	
	No difference	6	6
	A lot of fish	5	
	No. of fish decreased		3
Life-style	Difficult	4	9
	Good	12	6
	Unchanged	3	4
	Self-employed	2	5
	Government staff		
	Traditional	9	
	Modern		5
	Business		1
Income	Unchanged	14	19
	Unfixed	7	1
	Increased	4	7
	Decreased	4	3
Entrance to forest	No restriction	25	1
	Difficult to enter	2	26
	No problem to enter	3	3
Animals	Plenty	24	
	Decreased		23
	No difference	4	5
	Not hunting	2	2

TABLE 4
Values of animals hunted in Ayer Hitam Forest Reserve, 2004

Type of animal	Scientific name	Sold (units)	Price range RM/unit	Total value for 3 months (RM)	Total value for 10 months (RM)
Long tailed macaque	*Macaca fasicularis*	7	20.00-29.00	167.00	556.67
Wild boar	*Sus scrofa*	3	230.00-250.00	710.00	2,366.67
Plantain squirrel	*Callosciurus notatus*	36	4.17-9.00	188.76	629.20
Banded leaf monkey	*Presbytis melalophos*	7	6.25-9.00	52.00	173.33
Pig-tailed macaque	*Macaa nemistrina*	18	4.00-13.00	144.00	480.00
Mousedeer	*Tragulus javanicus*	3	21.67-114.00	249.67	832.23
Porcupine	*Hystrix brachyura*	14	26.25-35.00	385.00	1,283.33
Water monitor	*Varanus salvator*	33	17.00-30.00	925.00	3,083.33
Python	*Python neticulatus*	10	178.00-350.00	3,156.00	10,520.00
Frog	*Rana blythi*	42	16.00-24.00	824.00	2,746.67
Tortoise	*Geomyda spinosa*	55	1.87-2.00	109.35	364.50
Deer	*Cervus unicolor*	6	600.00	3,600.00	12,000.00
Water rat	*Hydromys chrysogaster*	43	7.50	322.50	1,075.00
Labi-labi	*Pelochelys bibroni*	4	58.00	232.00	773.33
Malaysian wood rat	*Rattus tiomanicus*	84	10.00	840.00	2,800.00
Giant treeshrew	*Tupaia tana*	84	10.00	840.00	2,800.00
Emerald dove	*Chalcophaps indica*	20	20.00	400.00	1,333.33
Total		469		1,3145.28	43,817.59

For instance, the collection of medicinal plants and of fruits/vegetables in 2004 was estimated to be worth RM11,553.56 and RM13,301.44 respectively.

(iv) Yearly Values of Rattan Collected
Besides fish, fruits/vegetables, medicinal plants, and animals collected and hunted, both the Temuan groups also collected various types of rattan from AHFR. The most common species collected was rattan manau (*Calamus manan*). Based on the survey conducted, the total yearly collection of all rattan from AHFR was estimated to be around RM7,403.

(v) Total Yearly Values of Various Activities
Adding the collections from the various activities yielded a total figure of RM77,309.24. This total collection for 2004 was much lower than the RM110,000 reported earlier by Rusli *et al.* (1997). If one were to relate the total value of collections to the cognitive map presented in *Fig. 1*, one would see that the statement that NTFPs were abundant back in the 1970s is accurate. In fact, the decreasing trend in collections of NTFPs should be a direct concern to most foresters. One could argue that the lower total collection could also be due to the smaller number of Temuans making visits or fewer visits being made to the forest. One way of measuring this is through time-series data regarding the number of visits and number of households engaged in collecting NTFPs from AHFR. Whatever the reason may be, the decline in collection of NTFPs is a major concern to all.

TABLE 5
Total yearly values of fish collected from Ayer Hitam Forest Reserve, 2004

Type of fish	Scientific name	Sold (kg)	Price range (RM)/kg	Total value 3 months (RM)	Total value 10 months (RM)
Ikan tenggalan	*Puntius bulu*	4.5	1.50-3.00	40.08	133.60
Hampala barb	*Hampala macroleipido*	1.5	3.00	4.50	15.00
Giant snakehead	*Ophicephalus laevis*	9.1	11.43-12.11	108.77	362.58
Ikan belisik	*Rasbora sumatrana*	4.8	6.80-11.00	45.24	150.80
Broadhead catfish	*Clarias macrocephalus*	2.5	4.50	11.25	37.50
Spotted bard	*Puntius binotatus*	10	0.60	6.00	20.00
Black snakehead	*Channa melasoma*	3	14.00	42.00	140.00
Others		16.5		112.15	373.83
Total		51.9		369.99	1,233.31

TABLE 6
Values of medicinal plants collected from Ayer Hitam Forest Reserve, 2004

Type of medicinal plant	Scientific name	Sold (units)	Price range (RM)/unit	Total value 3 months (RM)	Total value 10 months (RM)
Ubi jaga	*Smilax myosotiflora*	18	10.00-20.00	350.00	1,166.67
Tongkat ali	*Eurycoma epiculata*	8	7.50-20.00	149.81	499.37
Kacip fatimah	*Labisia pothoina*	5	18.00-27.40	127.60	425.33
Buah pakma	*Rafflesia hasseltii*	7	18.00-19.00	132.00	440.00
Gajah beranak	*Goniothalamus scortechinii*	11	17.00	187.00	623.33
Rempah gunung	*Leptospermum flavescens*	11	17.00	187.00	623.33
Cendawan rimau	*Travesia cheirantha*	7	19.00	133.00	443.33
Tembaga besi	*Crinum asiaticum*	42	19.00	798.00	2,660.00
Buah jes	NA	6	16.00	96.00	320.00
Akar bertam	*Eugeissona tristis*	5	17.00-17.25	86.00	286.67
Serapat	*Parameria polyneura*	10	16.0	160.00	533.33
Tengkuk biawak	*Allomorphia malaccensis*	8.3	11.25-16.00	94.80	316.00
Merian air	NA	7	9.23-11.33	77.21	257.37
Merian batu	*Labisia pothoina*	5.3	12.25-13.00	65.15	217.17
Merian kayu	*Croton griffithi*	5.5	13.00	71.50	238.33
Tongkat haji samad	*Eugenia dyeriana*	50	13.00	650.00	2,166.67
Merian panas	*Cyrtandra pendula*	2	8.00	16.00	53.33
Kayu serong	NA	5	17.00	85.00	283.33
Total		213.1		3,466.07	11,553.56

Note: NA denotes not available.

TABLE 7
Values of fruits/vegetables collected from Ayer Hitam Forest Reserve, 2004

Type of fruit/ vegetable	Scientific name	Sold (kg)	Price range (RM)/kg	Total value 3 month (RM)	Total value 10 months (RM)
Rambutan	*Nepheliu lappaceum*	5.3	6.58-12.00	41.92	139.73
Tampoi	*Baccaurea graffithii*	75	8.50-12.00	672.50	2,241.67
Larat	*Acrostichum aureum*	12.5	18.00	225.00	750.00
Pulasan	*Nephelium mutabile*	36.25	18.00	652.50	2,175.00
Petai	*Parkia speciosa*	186.67	3.00-4.50	753.51	2511.70
Jering	*Pithecellobium jiringa*	13.75	5.00-14.00	75.50	251.67
Perah	*Elateriospermum tapos*	9.3	6.00	55.80	186.00
Makong	NA	140	3.00	420.00	1,400.00
Pelaga	*Amomum kepulaga*	12.2	10.00	122.00	406.67
Keledang	*Artocarpus lanceiolius*	10.1	17.00	171.70	572.33
Langsat	*Lansium domesticumjack*	12.5	10.00	125.00	416.67
Rambai	*Baccaurea motleyana*	55.1	6.00	330.60	1,102.00
Kerdas	*Pithecellobium bubalinum*	6.3	8.00	50.40	168.00
Pucuk bayas	*Oncosperma tigillaria*	27.5	6.00	165.00	550.00
Pucuk rotan	*Calamus ornatus*	3.2	10.00	32.00	106.67
Berangan	*Castanopsis hullethi*	1	12.00	12.00	40.00
Redan	*Nephelium glabrum*	9	5.00	45.00	150.00
Pucuk bertam	*Noronha Eugeissona tristis*	4	10.00	40.00	133.33
Total		619.67		3,990.43	13,301.44

CONCLUSION

Quick analyses of the data revealed that the Temuan are still dependent on AHFR as a source of food and income. About 79% of the households from Taman Orang Asli Saujana Puchong were engaged in some sort of forest-related activities in AHFR, whereas about 35% of the households from Kg. Sg. Rasau Hilir were dependent on AHFR as a source of food and income. Clearly, even though the Temuan are surrounded by development, the need to go into the forest for hunting, recreation or other activities is important to them. Their bond with the forest is here to stay.

Between the two groups of Temuan, households from Taman Orang Asli Saujana Puchong seem to be more attached to AHFR, even though they are currently living in modern homes. In short, modernization has not stopped the Temuan from continuously engaging in desirable forest-related activities. Comparison of data from this study with those of the earlier study by Rusli *et al.* (1997) revealed that the values of collection of NTFPs have declined. The next crucial question is: What can we do about it? One way of addressing this issue is to formulate a policy to include the Orang Asli in the decision-making process. Above all, policy decision-makers must understand the needs of the Orang Asli. Understanding their needs will help policy decision-makers better plan the management of the forest. In other words, getting the Orang Asli involved in the decision-making process would create a sense of belonging, which will indirectly help in managing the forest in a sustainable manner. Sustainability in this context refers not only to timber but also to NTFPs and environmental services that forests can offer.

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Valuation of Carbon Stock and Carbon Sequestration in Ayer Hitam Forest Reserve, Puchong

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Keywords: C sequestration, **economic value,** forest biomass, tropical forest

ABSTRACT

The study estimated the physical and monetary value of forest biomass and the existing stored carbon (C), and the rate of C sequestration by vegetation in Ayer Hitam Forest Reserve (AHFR), Puchong, Selangor. The estimates used direct measurement - based method by a sample survey of AHFR where both above-ground and below-ground C pools were considered. Allometric biomass equations were applied to estimate individual tree biomass per hectare. The total amount of forest biomass - above-ground and below-ground - ranged from 209 to 222 t ha^{-1} and the corresponding quantity of C stock ranged from 104 to 111 t ha^{-1}. The rate of change of the C stocks was between 4 and 6.5 t ha^{-1} yr^{-1}. Such rate of C sequestration was relatively high, comparable with sequestration rate of fast-growing Mahagony (sweitenia macrophylla) plantation. Using a weighted average price of carbon ranging from USD4.00 t^{-1} to USD50 t^{-1}, the estimates of the value of C stock ranged from RM1,654 ha^{-1} to RM20,800 ha^{-1}. The corresponding value of AHFR as a carbon sink thus amounted to RM2.06-25.96 million. In terms of the dynamics, the estimates of the value of C sequestration ranged from RM 0.87 million to RM 1.45 million yr^{-1}. The information is very useful in estimating the total economic value of AHFR and other tropical forests in future.

INTRODUCTION

Global climate change is a fluctuation in the average global temperature, commonly known as "global warming". As more scientific information about global warming accumulates, climate change is emerging as perhaps the greatest environmental challenge of the twenty-first century, which leads to destruction of the earth's ecosystem. The phenomenon of rising global temperatures affects both weather and climate.

Major global threats such as hunger, poverty, water shortage, displacement of population, air pollution, soil degradation, desertification and deforestation all contribute to climate change that necessitates a comprehensive approach to a solution. Changes in climate will also impact economic well being. Since temperature and precipitation are direct inputs to agriculture production, many believe that the largest effects will be felt in this sector.

The forest has an important role in regulating climate change. Tropical forests are important sources and sinks of carbon (C). When forests are cleared or degraded they contribute about one-sixth of global carbon emissions. In contrast, they have the potential to absorb about one-tenth of global carbon emissions projected for the first half of this century into their biomass, soils and products and store them in perpetuity. Conserving tropical forests is an important step towards reducing CO_2 in the atmosphere as the forests maintain a balance between the biomass of the world's vegetation and the amount of carbon dioxide. However, there is limited information on the extent of carbon sequestered and stored by tropical forests. This paper focuses on and attempts to develop a reliable estimate of the C stocks and the rate of C sequestration in the secondary forest of Ayer Hitam Forest Reserve (AHFR), Malaysia. Another objective of the paper is to monetize the value of the forest for its ecosystem service in terms of its carbon stock and carbon sequestration.

MATERIALS AND METHOD

Physical Measure of Forest Biomass and C Stock

A previous study estimates the total forest biomass and C stock of Air Hitam Forest Reserve (AHFR) using large scale volume based assessment from inventory data (Kueh and Lim, 1999). In this study a field inventory was conducted to estimate the biomass and C stock and the rate of CO_2 sequestration. This is considered as direct measurement-based as opposed to volume-based estimates of forest biomass (Brown and Lugo, 1982). Major C pools measured were above-ground biomass, below-ground biomass and forest litter. For the above-ground measurement sampling consisted of measuring the diameter and height of each tree. Six, 10 x 100 m transects, were laid out in forest areas representing the range of forest conditions in the forest reserve. Complete enumeration of all trees (≥ 10 cm dbh) was conducted in each transect. For each tree, the following data were recorded: a) species name, dbh (stem diameter at 1.3 m above the ground); b) total height; and c) height of first branch. The volume, biomass and carbon content per tree and per hectare were calculated.

Biomass per tree was computed using biomass regression equations. To facilitate comparison of biomass calculations, the following equations were used (Brown *et al.*, 1989; Brown, 1997):

$$Y = 42.69 - 12.8\ D + 1.242\ D^2 \quad [1]$$

$$Y = \text{Exp}\ \{-2.134 + 2.530 \ln D\} \quad [2]$$

$$Y = \text{Exp}\ \{-3.1141 + 0.9719 \ln D^2 * H\} \quad [3]$$

where: Y = biomass per tree (kg) and D = dbh (cm) and H = the total height (m). A carbon content of 50% of biomass was assumed. Equation 3 has a height variable incorporated in the estimate of tree biomass.

For sampling of under-storey vegetation (saplings and seedlings ≤ 10 cm dbh), five plots measuring 1 x 1 m were randomly laid out. All individual trees and woody species in each plot were harvested. Fresh weights of leaves, branches and stems of harvested trees and woody species were recorded in the field. Then these materials were taken to the laboratory for drying in the oven. Their oven-dry weights were recorded and the carbon contents of plant tissues were determined. Herbaceous vegetation was collected in five 2 x 2m plots randomly scattered in each transect. The fresh weights, oven-dry weights and C contents were determined. C stored in the litter layer on the forest floor was obtained by randomly laying out 0.5 x 0.5 m frame at five locations. Fresh weights, oven-dry weights and C contents were determined.

The field survey on C stocking in AHFR lasted three weeks. About 120 quadrants of 10 x 100 m were established in Compartments 12, 13, 14 and 15. Each quadrant was subdivided into 4 sub quadrants: 10 x 10 m, 2 x 2 m, 1 x 1 m, and 0.5 x 0.5 m. Trees were identified; the volumes, biomass and carbon contents per tree and per hectare were calculated.

The above-ground tree biomass measurements were taken twice: at the beginning and towards the end of the study to estimate C sequestration per year. It was assumed that litter biomass and soil organic C remained unchanged during the observation period.

Valuation of C Stock and C Sequestration

A review of the literature suggests that carbon can be valued from about USD5 to USD300 t^{-1}. Richard and Stokes (1995), as quoted by Thompson *et al.* (1997) argued that the divergence arises because the marginal costs of CO_2 absorption through tree plantations are initially low, but then rise rapidly thereafter. The estimates of the marginal damage caused by aggravated greenhouse effect are not well known and the carbon value one chooses depends on the point on the marginal cost curve that is taken. Nordhaus (1991) arrived at a carbon value of about USD 20 t^{-1} following his estimates of marginal benefit and marginal cost of abating CO_2 emissions; van Kooten *et al.* (1993) considered carbon values of USD20, USD50 and USD300. Thompson *et al.* (1997) adjudged a value of carbon of USD 50 t^{-1} as reasonable after his review of carbon values used by Nordhaus and van Kooten.

Another source for carbon value is the price of carbon traded in the carbon market. The carbon market encompasses both the *generation of emission reductions* (*ERs*) through *project-based transactions* where a buyer purchases ERs from a project that produces measurable reductions in greenhouse gases (GHG), and *trading of GHG emissions allowances* allocated under existing (or upcoming) cap-and-trade regimes such as the European Emissions Trading Scheme (EU ETS).

The "cap-and-trade" approach, being used in the EU ETS, sets an overall cap or maximum

amount of emissions per compliance period. Companies are given allowances which represent their targets or "caps" for a compliance period. At the end of the period they must surrender sufficient allowances to reconcile against their total emissions during the period, if this is below their caps then they have allowances to sell; if not, they must purchase allowances from companies which have exceeded their emissions reductions targets. Each allowance permits the holder to emit one tonne of CO_2.

Lecocq and Capoor (2005) reported that Verified Emission Reductions (VER) have traded between USD3.6 and USD5t^{-1} CO_2e between January 2004 and April 2005, with a weighted average price of USD4.23t^{-1} CO_2e. Certified Emission Reductions (CER), on the other hand, have traded between USD3 and USD7.15t^{-1} CO_2e over the same period of time, with a weighted average of USD5.63t^{-1} CO_2e.

On the other hand, the Katoomba group's Ecosystem Market Place (2004) reported that the trading activity and prices per tonne of carbon traded at the Chicago Climate Exchange (CCX) have been growing steadily. A total amount of 2,250,000 tCO_2e valued at about USD2 million was traded through the CCX during 2004. During that period, prices ranged from USD0.71 to USD2.06t^{-1} CO_2e, with most trading occurring around USD1t^{-1} and between USD1.63 and USD4.65t^{-1} CO_2e from January 2004 to December 2006 in the carbon market. These prices are much lower than those found in the regulated carbon markets, such as the EU ETS, NSW, and Kyoto, in part because the CCX is voluntary and also because of the large volume of inexpensive agricultural sequestration offsets being offered, which would not be permitted under the other schemes.

Unlike project-based assets, allowances are homogeneous assets, and purchase contracts for allowances are fairly homogenous as well. As a result, the spread of prices for Europe allowance (EUA) at any given point in time is small. EUAs traded between €7 and €9 in 2004, but their prices have increased substantially in recent months, to reach more than €17 in March and April 2005.

The economic valuation of AHFR in terms of its C stock and C sequestration will use several carbon values of USD 50t^{-1}, the weighted average prices of USD4.23/tCO_2 e, USD5.63/tCO_2e and €17 t^{-1}. These currencies were converted to local currency using appropriate exchange rates.

RESULTS AND DISCUSSION

The inventory of AHFR was conducted in May 2004 and was repeated in the subsequent year to learn the dynamics of the forest biomass and the rate of C sequestration. The distribution of tree

TABLE 1
Species distribution in AHFR

No.	Species	No. of trees (May 2004)	No. of trees (June 2005)
1	*Anisoptera*	6	6
2	*Calophyllum sp.*	6	6
3	*Canarium*	10	10
4	*Dipterocarpus*	53	53
5	*Elaeocarpus*	12	12
6	*Endospermum*	10	12
7	*Hopea*	21	22
8	*Knema*	15	15
9	*Palaquium gutta*	22	24
10	*Santiria*	12	12
11	*Shorea acuminate*	12	12
12	*Shorea macroptera*	22	20
13	*Other Shorea*	10	10
14	*Syzygium*	58	57
15	*Terminalia*	12	12
16	*Other species*	246	245
	Total	527	528

species in AHFR is presented in Table 1. The results show that a variety of tree species are found in AHFR, the majority being the lesser-known timber species. A total of 575 tree were sampled. Some of the more common commercial timber species found were the *Dipterocarpus* (10%), *Syzygium* (11%), and the *Shorea* species (8%). The composition of species was so diverse that about 250 trees recorded do not belong to species listed in the Table. They were categorized as other species and they made up almost 50% of the population.

The diameter distribution of tree species is shown in Table 2. About 80% of trees in AHFR were under 30 cm diameter where the majority belong to the lowest diameter class (10-20 cm) followed by trees in the 21-30 cm diameter class (about 21%). During the follow-up survey about 2% of trees in the initial sample had died. On the other hand, about 2.4% of trees were new members in the lowest diameter class (inbreeding). The diameter remained constant for about 14% of the trees but the trees grew taller. In general the change in the diameter was in the range of 0.1to 3.0 cm yr^{-1} and in the height, 0.1 to 4.1 cm yr^{-1}.

Above-ground Biomass

Biomass stocks accounted in this analysis were above-ground tree biomass (leaves, branches and trunks) per hectare. Given the information on the dbh and the total height measurements, total biomass of trees 10 cm dbh and above was estimated using allometric equations (equations 1, 2, and 3) shown previously. Two of the equations (1 and 2) use only diameter variable, the third equation incorporates the information on tree height to estimate tree biomass.

The total above-ground biomass value (TAGB), calculated by means of the three regression equations are shown in Table 3. The TAGB of AHFR range from196 t ha^{-1} to 209 t ha^{-1} in the initial year and from 201 to 215 t ha^{-1} in the following year. The results were comparable with biomass estimates in logged hill and disturbed hill forests in Peninsular Malaysia (Brown, 1997). The table shows that equation 3 consistently generated TAGB values midway between the highest and lowest values generated by equation 1 and 2 respectively. According to Brown *et al.* (1989), results from equation 3 that considers both diameter (*D*) and height (*H*) yield preferably better estimates since the biomass equation has additional information incorporated by the knowledge of *H*. Moreover, considering that about 80% of trees in AHFR were below 30 cm diameter, the rotation age when growth in diameter and height is rapid, excluding height information in biomass computation will miscalculate the value significantly. The use of allometric equation as in equation 3 was possible since the inventory of AHFR used direct measurement-based method that recorded both the diameter and height of the tree. In contrast, a large-scale volume-based assessment of biomass that usually lacks *H* information (usually due to time and cost constraints) may generate poorer estimates of forest biomass.

The study of Kueh and Lim (1999) on biomass density in AHFR showed variations in the density due to species diversity and state of recovery of some forest compartments after

TABLE 2
Diameter class distribution of tree species in AHFR

No.	Diameter range (cm)	No. of trees (May 2004)	No. of trees (June 2005)
1	10.00- 19.99	299	292
2	20.00- 29.99	111	115
3	30.00- 39.99	49	50
4	40.00- 49.99	34	35
5	50.00- 59.99	19	21
6	60.00- 69.99	7	7
7	70.00- 79.99	4	4
8	80.00- 89.99	2	2
9	> 90	2	2
	Total	527	528

TABLE 3
Total above-ground biomass in AHFR

	May 2004			June 2005		
	Eq1	Eq2	Eq3	Eq1	Eq2	Eq3
Biomass (t ha-1)	209.30	195.61	197.64	215.32	201.46	208.24
C stock (t ha-1)	104.66	97.82	98.83	107.67	100.92	104.12
Total AHFR biomass (t)				268,753	251,930	259,900
Total AHFR C stock (t)				134,376	125,965	129,950
Change in biomass (t ha-1 yr-1)				9.13	8.91	12.65
Change in C stock (t ha-1 yr-1)				4.57	4.46	6.33
Total C sequestration (t yr-1)				5,700	5,561	7,895

Note: Equation (Eq)1 = $Y = 42.69 - 12.8\ D + 1.242\ D^2$
Equation (Eq)2= $Y = Exp\ \{- 2.134 + 2.530\ ln\ D\}$;
Equation (Eq)3 =$Y = Exp\ \{-3.1141 + 0.9719\ ln\ D^2 * H\}$

disturbance. From species and diameter distribution in this study (Tables 1 and 2) it was observed that the forest stands were in the early stages of succession and were recovering from previous disturbances.

Given the results of the estimate, on average, the total above-ground biomass for the entire forest reserve of 1,248 ha ranged from 250,000 to 270,000t. Accordingly, the C stock in the AHFR ranges from 100 to108 t ha^{-1}, and from 125,000 to134,000t of carbon for the entire forest reserve.

In terms of the dynamics of the biomass and C stock in AHFR, the study showed that the rate of change of TAGB ranged from 9 to13 t ha^{-1} yr^{-1} and the C stocks, from 4 to 6.5 t ha^{-1} yr^{-1} (Table 4). The rate of C sequestration was rather high, comparable with the sequestration rate of fast-growing Mahagony plantation of 3.28 t ha^{-1} yr^{-1}. Generally, forest tree plantations have an average sequestration rate of 10.01 t C ha^{-1} yr^{-1} (Lasco *et al.* 2000). Hence based on the estimate of biomass accumulation, the C sequestration for the entire 1,248 ha of AHFR amounts to 5,500 - 7,900 t yr^{-1}.

The graphical analysis of the relationship of TAGB (kg), and dbh (cm) from the three regression equations are shown in *Figs. 1a* and 1b, *Fig. 1a* for all trees > 10 cm dbh while *Fig.1b* for all trees >10 cm < 20 cm dbh.

Below-ground Biomass

Biomass for other parts of the tree (fallen leaves, twigs, branches and seeds) was categorized under the below-ground biomass pool. The soil pool was not included in the assessment because of the destructive nature of data collection. The total below-ground biomass was made up of forest litter and herbaceous and woody plants; each category was further categorized into biomass types - leaves, branches, stems and other forest debris such as composed living matters.

The below-ground biomass estimates are presented in Table 4. Out of the total below-ground biomass of over 7,000 kg ha^{-1}, about 92% was forest litter amounting to 6561.69 kg ha^{-1} (6.56 t ha^{-1}). Considering that 50% of biomass is carbon, in terms of C stock, the belowground estimate amounted to about 3.60t ha^{-1}. Excluding the soil pool in the assessment tends to underestimate the total amount of C stock in this category.

Table 5 presents the total biomass and C stock - above-ground and below-ground - in AHFR according to allometric equations 1, 2 and 3. The total forest biomass ranged from 208 to 223 t ha^{-1}, the corresponding amount of C stock ranged between 104 and 112 t ha^{-1}. Considering the three equations and both types of biomass and C stock, it was estimated that the total C stock for AHFR was between 130,400 and 138,832t.

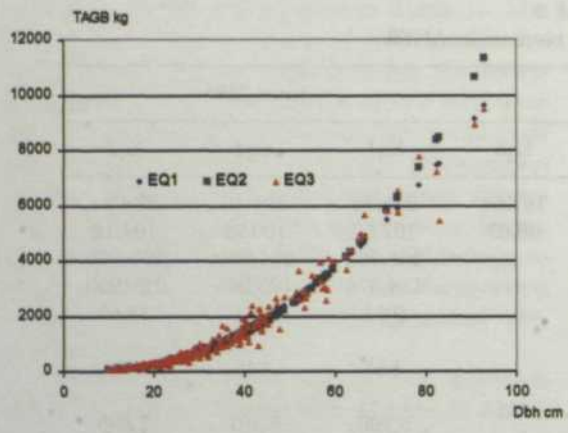

Fig. 1a: Scatterplot for all tree > 10 cm dbh

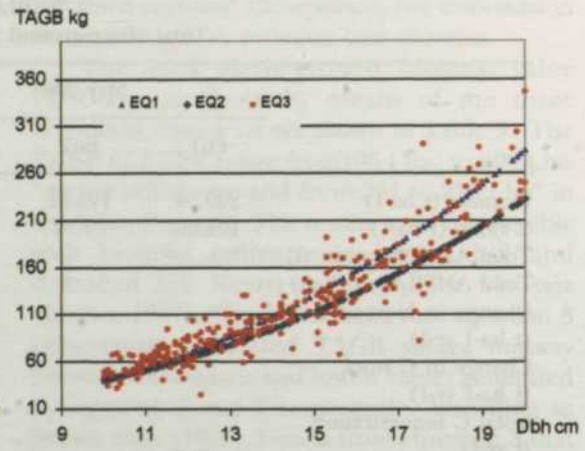

Fig. 1b: Scatterplot for all tree > 10 cm < 20 cm dbh

TABLE 4
Below-ground biomass estimate of AHFR

Sample size	Category	Unit	Biomass Type	Biomass	C stock
0.5 X 0.5 m	Forest litter	kg ha^{-1}	Leaves	1,384.89	692.45
			Branches	1,235.20	617.60
			Other	3,941.60	1,970.80
1.0 X 1.0 m	Herbaceous	kg ha^{-1}	Leaves	129.36	64.68
			Stem	323.25	161.62
2.0 X 2.0 m	Woody plants	kg ha^{-1}	Leaves	23.09	11.54
			Stem	97.38	48.69
			Branches	11.41	5.07
Total		kg ha^{-1}		7,147.19	3,573.09
Total		t ha^{-1}		7.15	3.57

TABLE 5
Total biomass and C stock in AHFR

Allometric equation	Biomass (t ha^{-1})		Total biomass (t ha^{-1})	C stock (t ha^{-1})	Total C stock AHFR (t)
	Above-ground	Below-ground			
Eq 1	215.32	7.15	222	111	138,831
Eq 2	201.46	7.15	209	104	130,407
Eq 3	208.24	7.15	215	108	134,401

Given the quantity of physical C stock, the economic value of carbon could be estimated by assigning its monetary value as outlined previously. The weighted average prices of carbon value used were USD50t^{-1}, USD4.23 t^{-1}, USD5.63 t^{-1} and €17 t^{-1}.

Table 6 provides the carbon values in various currencies, the exchange rates of the currencies as at June 2005, and the total values in local currency of C stock in AHFR according to the three equations.

The estimates show that the values of C stock ranged from MR1,653 ha^{-1} to MR 20,797 ha^{1}. The corresponding values of AHFR as a carbon sink amounted to MR 2.06 million and MR 25.96 million. In terms of the dynamics, the estimates of the value of C sequestration ranged between MR 0.088 million and MR 1.48 million yr^{-1}.

TABLE 6
Economic value of C stock in AHFR

	Carbon value (per tonne)*			
	USD$4.23	USD$5.63	USD$50.00	17.00
MR per tonne	15.82	21.05	186.95	80.66
Value of C stock	MR ha-1			
Eq 1	1,760	2,342	20,797	8,973
Eq 2	1,653	2,200	19,535	8,429
Eq 3	1,704	2,267	20,134	8,687
Total Value of C stock in AHFR		MR		
Eq 1	2,196,306	2,922,766	25,955,063	11,198,763
Eq 2	2,063,039	2,745,418	24,380,164	10,519,246
Eq 3	2,126,217	2,829,494	25,126,783	10,841,387
Value of C sequestration			RM yr-1	
Eq 1	90,174	120,000	1,065,637	459,788
Eq 2	87,975	117,074	1,039,650	448,575
Eq 3	124,899	166,211	1,476,001	636,846

Note: Exchange rate (as at June 2005)
1 US @ MR 3.68
1 Euro@ MR 4.67
* 1 tonne = 0.9842 ton

CONCLUSION

AHFR is a secondary forest that had been logged since the 1930s. The survey conducted in 2004 and repeated a year later suggested that the forest is generally at the early stage of succession and is recovering from earlier disturbances. Considering species composition in AHFR, the disturbed forest is categorized as a commercially poor forest. Hence the appropriate land use of the forest reserve is not for commercial timber production unless interventions such as replanting or enrichment plantings of commercial species are carried out. While AHFR could be ruled out as being a productive forest, it seems more appropriate to be managed for its protective services. If conserved, AHFR will continue to provide ecosystem services, one of which is as a C sink.

The study indicates that conservation of AHFR will safeguard between 130,000 t and 139,000 t forest C stock while allowing the forest to sequester C at the rate of 5500 to 7,900 t yr^{-1} in total. The rate of C sequestration is relatively high because AHFR is at the stage of rapid growth as the stands are relatively young. The assessment of the rate of C sequestration was constrained by the duration of the study. Ideally, to increase the accuracy of the results, biomass change should be observed for a number of years.

In terms of the economics, the value of AHFR as a C sink was worth between RM2 million and RM26 million, with annual incremental value varying between RM0.87 million and RM1.45 million yr^{-1}, depending on the unit price of C.

An important implication of these findings is that apart from C sink, conservation of the AHFR will protect other ecosystem services. The goal of forest management for production forests to a large extent is mutually exclusive of other protective goals. Conservation of AHFR for C sink provides joint benefit with other ecosystem services that include watershed services, wildlife sanctuary, medicinal and herbal reserves, recreational services, research and educational purposes, and for indigenous forest dwellers.

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Economic Valuation of Medicinal Plants in Ayer Hitam Forest Reserve (AHFR), Puchong, Selangor Darul Ehsan

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Keywords: Economic valuation, medicinal plants, medicinal values, resource inventory

ABSTRACT

The importance of forests has long been associated with timber rather than non-timber forest produce (NTFP) and environmental services (ESs). The interest in assigning values to these NTFP and ESs, such as medicinal plants, biodiversity protection, carbon sequestration and storage services, has increased since it was realized that forests also serve other functions that are equally important to be explored. Ayer Hitam Forest Reserve (AHFR) in Puchong, Selangor, is known to have all the treasured heritage of a rich forest. Nevertheless, due to its strategic location in combination with the current pressure for socio-economic development, the possibility of AHFR being converted into some other uses cannot be ruled out. Every effort must be made to quantify the treasures of AHFR as a centre for research and education, as well as a provider of other environmental services. To date, various scientific studies have been conducted in AHFR, including economic valuation of its timber and identification of its flora and fauna. The identification of the flora, especially medicinal plants, thus far has not involved any form of economic valuation. Results showed that the estimated total economic value of medicinal plants ranged from a low of RM67,192 to a high of RM254,255. The medicinal plant species commonly found in AHFR include tongkat ali (Eurycoma longifolia), *kacip fatimah* (Labisia pumila) *and tongkat hj. samad* (Prismatomeris *sp.*).

INTRODUCTION

Valuation of non-timber forest produce (NTFP) and environmental services (ESs) became a major interest when it was discovered that timber could no longer provide the needed revenue for continuous economic development. This is especially true for certain countries in which a majority of their coffers come from forest revenues. Put simply, to depend on timber as a sole source of revenue from the forest in the long run may no longer be a wise decision since the resource itself is getting scarcer due to increasing public demands. In order to ensure continuous economic growth, every effort must be made to seek other forms of revenue from the forest, in this case NTFP and ESs. The call to place more emphasis on not only timber but also NTFP and ESs in Malaysia has emerged with the full endorsement from the National Forest Policy (NFP) in 1978 (revised in 1992). With its main principle being sustainable management of forest resources, either the timber or NTFP and ESs, the NFP's endorsement also indirectly indicates the commitment of the Government of Malaysia (GoM) in ensuring that the protection of the environment and conservation of her rich and diverse forest resources persist over time.

Since 1978, the importance of NTFP and ESs has started to gain ground locally. Also, from that date onward, economic valuation of NTFP and ESs, such as medicinal plants and fruits, watershed protection, air-pollution reduction/abatement, biodiversity, culture, heritage and other non-use values, has gained popularity. Local empirical research on these NTFP and ESs includes studies by Woon *et al.* (1996) on petai *(Parkia speciosa)*, Norini and Mohd Azmi (2001) on the market value of tongkat ali (*Eurycoma longifolia*), Kumari *et al.* (1996) on the trade of medicinal plants in Peninsular Malaysia, Mohd Shahwahid *et al.* (1996) on the value of watershed protection versus timber production in Hulu Langat Forest Reserve (HLFR), and Kenneth *et al.* (1996) on consumer demand for forest recreation in Peninsular Malaysia.

About Ayer Hitam Forest Reserve (AHFR), Awang Noor *et al.* (1999) discussed selected economic values of the said forest reserve, such as those of timber, recreational opportunities, benefits to the local community, and wildlife resources. Timber value was estimated using the stumpage value approach, while the value of recreational benefits of AHFR was determined using the zonal travel cost method (Mohd Shahwahid *et al.*, 1998). The main objective of the study was to calculate the net social benefit by estimating the demand function of recreational opportunities of AHFR. The difficulty of attaching economic values to these NTFP and ESs is another major reason why these resources usually lose out to other land-use competitors. Above all, full recognition of NTFP and ESs does not stop with valuation but also involves disseminating these values to policy-makers. Various techniques are available for valuation of timber, NTFP and ESs, such as (a) market price or cost-based methods, (b) surrogate market methods and (c) constructed market or contingent methods (Bishop, 1996). Regardless of the technique used, the main reason for such evaluation is to indicate the increasing importance placed on NTFP and ESs in serving the well-being of the Malaysian society (Table 1). Other empirical studies carried out on AFHR focused on weedy plants, fruit trees, small mammals, mosses and herbaceous plants. Of the studies conducted so far, none has focused on giving economic value to medicinal plants found in AHFR.

The current socio-economic pressure for development, coupled with its strategic location, does not rule out the possibility of AHFR being opened up for other land development. Therefore, this paper aims at quantifying the medicinal plants available in AHFR and giving economic values to the said resources. It is hoped that such valuations will help boost the true economic value of AHFR.

MATERIALS AND METHODS

Basically, there are two main steps involved in quantifying and giving economic value to medicinal plants found in AHFR. First is an inventory of medicinal plants based on accessible compartments selected at random. Second is

TABLE 1
Evaluation techniques for market and non-market values in forestry

	Use values			Non-use values
VALUES	1. Direct	2. Indirect	3. Option	4. Existence
	Wood products (timber, fuel)	Watershed protection	Future uses as per 1 & 2	Biodiversity
		Nutrient cycling		Culture, heritage
	Non-wood products (food, medicine, genetic material)	Air pollution reduction		Intrinsic worth
		Microclimatic regulation		
	Educational, recreational & cultural uses	Carbon store		
	Human habitat			
	Amenities			
TECHNIQUES	Market prices and analysis	Production function	Contingent valuation	Contingent valuation
	Related goods & approaches	Preventive expenditures		
	Contingent valuation	Replacement costs		
	Hedonic price			
	Replacement costs			

Source: Bishop (1996)

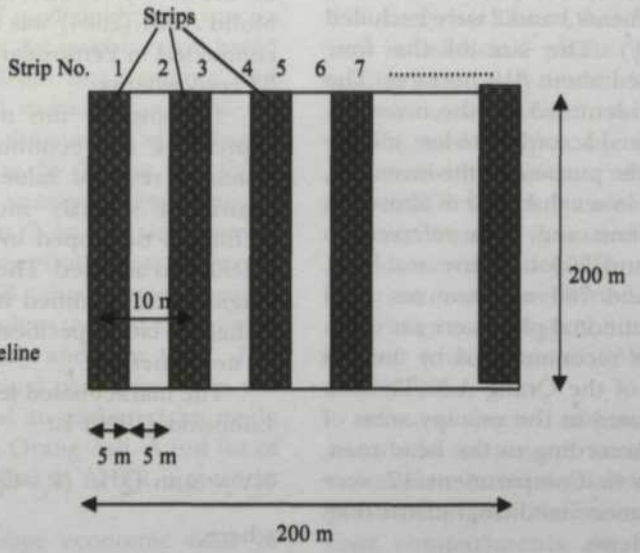
the computation of the economic value based on a survey of medicinal plants collectors carried out by Mohd Azmi in 2004. Two separate techniques were used in conducting the inventory, namely, the techniques popularized by Awang Noor and Mohd Shahwahid (1995) and Norini and Mohd Azmi (2001).

Inventory Based on the Strip-Line Approach

The technique improvised by Awang Noor and Mohd Shahwahid (1995) involved setting up an inventory block measuring 200 m by 200 m (*Fig. 1*). The inventory block was further divided into 40 strips measuring 5 m by 200 m. For the purpose of this inventory, only alternate strips were fully inventoried. This included measuring all medicinal plants of height 1 foot and above.

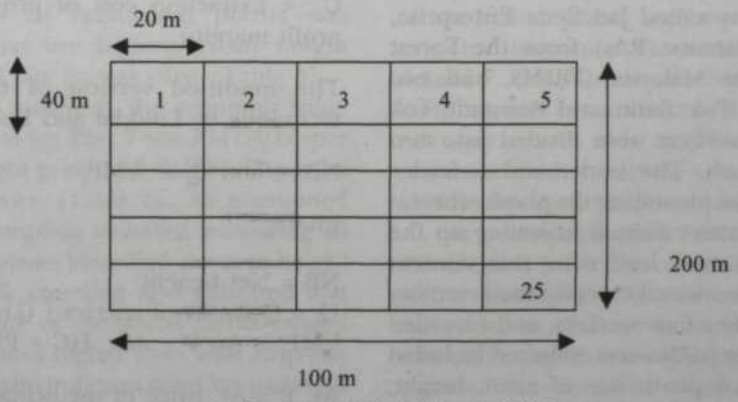
Inventory Based on the Sub-blocks Approach

On the basis of an earlier inventory technique developed by Awang Noor and Mohd Shahwahid (1995), Norini and Mohd Azmi (2001) further modified the size of the main inventory block into a 200 m by 100 m block (*Fig. 2*). The main inventory block was further divided into another 25 sub-blocks measuring 20 m by 40 m each. Using a slightly different approach, Norini and Mohd Azmi (2001) suggested that all medicinal plants in the 25 sub-blocks should be inventoried. The main inventory block was divided into sub-



Source: Awang Noor and Mohd Shahwahid (1995)

Fig. 1: An inventory block measuring 200 m by 200 m



Source: Norini and Mohd Azmi (2001)

Fig. 2: An inventory block measuring 100 m by 200 m

blocks for better monitoring of the data-collection process. Hence, once the inventory of a compartment was completed, the medicinal plants that were recorded could easily be cross-checked with a few plots chosen at random. The setting up of a sample plot was in line with the direction of the compartment, i.e. facing north.

Selection of Areas to be Inventoried

To be able to get a good indication of the availability of medicinal plant resources in AHFR, the selection of areas to be inventoried should have covered all compartments. However, because of budget constraints and problems of accessibility, only four of the six compartments were inventoried, namely Compartments 12, 13, 14 and 15 (Compartments 1 and 2 were excluded from the inventory). The size of the four compartments totalled about 919 hectares. The four compartments identified for the inventory were further categorized according to low, middle and high lands. For the purpose of the inventory, low referred to land lower than 400 m above sea level, whereas medium and high referred to land between 400 and 500 m above sea level, and between 500 and 700 m above sea level respectively. Two additional plots were set up in Compartment 12, as recommended by the *Tok Batin* or head man of the Orang Asli. The two extra plots were located in the swampy areas of the forest reserve. According to the head man, these swampy areas in Compartment 12 were believed to contain more medicinal plants than the other compartments.

The Inventory Group

The inventory was carried out by 10 workers (i.e. 1 leader, 1 co-leader and 8 field workers) from a private company called Jati Sena Enterprise, two research assistants (RAs) from the Forest Research Institute Malaysia (FRIM), and two Orang Asli (i.e. Tok Batin and Assistant Tok Batin). The 10 workers were divided into two groups of five each. The leader and co-leader were responsible for identifying the plants, whereas the other two workers assisted in setting up the plots. The appointed leader in this context conducted the inventory, i.e. set up the inventory block with the other four workers, and recorded all of the data. The parameters collected included types of medicinal plant, size of stem, height, crown width and other related information (Appendix 1). The Tok Batin, Assistant Tok Batin, and the two RAs were responsible for identifying the medicinal plants. Three perspectives, namely botanical, local and Orang Asli names, were noted. All in all, the inventory took about a month to complete.

Valuation of Medicinal Plants

In the preceding paragraphs, the two inventory techniques used in the study were explained. The next crucial step was to translate the quantity of medicinal plants collected into value. To be able to estimate the value of medicinal plants, information on average price per kilogram, average harvesting cost, and profit margin had to be made available. For this study, information on the survey of collectors conducted earlier by Mohd Azmi (2004) was utilized. The survey was conducted in Peninsular Malaysia with a total of 33 respondents.

To estimate the net benefit, which also represents the economic standing stock or potential residual value of the said medicinal plants, a slightly modified market-based technique developed by Linddal and Luboswki (1999) was adopted. The difference between the original and modified market-based techniques is that the latter specifically details the calculation of net benefit.

The market-based technique by Linddal and Luboswki (1999) is:

$$NV = \text{Sum } Q_i \times (P_i - C_i)$$

where,

NV = Net value
Q_i = Quantity of product i
P_i = Price of product i
C_i = Extraction cost of product i (including profit margin)

The modified version of the market-based technique by Linddal and Luboswki (1999) is:

$$NB = \text{Sum } Q_i \times VMP_i$$

where,

NB = Net benefit
Q_i = Quantity of species i (i.e. stock)
VMP_i = Av. P - (Av. HC + PM)

Av. P = Av. price of medicinal plants per kg
HC is the average of harvesting cost
PM is the profit margin

VMP_i is actually the value of medicinal plant species per kg.

RESULTS AND DISCUSSION

Analysis indicated that there were no significant differences between the numbers of species identified based on location, i.e. low, medium and high lands. For instance, using strip-line sampling, 10 species were identified in Compartment 15 located on the low land, whereas another 10 and 7 species were identified in Compartments 13 and 15 located on the medium and high lands respectively (Table 2). In other words, the number of species identified did not vary much with regard to location above sea level.

Similar numbers of medicinal plant species also were observed when the inventory was based on a 100% sampling from low, medium and high lands (Table 3). A quick look at Tables 2 and 3 also indicates that the number of medicinal plant species seemed to be higher for those plots located in the swampy areas, namely Compartment 12 (Plots 7 and 8) inventoried using the two techniques. Both plots indicated more than 166 and 763 other species, besides the common species, such as tongkat ali, tongkat hj. samad, tapak sulaiman and akar lepar. The large number of medicinal plants found in the swampy areas confirmed an earlier claim made by the Tok Batin of the Orang Asli. A full list of medicinal plants identified in AHFR is given in Appendix 2.

The estimated average economic value of medicinal plants based on a strip-line inventory of all eight plots was RM26,556.80 (i.e. average green weight price per ha multiplied by 1,248 ha, the total size of AHFR). The highest estimated economic value of medicinal plants was RM96,894.72 when the highest green weight price of RM77.64 per ha was used (Table 4).

With a 100% sampling, the economic value of medicinal plants for Plot 7 was RM770.66 per ha for green weight price and RM385.33 per ha for dry weight price (Table 5). As mentioned earlier, a 100% sampling included measuring all of the medicinal plants identified down to height of 1 foot. A 100% sampling also indicated that the economic value of medicinal plants ranged from 3.5 to 1.3 times higher than with strip-line sampling. Table 5 also indicates that Compartment 12 seemed to have a higher value for medicinal plants of between RM46.85 per ha and RM770.66, per ha. This valuation implied that Compartment 12 is richer in medicinal plants than other compartments. The average economic value for medicinal plants, after excluding the two extreme values (RM1.83 per ha from Plot 2, Compartment 13, and RM770.66 per ha from Plot 7, Compartment 12), was estimated to be RM53.84 per ha. Therefore, with a total area of 1,248 ha, the total economic value of medicinal plants in AHFR was approximately RM67,192.32. A much higher total economic value of medicinal plants of RM254,255.00 was obtained when the higher economic green weight price of RM203.75 per ha was used.

CONCLUSION

The study has shown that AHFR is substantially rich in medicinal plants. The medicinal plant species commonly found, including tongkat ali (*Eurycoma longifolia*), kacip fatimah (*Labisia pumila*) and tongkat hj. samad (*Prismatomeris* sp.), and with addition of other species, indicated that AHFR is rich in resources. Analyses also indicated that the estimated total economic value based on six plots from four of the six compartments inventoried based on a 100% sampling, excluding the two extreme values, ranged from a low of RM67,192 to a high of RM254,255.

One of the two additional plots, i.e., Plot 7 located in the swampy area, had a much higher economic value of medicinal plants of RM770.66 per ha than the other seven plots found in the four compartments. In fact, the estimated economic value of Plot 8 (RM46.85 per ha), also located in the swampy area, was higher than that of the rest of the plots, except for Plot 4, Compartment 12 (Table 5). The economic value of medicinal plants was much lower when a strip-line inventory was used. Because of the detailed information derived from a 100% sampling and because the cost of inventory does not vary much with strip-line sampling, it is recommended that such a sampling technique (100%) be used for inventorying small plants.

As mentioned earlier and again stressed in this section, to be able to get a good indication of the availability of medicinal plant resources, the selection of areas to be inventoried should cover all compartments. Above all, the different types of location also need to be sufficiently replicated. Such an approach would not only be representative of the inventory results but also

TABLE 2

Inventory of medicinal plant species in Ayer Hitam Forest Reserve, Puchong (based on strip-line sampling)

Compartment	Plot	Location	No. of medicinal plant species identified	Common species identified	Botanical name	Local name	Name as quoted by Orang Asli
13	3	Medium	10	Tongkat hj. samad (2)	*Prismatomeris sp.*	Tongkat hj. samad	Tongkat hj. samad
				Tongkat ali (4)	*Eurycoma longifolia*	Tongkat ali	Pasak bumi
				Kembang semangkok (14)	*Scaphium affinis*	Jarak hutan, renung	Meluar
				Pecah kelambu (16)	*Cordyline fruticosa*	Pecah kelambu	Jejuang
				Others (57)			
12	4	Medium	12	Akar ipoh (9)	*Strychnos ovalifolia*	Akar ipoh	Ipoh malai
				Tongkat ali (3)	*Eurycoma longifolia*	Tongkat ali	Pasak bumi
				Kembang semangkok (7)	*Scaphium* ssp.	Jarak hutan, renung	Meluar
				Pecah kelambu (14)	*Cordyline fruticosa*	Pecah kelambu	Jejuang
				Others (22)			
12	7*	Low	16	Tongkat ali (2)	*Eurycoma longifolia*	Tongkat ali	Pasak bumi
				Tongkat hj. samad (6)	*Eugenia dyeriana*	Tongkat hj. samad	Tongkat hj.samad
				Tapak sulaiman (20)	*Elephantopus scaber*	Tapak sulaiman	Tapak badak
				Akar lepang (21)	*Bauhinia* ssp.	Akar lepang	Akar lepang
				Others (77)			

Note: "*" denotes swampy area.

TABLE 2 (Continued)

Compartment	Plot No.	Location	No. of medicinal plant species identified	Common species identified	Botanical name	Local name	Name as quoted by Orang Asli
15	1	Low	10	Tongkat ali (8)	*Eurycoma longifolia*	Tongkat ali	Pasak bumi
				Pokok ipoh (9)	*Strychnos ovalifolia*	Pokok ipoh	Ipoh balai
				Mempelas (9)	*Delima scandens*	Mempelas	Sepelas bulu
				Merian (7)	*Ardisia* ssp.	Merian	Merian kayu
				Others (24)			
15	5	High	7	Tongkat ali (11)		Tongkat ali	Pasak bumi
				Paku miding (14)		Paku miding	Paku seleleh
				Jelai (10)		Jelai	Paku lagu
				Pokok ipoh (8)		Pokok ipoh	Ipoh malai
				Others (14)			
12	2	Low	13	Tongkat ali (3)		Tongkat ali	Pasak bumi
				Kacip fatimah (7)		Kacip fatimah	Merian batu
				Tongkat haji samad (2)		Tongkat haji samad	Tongkat haji samad
				Kembang semangkok (27)		Kembang semangkok	Meluar
				Others (68)			
12	8*	Low	22	Tongkat ali (7)		Tongkat ali	Pasak bumi
				Tongkat haji samad (27)		Tongkat haji samad	Tongkat haji samad
				Tapak sulaiman (50)		Tapak sulaiman	Tapak badak
				Pecah kelambu (67)		Pecah kelambu	Jejuang
				Others (208)			
14	6	High	15	Tongkat ali (14)		Tongkat ali	Pasak bumi
				Tongkat haji samad (6)		Tongkat haji samad	Tongkat haji samad
				Kacip fatimah (16)		Kacip fatimah	Merian batu
				Pecah kelambu (34)		Pecah kelambu	Jejuang
				Others (120)			

Note: "*" denotes swampy area.

TABLE 3

Inventory of medicinal plant species in Ayer Hitam Forest Reserve, Puchong (based on 100% sampling)

Compartment	Plot No.	Location	No. of medicinal plant species identified	Common species identified	Botanical name	Local name	Name as quoted by the Orang Asli
13	3	Medium	20	Tongkat hj. samad (2)		Tongkat hj. samad	Tongkat hj. samad
				Tongkat ali (9)		Tongkat ali	Pasak bumi
				Kacip fatimah (3)		Kacip fatimah	Merian kayu
				Pecah kelambu (21)		Pecah kelambu	Jejuang
				Others (126)			
12	4	Medium	22	Tongkat hj. samad (5)		Tongkat hj. samad	Tongkat hj. samad
				Tongkat ali (11)		Tongkat ali	Pasak bumi
				Kembang semangkok (12)		Jarak hutan, renung	Meluar
				Pecah kelambu (21)		Pecah kelambu	Jejuang
				Others (117)			
12	7*	Low	19	Tongkat ali (6)		Tongkat ali	Pasak bumi
				Tongkat hj.samad (27)		Tongkat hj. samad	Tongkat hj. samad
				Tapak sulaiman (39)		Tapak sulaiman	Tapak badak
				Akar lepang (37)		Akar lepang	Akar lepang
				Others (166)			

Note: "*" denotes swampy area.

TABLE 3 (Continued)

Compartment	Plot No.	Location	No. of medicinal plant species identified	Common species identified	Botanical name	Local name	Name as quoted by Orang Asli
15	1	Low	15	Tongkat ali (8)		Tongkat ali	Pasak bumi
				Paku miding (52)		Paku miding	Paku seleleh
				Kacip fatimah (7)		Kacip fatimah	Merian batu
				Pokok ipoh (19)		Pokok ipoh	Ipoh malai
				Others (66)			
15	5	High	9	Tongkat ali (35)		Tongkat ali	Pasak bumi
				Merian (13)		MerianMerian kayu	
				Paku miding (11)		Paku miding	Paku seleleh
				Mempelas (7)		Mempelas	Sepelas bulu
				Others (11)			
12	2	Low	15	Tongkat ali (2)		Tongkat ali	Pasak bumi
				Tongkat haji samad (3)		Tongkat haji samad	Tongkat haji samad
				Pecah kelambu (14)		Kembang semangkok	Meluar
				Kacip fatimah (8)		Pokok ipoh	Ipoh malai
				Others (60)			
12	8*	Low	23	Tongkat ali (20)		Tongkat ali	Pasak bumi
				Tongkat haji samad (54)		Tongkat haji samad	Tongkat haji samad
				Tapak sulaiman (259)		Tapak sulaiman	Tapak badak
				Pecah kelambu (187)		Pecah kelambu	Jejuang
				Others (763)			
14	6	High	16	Tongkat ali (32)		Tongkat ali	Pasak bumi
				Tongkat haji samad (9)		Tongkat haji samad	Tongkat haji samad
				Kacip fatimah (51)		Kacip fatimah	Merian batu
				Pecah kelambu (89)		Pecah kelambu	Jejuang
				Others (376)			

Note: 1. "*" denotes swampy area.

2. Others in Plot 3, Compartment 13, include akar ipoh (*Antiaris toxicaria*), jelai (*Helminthostachys zeylanica*), paku miding (*Stenochlaena palustris*), lemba (*Curculigo latifolia*) and mempelas (*Tetracera scandens*).

3. Figure in brackets denotes number.

TABLE 4
Economic value of medicinal plant species, AHFR, Puchong Selangor (based on strip-line sampling)

Compartment	Plot No.	Location	Economic value(RM)- green weight		Economic value(RM)- dry weight
			2 ha	1 ha	1 ha
15	1	Low (<400 m)	19.83	9.92	4.96
13	2	Low (<400 m)	2.72	1.36	0.68
13	3	Medium (400-500 m)	11.28	5.64	2.82
12	4	Medium (400-500 m)	118.46	59.23	29.62
15	5	High (700 m)	6.61	3.31	1.66
14	6	High (700 m)	15.66	7.83	3.92
12	7*	Low (<400 m)	155.28	77.64	38.82
12	8*	Low (<400 m)	10.74	5.37	2.69
Total			340.58	170.30	85.17

Note: Av. Price = RM9.50; Av. HC+PM =RM3.88; VMP=RM5.62 per kg.
Note: "*" denotes additional plots
"1" denotes conversion factor (green weight to dry weight = 50%) (Mohd. Azmi 2004)

TABLE 5
Economic value of medicinal plant species, AHFR, Puchong Selangor (based on 100% sampling)

Compartment	Plot No.	Location	Economic value (RM)- green weight		Economic value (RM)-dry weight
			2 ha	1 ha	1 ha
15	1	Low (<400 m)	26.02	13.01	6.51
13	2	Low (<400 m)	3.66	1.83	0.92
13	3	Medium (400-500 m)	28.33	14.17	7.09
12	4	Medium (400-500 m)	407.50	203.75	101.88
15	5	High (700 m)	46.50	23.25	11.63
14	6	High (700 m)	44.06	22.03	11.02
12	7*	Low (<400 m)	1,541.32	770.66	385.33
12	8*	Low (<400 m)	93.69	46.85	23.43
Total		2191.08	1,095.55	547.81	

ensure reliability. This study was intended to provide an indication of economic values of medicinal plants found in AHFR. Such results are of paramount importance as this adds a value to existing values of other non-timber resources quantified by earlier researchers.

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APPENDIX 1

Inventory of tongkat ali (*E. logifolia*) and other medicinal plants

1. State:
2. District:
3. Forest Reserve:
4. Compartment:
5. Block size:
6. Plot No:
7. Type of forest:
8. Headman:
9. No. of crew:
10. Date of inventory:
11. Time in:
12. Time out:
13. Location of mother plane: plot No.:

No.	Type of medicinal plant	Distance from mother plant	Size of stem	Height	Crown width	Leaf		Stem	Flower	Fruits
						Width	Length	Length	No. per tree	No. per tree

Source: Awang Noor and Mohd Shahwahid (1995)

APPENDIX 2
Names of medicinal species in H.S. Ayer Hitam, Puchong, Selangor

No	Local Name	Scientific Name	Orang Asli Name
1	Kembang semangkok	**Scaphium sp.*	Jarak hutan, Meluar, Renung
2	Mempelas	**Tetracera scandens*	Sepelas bulu
3	Jelai	**Helminthostachys zeylanica*	Paku telentang, Paku laga
4	Pecah kelambu	**Dracaena elliptica*	Jejuang
5	Tongkat ali	**Eurycoma longifolia*	Pasak bumi
6	Tongkat haji samad	**Prismatomeris sp.*	Tongkat haji samad
7	Akar ipoh	**Antiaris toxicania*	Ipoh malai
8	Palas	**Licuala kunstleri*	Kelapa puyuh
9	Lemba	**Curculigo latifolia*	Lemba batu
10	Resam	**Gleichenia linearis*	Resam
11	Belimbing batu betina	**Averrhoa carambola*	Kemoyan betina
12	Kancing anjing	**Sclerophyrum pentandrum*	Kancing anjing
13	Merian	**Ardisia elliptica*	Merian kayu
14	Kacip fatimah	**Labisia pumila*	Merian batu
15	Kekunyit	**Coscinium blumeanum*	Kekunyit
16	Pandan tikus	**Freycinetia montana*	Pandan tikus
17	Paku miding	**Stenochlaena palustris*	Paku seleleh
18	Tapak kuda	**Bauhinia sp.*	Akar lepang
19	Tapak sulaiman	**Elephantopus scaber*	Tapak badak
20	Kemoyan jantan	**Homalomena griffithii*	Kemoyan jantan
21	Rancang besi	**Freycinetia mallaccensis*	Rancang besi

* *Source:* Burkill (1935)

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Introducing Stakeholder Analysis in Malaysian Forestry – The Case of Ayer Hitam Forest Reserve

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Keywords: Cognitive mapping, oval mapping, SODA, stakeholder analysis

ABSTRACT

Environmental management problems involving many stakeholders are complex in nature. Often, some of the stakeholders are not consulted in the decision-making process leading to problems and conflicts. Furthermore, conventional methods such as local citizen meetings on problem solving do not adequately address stakeholder interests. These conflicts can be resolved by agreement on collaborative management of natural resources. Stakeholder analysis can provide negotiated options leading to conflict resolution. A study was conducted to examine various concerns and issues relating to the management of Ayer Hitam Forest Reserve (AHFR) using the cognitive approach. The stakeholders were interviewed and cognitive maps of issues were drawn. Then the stakeholders discussed the issues and reached consensus on a prioritized list of issues. The stakeholders were then presented with the economic valuation of timber and non-timber resources of AHFR and were asked to reprioritize the issues and rank them again. The stakeholders ranked the ecological role of forest as the most important while the use of forest as a social-cultural heritage was ranked the least important. The information on the value of conservation and non-timber products of the forest presented during the second workshop has influenced the stakeholders thus allowing them to reconsider the issues. This new list would be used as a basis for the management of the Ayer Hitam Forest Reserve.

INTRODUCTION

The increased awareness of the environment of different groups within the Malaysian society has led to changing perspectives on environmental issues and natural resource management. The number of protest letters written to newspapers on environmental issues also indicates that this awareness has translated into attitudinal change and action. This has resulted from the dissatisfaction of the masses leading to problems for the decision-makers in trying to implement developmental projects.

Environmental management problems involve many stakeholders and natural resources and therefore are complex in nature. Often some of the stakeholders are not consulted in the decision-making process resulting in difficulties and conflicts. Furthermore conventional methods such as town-hall meetings do not adequately address stakeholder interests. These conflicts can be resolved by dialogue and agreement on collaborative management of natural resources.

Resource managers and people involved in making policy need to keep abreast of changing values. They need to know which segment of the society supports or opposes given policies or management prescriptions. They also need to know how different groups are affected by policy change. Hence better understanding of the political, social and economic aspects of a specific management option is of increasing importance. And more dialogues and communications between the resource managers, policy-makers and society are needed to develop better understanding among these players.

Stakeholder analysis can provide negotiated options leading to conflict resolution. Many studies have been conducted to see how stakeholder analysis can be used to resolve natural resource problem (De Lopez, 2001, Ravnborg and Westermann, 2002). Stakeholder analysis can be defined as an approach to understanding a system by identifying the key actors or stakeholders in the system, assessing their respective interests in that system and examination of inherent conflicts, compatibilities and trade-offs (Grimble and Wellard, 1997). These identified conflicts will be mediated through dispute resolution, consensus building or other mechanisms for stakeholder involvement.

Stakeholder analysis was first used in business to understand stakeholder interests with society and to search for better prospects of financial success (Chevalier, 2001). It is also a response by the business sector to deal with increasingly complex social systems in which modern corporations have to operate (Grimble and Chan, 1995). This approach is further enhanced by Freeman and Gilbert, Jr. (1987) who acknowledge the importance and the need to manage the stakeholder, thus the term stakeholder management. Grimble and Chan (1995) suggest guidelines on stakeholder analysis for natural resource management to be effective.

In Malaysia, stakeholder analysis of forest resource management is new and not much work has been done. The aim of this paper is to report a case study where stakeholder analysis was applied in the multiple-use management of Ayer Hitam Forest Reserve (AHFR), Selangor.

DESCRIPTION OF THE STUDY AREA

AHFR in Puchong is a lowland dipterocarp forest under the management of the Central Selangor District Forest Office. The forest is about 25 km from Universiti Putra Malaysia (UPM) and approximately 45 km from Kuala Lumpur. The size of AHFR is approximately 1,248 ha, consisting of compartments 1, 2, 12, 13, 14 and 15. The State Government of Selangor leased the forest to UPM for the purposes of teaching, research and extension.

Physical Environment

AHFR is a lowland dipterocarp forest with altitude between 15 and 233 m above mean sea level. The highest peak in the forest is located in Permatang Kumbang. The slopes of the forest area range between 10 and 20%. In general, the topography of the forest is undulating. In terms of its river system, AHFR is dissected by two major rivers, Rasau River on the southern half and Bohol River on the northern side.

The temperature in AHFR ranges between 22.9 and 27.7 oC; the mean daily temperature is about 25.3 oC. The relative humidity of the area ranges from 59 to 96%, and the mean daily relative humidity is about 83% (Ainuddin and Salleh, 1999).

Geologically, the forest area is covered with igneous rock; the primary component is granite. The inner soil layer has metamorphic primary matter and ferro-magnesium as secondary matter. The soil series of the area are classified as Serdang-Kedah and Serdang-Bungor-Munchong which consist of a combination of local alluvium formed by metamorphic rock.

Flora

AHFR is a logged-over forest that has not fully recovered. It is a fragmented forest that is rich in plant species. According to Faridah (1999), there are 430 species of seed plants from 203 genera and 72 families. Of all the species 20 are endemic to Peninsular Malaysia, whereas 5 have been recorded in Selangor. In addition, there are 33 species of ferns, and 98 species of medicinal plants. The indigenous people from the Temuan group use almost all of these medicinal plants for more than 140 purposes.

Fauna

AHFR is also rich in fauna diversity. Studies indicate that there exist more than 160 species of birds from 38 families. Three families representing almost 24% of the population are Timaliidae, Cuculidae and Pycnonotidae. In terms of trophic structures/groups, the forest is dominated by the insectivore/frugivore groups, especially from the Pycnonotidae family (Zakaria and Abdul Rahim, 1999). With regard to mammals, the forest has been reported to have 5 species of large primates from the lotong, ungka, beruk and kera genera. Research conducted in the area showed that there are 14 species of small mammals, not including the bat, and 10 genera of 5 families and 3 orders. The species include 6 rats, 4 squirrels, 3 insectivores, and 1 primate. A total of 13 species of bats have been found. Besides that, there also exist 10

species of reptilia, 18 species of amphibia, and 10 species of fish. In terms of insects, the largest number of species in the forest belongs to the order Hymenoptera. Other orders which have higher individuals are Collembola, Isoptera and Coleoptera (Sajap *et al.*, 1999).

Location

AHFR is surrounded by various developments (*Fig. 1*). To the north, the forest is bounded by Kinrara township. On the west side of the forest is Puchong, a housing and township development, while the southern boundary of the forest faces Putra Jaya, the new government administrative centre. On the eastern side of AHFR lies recently built townships such as Equinine Park and Putra Permai.

The AHFR vicinity near Putrajaya has generated a lot of interest from the corporate sector and politically connected individuals. Their aim is to convert AHFR into another sprawling new township. Indeed, the agency that is responsible for AHFR has received numerous proposals to convert the forest into other types of land use. On the other hand, the Orang Asli and the communities around AHFR would like to maintain the reserve as it is because they have benefited from the forest. These conflicting uses may be detrimental to AHFR, unless a mechanism is set up to resolve the problem.

AHFR is leased to the Universiti Putra Malaysia for 88 years as a research and educational forest. Harvesting activities are not allowed in this forest. AHFR is being used as an outdoor laboratory by the Faculty of Forestry students and also as two weeks mandatory forestry camps for both Forestry Diploma and Bachelor programmes. Research activities are also conducted here by UPM and other agencies such as the Forest Research Institute of Malaysia (FRIM). All these activities are coordinated by the forest conservator of the Faculty of Forestry, UPM, and must follow the guidelines in the AHFR management plan.

AHFR is also being used by the residents of these townships for recreational and physical activities such jogging. However, these usages have been stopped because the area has been fenced along the AHFR perimeter to prevent encroachment. This has created resentment among the residents.

The multiple uses of AHFR by different stakeholders may lead to disputes in the future and it is important to understand the needs of different stakeholders for the forest. One of the approaches is to use stakeholder analysis to identify interested parties and to understand their needs in using the AHFR. Only by understanding the stakeholders' interests and needs can the manager develop a comprehensive management plan that addresses them.

Fig. 1: An aerial view of Ayer Hitam Forest Reserve (AHFR)

METHODS

In the stakeholder analysis two workshops were conducted. In the first workshop the stakeholders were invited and interviewed by the researchers and their ideas were mapped into network of concepts and issues that were linked to form chains of argumentation. The concepts and issues were aggregated, linked and prioritized. This approach which is called cognitive mapping has been used by many authors to analyse policy (Eden and Ackermann, 2004), public participation (Hjortso 2004) and stakeholder analysis (Ainuddin *et al.*, 2005).

The critical success factor in ensuring meaningful outcomes of the cognitive group mapping approach is the participation of all relevant groups of stakeholders. This is to make sure that issues, trade-offs, conflicting interests and their justifications, constraints, opportunities and other influential factors are all taken into consideration and thoroughly deliberated in the discussions before consensus building is achieved. In the first workshop held on 16 to 17 March 2004, efforts were taken to bring in relevant stakeholders of various backgrounds. Although, a number of important stakeholders could not make it to the workshop, the deliberations have been very open and productive.

The stakeholders were interviewed about their views on the usage of AHFR and what roles they could play to ensure they continue to benefit from AHFR. Their responses were mapped using the cognitive mapping technique. The maps were later discussed by the facilitators and the issues raised by the stakeholders were aggregated into issues. This was to avoid overlapping and redundancy among the issues. The next day, the aggregated issues were presented to the stakeholders and discussed. After getting feedback from the stakeholders, some of the issues were reworded to bring more clarity to the statements. The issues were then prioritized and ranked by the stakeholders (*Fig. 2*).

In the second workshop held on 23 February 2005, the same participants were invited and were enlightened on the valuation of timber and non-timber resources of AHFR including recreation, carbon sequestration and medicinal plants. At the end of the second workshop they were again asked to rank the issues that were given in the first workshop.

RESULTS AND DISCUSSION

Stakeholders of Ayer Hitam Forest Reserve

As mentioned earlier, there are various government agencies, groups and individuals who are interested in and want to influence the usage and decisions regarding AHFR. These are called stakeholders that may have conflicting uses of AHFR. Table 1 lists the stakeholders of AHFR.

Stakeholders' Roles

The stakeholders' range from the Selangor Forestry Department, which is the state agency responsible for safeguarding the forest, to the individual Orang Asli who depends for his livelihood on the forest. They can be classified into government agencies, educational

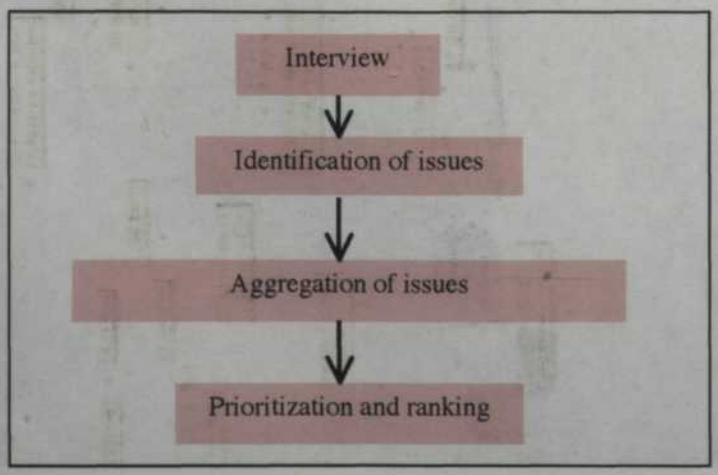

Fig. 2: Flowchart in the stakeholder analysis using cognitive mapping

TABLE 1
Stakeholders of Air Hitam Forest Reserve interviewed in this study

Stakeholder	Type
Selangor Forestry Department	Government agency
Selangor Wildlife Department	Government agency
Department of Urban and Rural Planning	Government agency
Orang Asli community	Local community
Taman Lestari Puchong community	Local community
Bandar Kinrara community	Local community
Majlis Perbandaran Subang Jaya	Government agency
Bandar Kinrara	Corporate institution
Malaysian Nature Society	Non-government organization

institutions, corporate institutions, non-government organizations and local communities.

Stakeholders that fall under government agencies play the role of managers of the forest and are involved in protection and conservation of the flora and fauna of the forest. The Selangor Forest Department is the agency responsible for the forest. One of its major activities is monitoring encroachment of the area. To date the department has erected fences along the border of AHFR. The department also monitors forest management activities conducted in AHFR. The Wildlife Department, on the other hand, is responsible for the conservation and the protection of wildlife present in AHFR. There were a few times when teams from the Wildlife Department had gone into AHFR to survey the existence of big mammals.

AHFR is under the jurisdiction of Subang Jaya Urban Council (MPSJ) which has designated AHFR as a green area in its structural plan. Its role is also to make sure that AHFR is maintained as a green area. The Department of Urban and Rural Planning (JPBD) is a government agency which develops the National Physical Plan (NPP) and also the structural plan with MPSJ.

Communities in the townships and villagers around AHFR perceive the forest as a valuable resource to ameliorate the harsh urban climate. It is a place where they can go for recreation at the waterfalls and streams in the forest. During weekends AHFR has many visitors even though admittance into the forest is being restricted. The Orang Asli living near AHFR have been using this forest as the source of their medicinal supplies for many generations. Here they still find many herbal species which can be used as health remedies.

Corporate institutions owe their existence to the bottom line, i.e. all projects undertaken should result in profit. With this in view, these companies see AHFR as a big land bank that could be converted into housing estates and urban development. There have been many such proposals forwarded to the agency concerned, raising doubts as to the survival of AHFR in the future. Unless the corporate institutions understand the socio-environmental and educational roles of AHFR, their perceptions of AHFR would be negative.

Non-governmental organizations such as the Malaysian Nature Society play an important role in raising public awareness of environmental issues. They view AHFR as an important green lung and wildlife corridor joining the north and south of Klang Valley which therefore needs to be conserved. With their grassroots support and organizational ability, their role would greatly help the conservation of AHFR.

Stakeholders Interviews and Cognitive Maps

In the first workshop the stakeholders responses were mapped using the cognitive mapping technique. The maps were developed using a software called Decision Explorer®. The casual points were written in blue with arrows pointing to green rectangles designated as concerns. These concerns led to red rectangles designated as issues. The issues led to the uses of AHFR. The cognitive maps were later collected and discussed by the facilitators and the issues were aggregated into 13 groups. *Fig. 3* shows the combined cognitive map of all the stakeholders.

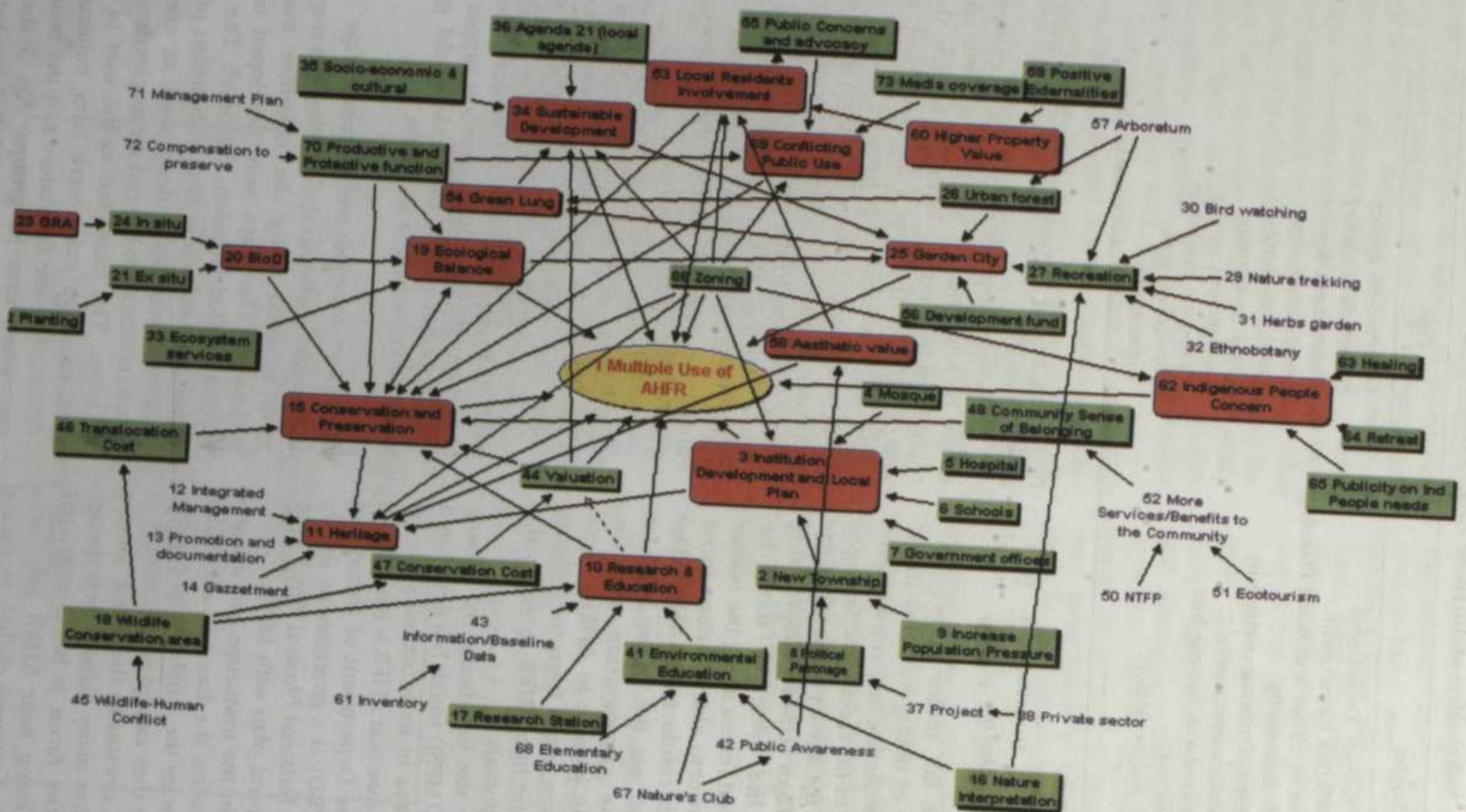

Fig. 3: Cognitive map of all the stakeholders combined

Next, the aggregated issues were presented to the stakeholders and discussed. After getting feedback from the stakeholders, some of the issues were reworded to bring more clarity to the statements. The issues were then prioritized by the stakeholders (Table 2). The top three top ranking issues were education of the public on nature, ecological balance/use and research while the last three were indigenous peoples' concerns, wilderness and exploitation of nature theme for development.

The ranked issues of the second workshop are presented in Table 3. The three top ranking issues were ecological balance, sustainable balance and green lung. There were slight changes compared with the last workshop; the issue on sustainable development rose to the second ranking and research fell into the fifth ranking. The last three ranking issues were wildlife refuge, aesthetic value and socio-cultural heritage. These different rankings were due to the additional information given during the second workshop where the non-timber values of AHFR were presented. Furthermore there were also more time for the stakeholders to discuss the issues pertaining to the uses of AHFR.

The thirteen issues identified during the workshops show that different stakeholders have different issues regarding how they want to use AHFR. Previously, the uses of AHFR were only from the perspective of the State Forestry Department. Based on the second workshop, the number one ranking (i.e. most important) issue was the role of the forest as an ecological balance/use serving as a buffer against the concrete jungle and in the amelioration of the urban environment. The role of forest in urban areas is becoming more significant because of the increasing environmental awareness of the public with more calls being made by the urban community to preserve green areas and to discourage tree cutting in the urban areas (Akbari *et al.*, 2001). In fact the third ranking issue of green area further strenghtens this argument.

The second most important issue ranked by the stakeholders was sustainable development of AHFR. The stakeholders recognized that other than ameliorating the environment there are other activities that can be conducted in the forest with minimal disturbances. Activities such as those concerning conservation of biodiversity, medicinal plants and recreation are examples causing minimal disturbances to the forest. This is in line with the local agenda 21 which the local government authorities must adhere to.

The stakeholders also recognized the importance of the forest to the indigenous community by ranking it seventh.. The forest serves as a place where the indigenous people spend days or weeks for their spiritual retreat trying to recuperate from the stress of urban life. They also depend on AHFR as their pharmacy where they can get their medicine when afflicted with ailments.

The last three ranking issues from the stakeholder analysis relate to the socio-cultural aspects of the forest. Putting near the bottom the issue of AHFR as a refuge for wild animals,

TABLE 2
Ranking of issues after the first workshop

No.	Issue	Rank
1.	Education of public on nature	1
2.	Ecological balance/use	2
3.	Research	3
4.	Green lung area/environmental use	3
5.	Wildlife survival - as a refuge	4
6.	Aesthetic value	4
7.	Local community use	5
8.	Recreation/public use	5
9.	Sustainable development	5
10.	Socio-cultural heritage	5
11.	Indigenous peoples' concerns	6
12.	Wilderness	7
13.	Exploitation of nature theme for building township near forest	8

TABLE 3
Ranked issues after the second workshop

No.	Issue	Rank
1.	Ecological balance/use	1
2.	Sustainable development	2
3.	Green lung area/environmental use	3
4.	Education of public on nature	4
5.	Research	5
6.	Exploitation of nature theme for building township near forest	6
7.	Local community use	6
8.	Wilderness	7
9.	Indigenous peoples' concern	7
10.	Recreation/public use	7
11.	Wildlife survival - as a refuge	8
12.	Aesthetic value	9
13.	Socio-cultural heritage	10

the stakeholders recognized that AHFR with its small size and fragmentation from the main forest would not function effectively as a wildlife sanctuary.

This AHFR stakeholder analysis using cognitive mapping managed to gather the stakeholders together to discuss their concerns and issues related to the multiple uses of the forest. This is the first time that the stakeholders were brought together ranking their concerns on the uses of AHFR. The discussions and dialogues have also generated an understanding of the diverse needs of the stakeholders and have managed to narrow the differences among the different parties.

CONCLUSION

The stakeholders, from the dialogues and interviews, have been able to discern several issues of importance using the cognitive mapping technique. In the first workshop the stakeholders listed and ranked the issues related to the uses of AHFR. In the second workshop, where the stakeholders were presented with the non-timber values of AHFR, the rankings changed making the role of forest as an ecological balance the most important while the use of forest as a social-cultural heritage was the least important. This shows that when the stakeholders were presented with additional information and given more opportunities to discuss, the priority of the issues may change. These issues should be useful as a guide to develop activities in the AHFR and also to the management of the forest.

Similar studies conducted at different places are needed to fine-tune the stakeholder analysis approach in line with the cultural characteristics of the stakeholders involved. Naturally for Malaysia, interviewing with cognitive mapping appears to be more compatible with the cultural characteristics of the society.

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Valuing the Rain Forest: The Economic Values of Selected Forest Goods and Services in Ayer Hitam Forest Reserve, Puchong, Selangor

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ABSTRACT

The paper presents the economic values of selected forest goods and services in Ayer Hitam Forest Reserve (AHFR), Puchong, Selangor. It provides arguments for forest conservation and management on a sustainable basis. AHFR is currently used for research and education by UPM staff and students. Other important direct uses include the local dependence of Orang Asli for their livelihood, recreation by the local community, environmental education programme and other indirect uses such as protection of water resource and carbon sequestration. Appropriate methods were used to estimate the economic values of selected forest goods and services in AHFR. The total estimated economic value of five selected forest goods and services (timber, medicinal plants, Orang Asli dependence on forest, potential recreation benefit, and conservation value) was RM2.43 billion for the whole 1248 ha or RM1.94 million per hectare. This value is substantial and may be greater than the cost of conversion forest to other alternative uses such as housing development or agriculture. This study is important for policy-makers such that the forest can be maintained based on current uses and not to convert to other uses. The conversion to other uses may involve high social cost.

INTRODUCTION

The Malaysian tropical forest is well known for providing valuable timber resources to the state governments and communities 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, ecotourism and recreation opportunities, and help in maintaining favourable environmental conditions as well as "research labs." In the past, however, the forests have been viewed mainly as a source of timber for the wood-based industries, which produce a variety of products for domestic and export consumption. The other equally important components of the forest ecosystem but not given attention are the environmental services provided by the forests.

The full potential of the biologically diverse tropical forests has never been completely quantified in economic or monetary terms. While it is relatively simpler to determine the economic value of timber because of its readily available market price, it is not as simple to calculate the economic values of recreation, wildlife conservation, medicinal potential of forest species, and biological diversity. This could be an important factor for the past neglect of the non-timber components of the forest ecosystem in the decision to convert the forest to other uses. The economic potential of these resources has not been very much appreciated. Since the economic values of these resources are 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 values of all forest goods and services. Only then would we have a complete view on the costs and benefits of comparing alternative forest land use options.

In Malaysia, economic valuation has been applied extensively to forestry products. In general, the economic studies in this area could be applied to decision-making and to design management and conservation options. A good summary of previous studies can be found in Anon (2005). Some of the applications of these studies include comparing trade-off valuations between several options such as logging, construction, building of dam and conservation for water catchment, as well as justification for conservation policies on economic basis, optimization on the use of the conservation area, use of incremental cost framework in evaluating different logging technologies in a peat swamp forest, development of wetlands or mangrove areas to be properly evaluated and full social cost pricing, and sustainable forest management to ensure the social and environmental benefits. Previous economic valuation studies tended to focus on one element of total economic value (TEV); for instance, a study would focus on non-timber forest products (NTFPs), and another study would look at tourism values, etc. Other studies attempted to estimate components of total economic value (TEV), e.g. non-use values or just use values (direct and indirect). Examples of previous studies that focused on forest goods and services include those of Mohd. Shahwahid *et al.* (1999), Kumari (1995), Willis *et al.* (1998), Awang Noor *et al.* (1999), Jamal *et al.* (1998), and Woon *et al.* (1999).

This study presents the results of the application of TEV to Ayer Hitam Forest Reserve. The selection forest goods and services were selected based on their importance to the current direct use of the forest. The five forest goods and services analysed were timber, medicinal plants, *Orang Asli* (indigenous people) dependence on forest, potential recreation benefit, and conservation value. For each forest good and service selected, the appropriate method used for valuation was based on current market price. This study, however, does not compare the alternative of forest-land-use options.

METHODS

Study Site

The study area was the Ayer Hitam Forest Reserve (AHFR), Puchong, Selangor, which is located in a strategic place where rapid development is taking place. Some of the development projects that have been completed in the vicinity include agriculture project, a world-class sports complex, a multi-million dollar housing project, an incineration plant and waste disposal area, and an equine park. Part of the forest reserve has also been converted for the highway linking Seri Serdang and Lebuh Raya Damansara Puchong (LDP).

The forest is a production forest belonging to the forest type Lowland Dipterocarp Forest. It is classified as a secondary disturbed forest because it has been logged and treated several times since the 1930s (Paiman and Amat Ramsa, n.d.). Currently, the forest comprises six compartments, namely compartments 1, 2, 12, 13, 14 and 15. These compartments make up a total area of 1248 ha. According to the Forestry Department record, the area of AHFR has decreased substantially from the original forest area of 22 compartments of about 4266.23 ha in 1965. The extents of forest area and the

TABLE 1
Extents of Ayer Hitam Forest Reserve, Puchong, Selangor and area losses (1965-1997)

Year	Forested area (ha)	Percentage of area loss (compared to base year 1965)
1965	4266.23	
1980	4006.00	6.1
1983	4006.00	6.1
1993	2198.00	48.5
1994	1964.00	54.0
1997	1262.23[1]	70.4

[1] The total area reported by the Selangor State Forestry Department is less than the area given to UPM (1248 ha) may due to ground survey error.

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

TABLE 2
Conversions of Ayer Hitam Forest Reserve (AHFR) to other uses

Year	Use	Area (ha)
1970	Grazing	62.70
1973	Agriculture	240
1988	Agriculture	623.4
1989	Agriculture	658
1989	Agriculture	148
1993	Dumping site	58
1994	Settlement	11.3
1994	Rec./Housing	222.6
1995	Housing	324.2
1995	Housing	112
1995	Housing	447.2
Total		3007.4

percentages of area loss as compared with the original area are shown in Table 1. The conversions of AHFR were for grazing, agriculture, dumping site, housing, industry and highway (Table 2).

This forest reserve is one of the few remaining lowland forest reserves left in the State of Selangor. It was leased to UPM through a memorandum of understanding (MoU) signed in 1996 which gives Universiti Putra Malaysia (UPM) "custody" of the reserve for 80 years for use in education and research. 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 the 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). Towards this objective, the management plan for AHFR has been prepared with three broad goals as follows:

- to promote systematic and coordinated research into the working of a lowland rain forest 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 ecotourism for local as well as the surrounding urban communities.

According to Awang Noor *et al.* (1999), three categories of direct use of AHFR are research, education and other uses. AHFR is used directly by the staff and students of UPM, particularly the Faculty of Forestry for scientific research. The majority of research studies conducted at AHFR are carried out primarily by final year bachelor degree students and also graduate students for their theses. The foci of research include forest biology, ecology environment, dendrology, wildlife, mensuration, microclimate and soil analysis. Other areas of research have also been conducted such as wood science and forest recreation, forest economics and policy, GIS, entomology, pathology and silviculture. The main outputs of these activities are theses produced by final year bachelor degree and graduate students, books and monographs, seminar papers and other information on AHFR.

In terms of education, AHFR also plays an important role in environmental education such as providing forestry camp, field laboratories, practical training, team building, nature camping, organized visits by school children and other related environmental education. These activities are conducted not only by the UPM staff and students but also the local community in the Klang Valley area, mainly school children. AHFR is getting popular among the school children in the Klang Valley and the demand for

environmental education activities is increasing. Other direct uses of AHFR include recreation and use by the indigenous people. The economic value of recreation benefits by the local people has been determined by Mohd. Shahwahid *et al.* (1998). The dependence of the local indigenous people on AHFR has been established by Rusli *et al.* (1997).

The study period was conducted between 2003 and 2004 with data collection and analysis. The activities involved inventory of medicinal plants and non-timber forest products, personal interviews with *Orang Asli* and the local communities, stakeholder analysis, collection of data from secondary sources and holding of workshops.

Types of Values

To be able to provide an appropriate estimate of the economic values of selected forest goods and services, the types of benefits and costs of AHFR should be identified. The benefits or economic values can be divided into two categories: use and non-use values. The use values comprise direct, indirect and option values while the non-use values consist of existence and bequest values (Barbier, 1992; Munasinghe, 1993; Pearce, 1993). In view of the importance of forest goods and services to the community at large, the following forest goods and services were selected for estimating the economic values:

- timber resources
- medicinal plants
- economic value of forests to the *Orang Asli*
- potential recreation benefits
- conservation value

In this study, the total-economic-valuation (TEV) approach was applied since the objective of the study was to obtain a full accounting of the costs and benefits associated with conservation of AHFR. In particular, the estimated economic value will measure the economic contribution of AHFR to the welfare of the society as a whole. Ignoring these benefits and costs will provide a wrong signal to the policy-makers, and may involve the eventual depletion of the productive capacity of AHFR for the future generation.

The choice of methods used for each benefit selected depends on forest goods and services in question. Basically the methods used for each selected forest good and service are as follows:

Timber resources	Market price – residual-value technique
Medicinal plants	Market price – residual-value technique
Economic value of forests to the *Orang Asli*	Market price
Potential recreation benefits	Contingent-valuation method
Conservation value	Contingent-valuation method

Valuation of Timber Resources

The residual-value method was used to estimate the stumpage value of AHFR. The value of standing timber was 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 formula:

$$SV_{i,j} = \sum_{i=1}^{n}\sum_{j=1}^{k}\left(P_{ij} - C - PM_{i,j}\right) * V_{i,j}$$

where SV is the stumpage value (RM/ha), P is the ex-forest log price (RM/m^3), C is the logging cost (RM/m^3), PM is the profit margin (RM/m^3), and V is the estimated timber volume (m^3/ha). The subscripts i, j are indices for species and diameter class respectively. The profit margin, PM, is calculated using the equation $PM_{i,j} = (P_{i,j} * PR)/(1+PR)$, where PR is profit ratio. The subscripts i and j indicate that stumpage value ($SV_{i,j}$) varies due to variations in log price ($P_{i,j}$) at each diameter class j. The profit ratio used in this study was 0.30. It was also assumed that the logging cost was the same for all species and diameter classes.

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 equation: $V_i = 0.000362954 * DBH_i^{2.2988}$ (Awang Noor and Mohd. Radhi, 2002). Data on log prices were obtained from MASKAYU, the monthly bulletin produced by the Malaysian Timber Industry Board (MTIB). Data on logging costs were based on the works of previous researchers on the economics of

timber harvesting and costing of the logging industry in Peninsular Malaysia. The average logging cost used in the analysis was RM120/m^3 (Ahmad Fauzi *et al.*, 2002). Data collected were analysed to determine the stumpage value per hectare for compartments 1, 2, 12 13, 14 and 15 in AHFR.

Valuation of Medicinal Plants

Traditional medicine is important to all ethnic groups in Malaysia. The forest provides valuable medicinal plants and the estimates show that the forest supports more than 200 potential important medicinal plants. However, it is difficult and almost impossible to estimate the economic value of all medicinal plants as a source of medicinal products. Even though the tropical forest has yielded several important drugs which are vital to the treatment of diseases, the economic values derived from these plants have to be assessed in terms of their potential earnings, costs of prospecting, research and development, and cultural practices.

In this study, a market-based approach was adopted to determine the economic values of medicinal plants in AHFR (Norini and Mohd. Azmi, 2007). This requires the estimates of the physical resources of the medicinal plants, price, cost and profit margin. The physical resources of medicinal plants were estimated using appropriate forest inventory techniques on the selected compartments of AHFR. Two separate techniques were applied in conducting the inventory, namely a technique that involved setting up an inventory block measuring 200 x 200 m popularized by Awang Noor and Mohd Shahwahid (1995), and a technique that involved the creation of the main inventory block, measuring 100 x 200 m, and 25 subplots (Norini and Mohd Azmi, 2001). The inventory was supported by 10 workers (1 leader, 1 co-leader, and 8 field workers) from the hired contractor, two research assistants from the Forest Research Institute Malaysia (FRIM), and two *Orang Asli* (*Tok Batin* and Assistant *Tok Batin*).

The identification of medicinal plants and wild fruits was approached from three main perspectives, namely botanical, local and *Orang Asli* names. Above all, the indigenous knowledge that the *Orang Asli* possess on the uses of medicinal plants for treating illness and promoting good health will definitely help enrich existing records.

Information on market prices was based on Mohd Azmi and Norini (2001). The following formula was used to estimate the economic value (Linddal and Luboswki, 1999):

$NV = \Sigma\ Q_i \times (P_i - C_i)$, where NV is the net value, Q_i is the quantity of product i, P_i the price of product i, C_i is the extraction cost of product i (including profit margin). In this study, a modified formula was used:

$NB_i = \Sigma\ Q_i \times VMP_i$, where NB_i is the net benefit of medicinal plants of species i, Q_i is the quantity of species i and VMP_i is the value of medicinal plant of species i in RM/kg. The value of medicinal plant (VMP), was estimated based on the following equation:

$VMP = \bar{P} - (\overline{HC} + PM)$, where VMP is the value of medicinal plant species per kg, $\bar{P}$ is the average price of medicinal plants per kg, $\overline{HC}$ is average harvesting cost of medicinal plant per kg. Using this equation, the estimated average economic value of medicinal plant per kg is RM5.62.

Valuation of Forests to the Orang Asli (Temuan Ethnic Subgroup)

It is a well-known fact that the indigenous people or *Orang Asli*, have a prominent role to play in efforts to sustain the management of forest resources. The direct use of the forests for generations has made them more important to the *Orang Asli* than to other communities, whose lives usually have been less dependent on forest resources. There are about 42,000 (40%) of the 105,000 *Orang Asli* population in 1997 living close to or within forested areas, which indicates their direct association with the forests. States such as Pahang, Perak, and Selangor together had more than 77.00% of the total population of *Orang Asli* in 1991, compared with the other states in the Peninsula. Among the ethnic subgroups, the Semai had the largest number of members, more than 28 thousand (29.06%), followed closely by the Jakun and Temiar with 17 thousand (17.33%) and close to 17 thousand (17.15%) respectively. The Temuan ethnic subgroup, who were commonly found in Selangor, Negeri Sembilan, and Pahang, had a population size of slightly more than 15 thousand

(15.29%) in 1991. Unlike the Orang Laut, Orang Seletar and Mah Meri, the Semai, Temiar, Temuan, Chewong, Semelai, and Semoq Beri are known to be engaged in such activities as hill rice cultivation, hunting, and gathering of forest products.

To examine the role of forest conservation area to the *Orang Asli*, a study of the extent of use of AHFR by the Temuan ethnic group was conducted. The main objectives of the study were to estimate the quantities of timber and non-timber forest produce collected by the Temuans as well as the revenue that could have been generated by collecting these produce.

The data required in this study were based on a structured questionnaire, which included the following topics:

- socio-economic background (age, marital status, education level, type of work, income level, etc.);
- perceptions of development; and
- relationship/dependence on AHFR (quantity and price of NTFPs collected from the AHFR).

Using the structured questionnaire, interviews were held with the households of two Temuan communities residing at Sungai Rasau Hilir and and Taman Saujana Puchong (formally living in Sungai Rasau Hulu). The former group, Kg. Sg. Rasau Hilir, comprised 83 families with an average of six members per family, whereas the latter comprised only 34 families, also with an average of six members per family. About 79% of the households from Taman Orang Asli Saujana Puchong were engaged in some sort of forest-related activities in AHFR. On the other hand, about 35% of the households from Kg. Sg. Rasau Hilir were dependent on AHFR as a source of food and income.

Valuation of Potential Recreational Benefits

AHFR is also used by the local population for recreational activities. A study was conducted to determine the potential recreational benefits of AHFR to the local community. Under normal circumstances, the travel-cost method (TCM) is used to determine the economic value of a particular site for recreation purposes. The objective is to determine a demand function relating the number of visit/population of a zone with the average zonal values of travel cost. However, in this study the survey method was used to determine the potential recreation benefits of AHFR. In particular, the contingent-valuation method was used to elicit respondents' willingness-to-pay (WTP) for recreation purposes. The data were collected using a structured questionnaire which contained questions pertaining to description of AHFR, likely impact on management options, willingness-to-pay and socio-economic characteristics of respondents. The survey used five bid prices (RM1, RM2, RM3, RM4 and RM5). The dichotomous choice with follow-up questions was used. The payment vehicle adopted was the entrance fee to visit AHFR. A logit model was used to estimate the mean and median WTP as well as the total conservation value of AHFR. A total of 107 respondents were interviewed and they were mainly residents who lived in housing areas surrounding AHFR.

Valuation of Conservation Value

Forest ecosystems are quite complex as they represent a multitude of goods and services, which perform significant ecological functions that arise out of interdependence between their different components (timber and non-timber forest products). It may be difficult to estimate their accurate benefits. Nonetheless, as useful means to resolve conflicts between their conservation and development, various economic valuation techniques have been adopted in the evaluation of conservation values. Environmental economists employ a total-economic-value approach that focuses on monetizing a set of human preferences in a natural system. The analysis of economic values of forest conservation purposes can be done using the contingent-valuation method (CVM).

The CVM was applied in AHFR with the objectives to: (a) estimate the economic values of conservation of flora and fauna of the lowland forest ecosystems in AHFR, (b) examine the relationship between the willingness-to-pay and factors affecting it, and (c) examine the perceptions and attitudes of local people towards forest conservation.

Data required in estimating the economic values were collected from a survey conducted of non-users (i.e. people living in the surrounding areas or adjacent to AHFR). A structured questionnaire was prepared which comprised six sections (general question, plan to restore AHFR, reasons for conservation, willingness-to-pay, type

of experience to be gained in AHFR and socio-economic variables). The survey used five bid prices (RM5, RM10, RM15, RM20 and RM25). The dichotomous choice with follow-up question was used. The payment vehicle adopted was the trust fund which was to be used solely for the management and conservation of AHFR. An analysis of logit model was carried out on 115 respondents to estimate the mean and median WTP as well as the total conservation value of AHFR.

The general model is written as follows:

$$WTP = f(BID, AGE, INCOME) \quad (1)$$

where *WTP* is discrete choice variable (Yes =1, No=0), *BID* is the bid price posted to the respondents, *AGE* is the age of respondents (years) and *INCOME* is the monthly income of the respondent (RM). Since the dependent variable is the binary variable, the logit model is used to estimate the functional relationship and is specified as follows:

$$WTP_i = P(WTP=1/X_i) = \frac{1}{1+e^{-(\alpha+\beta_1 BID_i+\beta_2 AGE_i+\beta_3 INCOME_i)}} \quad (2)$$

Parameters α, β_1, β_2, and β_3 will be estimated parametrically. The mean maximum *WTP* for forest conservation can be calculated using the following formula:

Mean maximum *WTP* =

$$\frac{1}{-\beta_1}[\ln(e^{\alpha+\beta_2 \overline{AGE}+\beta_3 \overline{INCOME}} \quad (3)$$

The formula for median *WTP* is:

Median maximum *WTP* =

$$WTP = \frac{1}{-\beta_1}[\alpha+\beta_1 \overline{AGE}+\beta_2 \overline{INCOME}] \quad (4)$$

The mean and median *WTP* are evaluated at the mean values of the explanatory variables.

RESULTS

The results of valuation studies conducted of selected forest goods and services in AHFR are described below.

Values of Timber Resources

The results show that the estimated stumpage values for all trees above 15 cm and above were substantial, comparable with other estimates in the hill forest. The estimates of stumpage values for compartments 1, 2, 12 13, 14 and 15 were RM66,875 per ha, RM34,514 per ha, RM60,554, RM53,918 per ha, RM49,562 per ha and RM43,113 per ha respectively. The average estimated stumpage value per ha for trees 15 cm and above in all compartments was RM51,423 (Table 3). Based on trees 50 cm and above, the estimated stumpage values for compartments 1, 2, 12 13, 14 and 15 were RM35,606 per ha, RM9,775 per ha, RM33,467 per ha, RM30,086 per ha RM25,372 and RM21,051 per ha respectively. The average estimated stumpage value for all compartments was RM25,893 per ha. Based on trees 15 cm dbh and above, the total stumpage (stock) value of timber resources in the AHFR was estimated at RM64,175,904.00.

The net present value of timber can be calculated if the forest is managed based on a sustained yield basis at 30-year cutting cycle. This is done by calculating the current stumpage value plus the perpetual regular stumpage value at the end of every 30-year cutting cycle. This value is known as land expectation value (LEV) and the formula is as follows:

$LEV = SV+SV^* \left[\frac{1}{(1+r)^{30}-1}\right]$, where *SV* is the stumpage value and *r* is discount rate.

Using a 10% discount rate and based on trees above the cutting limit (i.e. trees > 50 cm dbh) and average *SV* of RM25,893 per ha yields *LEV* of RM34,278,940.00.

Values of Medicinal Plants

The results indicated that the numbers of species identified there were no significantly different between locations (low, medium and high lands). For instance, using strip-line sampling, 10 species were identified in compartment 15 (low land), another 10 and 7 species were identified in compartments 13 and 15 (medium and high lands respectively). However, the number of species was found to be higher in the swampy area than those in the low, medium or highland areas. For example, more than 166 and 763 other species were recorded in compartment 12

TABLE 3
Summary of stumpage values by compartment and tree size, AHFR

Compt.	Trees < 50 cm dbh		Trees > 50 cm dbh		Total stumpage value (RM/ha)	Total percent (%)
	Stumpage value (RM/ha)	Percentage (%)	Stumpage value (RM/ha)	Percentage (%)		
1	31,269	47	35,606	53	66,875	100
2	24,739	72	9,775	28	34,514	100
12	27,087	45	33,467	55	60,554	100
13	23,832	44	30,086	56	53,918	100
14	24,190	49	25,372	51	49,562	100
15	22,062	51	21,051	49	43,113	100
Average	25,530	51	25,893	49	51,423	100

(Plots 7 and 8) based on two inventory techniques besides common species, such as *Eurycoma longifolia (tongklat ali)*, *Prismatomeris sp.* (tongkat hj. Samad), *Elephantopus scaber* (tapak sulaiman) and akar lepar.

Based on the strip-line inventory technique, the total estimated economic value of medicinal plants for whole AHFR (1248 ha) was RM26,556.80. This was based on the average green weight value per ha multiplied by 1248 ha – the total size of AHFR). The estimated economic value of medicinal plants using the 100 percent-sampling showed a higher value, 3.5 to 1.3 more than those the strip-line sampling. The total economic value of medicinal plants for the 1248 ha was estimated at RM67,192.32. A much higher total economic value of medicinal plants was obtained when higher green weight price was used in the analysis. To calculate the net present value (NPV) under sustainable harvest of medicinal plants, a 10-year harvest cycle is assumed. This gives the annual harvest of 124.8 ha. For a forest land which provides constant annual economic value, the net present value (NPV) is:

$NPV = \frac{AEV}{r}$, where *AEV* is the annual economic value and r is the discount rate. Assuming a 10 percent discount rate, the *NPV* of medicinal plants is estimated at RM67,192.31.

Economic Value of AHFR to the Orang Asli (Temuan Ethnic Subgroup)

Based on the number of households surveyed, the majority (47%) of the Temuan community earned less than RM500 per month. However, 25 percent of them obtained income above RM1,000 per month. This group normally works in factories in Puchong area.

In terms of species collected, the Temuan communities are more dependent on the forest reserve for food (wildlife, plants, fish) than for other purposes like housing construction, handicraft-making and medicine. The total estimated economic values collected by the

TABLE 4
Economic contribution of forest goods and services to the *Orang Asli*, AHFR

No.	Forest Product	Total value (RM)	Percent
1	Animals	43,818	57
2	Fish	1,233	2
3	Medicinal Plants	11,554	15
4	Fruits	13,301	17
5	Rattan	7,403	10
	Total	77,309	100

Temuan communities from AHFR was RM77,309 (Table 4). Using the same formula as with medicinal plants and 5% discount rate, yields a net present value of RM773,090.

Economic Values of Potential Recreation Benefits

The respondents were adults 17 years old and above. About 99% of the respondents surveyed have attended school up to the university level. The mean monthly income was estimated at RM2,072. The majority of the respondents were Malays (52.4%) and the rest were Chinese and Indians. Males constituted about 56% of the respondents. The logit model results indicated that the mean and median WTP were RM4 and RM4.17 per visit per person respectively. These estimates are relatively higher than the estimated consumer surplus per visit using travel cost in the same study area, estimated at RM1.23 (Mohd. Shahwahid *et al.*, 1998) which is comparable with the values estimated by Awang Noor and Mohd Shahwahid (1997) for six forest recreational areas in Negeri Sembilan ranging from RM0.58 to RM2.26, with an average of RM1.49. Benson *et al.* (1996) obtained a similar result from a study on 20 forest recreational areas in Peninsular Malaysia with values ranging from RM0.78 to RM3.74, an average of RM2.30.

Based on the estimated value from this study, the calculated potential recreation benefits for the whole adult population of Selangor was RM86,576 and the present value of recreation benefits was estimated at RM865,770. However, Mohd. Shahwahid *et al.* (1998) obtained a lower estimate at RM44,280 using a 10% discount rate. This estimate was based on the direct users of AHFR for recreation purposes at 300 users per month. It should be pointed out that the estimated values are site specific and subject to existing conditions. If new facilities and accessibility are improved and developed, the estimated economic values of recreation benefits found in this study would be affected.

Economic Values of Forest Conservation

The mean and median maximum WTP were calculated with the formula shown in equations 3 and 4. For the calculation of the mean maximum WTP, all the independent variables were evaluated at the mean values.

Therefore, the mean maximum WTP is:

$$\frac{1}{0.0619}[\ln(e^{-0.7177-0.0234*30.72+0.0004*2011.40}+1]$$
$$= RM13.00$$

The median maximum WTP is:

$$\frac{1}{0.0619}[-0.7177-0.0234*30.72+0.0004*2011.40]$$
$$= RM12.99$$

Computing the economic values for the State of Selangor:

We need to assume the total population of Selangor. Based on 2004 statistics, the total population of Selangor and Kuala Lumpur (KL) was 4.6 million people, of which 70% were adults (age 15 and above). Therefore, the total adult population was estimated at 3.2 million people. This figure was used to calculate the economic values of AHFR based on mean maximum WTP at 10 percent discount rate for (a) the current period (b) 30-year period, (c) sustainable forest conservation.

Calculating the economic value for the current period for Selangor and KL:

EV = RM13 * 3.2 million = RM42 million

Calculating the economic value for 30-year period for the Selangor state and KL, the estimated present value (PV) is:

$$EV*\left[\frac{1-(1+r)^{-t}}{r}\right]=42,000,000*\left[\frac{1-(1+0.10)^{-30}}{0.10}\right]$$
$$=42,000,000*9.4269=RM395,929,800$$

Calculating the present value for sustainable forest conservation for Selangor and KL:

$$\frac{EV}{r}=\frac{42,000,000}{0.10}=RM420,000,000$$

At the national level, the significance of AHFR could also be calculated based on the assumption that each adult population (17.5 million people, 15 years and above) would be willing to pay to conserve AHFR. Using the same procedure, the estimated conservation value for sustainable management of AHFR was estimated at RM2.39 billion.

TABLE 5
Summary of economic values of AHFR

Forest good or service	Net present value (10% discount rate) (RM)
Timber	34,278,940.00
Medicinal plants	67,192.00
Indigenous people	773,090.00
Recreation benefits	865,770.00
Conservation value (Malaysia)	2,390,000,000.00
Total	2,425,984,992.00

Summary of Total Economic Value

A summary of the case results is given in Table 5 for the conservation and housing land use options. All figures are in constant 2004 terms discounted at 10 percent discount rate. The total benefits from conservation are larger than total benefits from housing. The net benefits are over RM2.43 billion when measured from the project perspective as compared with the next best alternative use such as housing project, estimated at RM926,433,481 (Awang Noor and Ahmad Ainuddin, 2005). It can therefore be concluded that the use of AHFR for conservation provides greater economic benefits to the society as a whole compared with that of the housing project.

CONCLUSION

The study shows that the overall economic value of conserving AHFR is large and may outweigh the next best alternative use such as housing development and agriculture development. The estimated economic values for the whole forest area are RM34,278,940 for timber, RM67,192 for medicinal plant's, RM773,090 for dependence of indigenous people, RM865,770 for potential recreation benefits and RM2.39 billion for conservation value based on Malaysian adult population. Thus, the total economic value for the five selected forest goods and services of AHFR is estimated at RM2.43 billion or RM1.94 million per ha. However, if we consider the total economic value, taking into account the adult population of Selangor and Kuala Lumpur, the estimated total economic value is only RM456 million or RM365,372 per ha. These values are one fifth of the estimated total economic values. The economic value as estimated in this study is the welfare contribution of AHFR to the local community. If we consider the benefits of AHFR to the global community (for example, the value of carbon sequestration), it would have been much higher than the estimated value. As such, the valuation used in this study can show policy-makers the need to conserve and manage AHFR based on existing use. Conversion of this forest to other uses will involve high social costs.

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The Role of Forestry Research and Development (R&D) Institution in Policy Formulation and Implementation: A Malaysian Perspective

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ABSTRACT

Decisions that are made in any field of interest will in one way or another affect the society, be they at the local or international level. Regardless of whether the decisions are intended for sustainable development of the nation's economic growth or something else, the ripple effects will definitely affect the society in both short and long terms. The effects sometimes are positive but at other times negative. The negative effects are the ones that policy-makers would like to avoid, if not lessen to a certain extent. In Peninsular Malaysia, the former Forest Research Institute (FRI) was a unit under the Department of Forestry Peninsular Malaysia. Subsequently, in 1985, FRI was instituted as a statutory body now called the Forest Research Institute Malaysia (FRIM), reporting directly to the Ministry of Primary Industries and now to the Ministry of Natural Resources and Environment (NRE). In the former structure under the Forestry Department of Peninsular Malaysia, a major disadvantage was that not all pertinent issues related to forestry reached the institute. This resulted in FRI's having a limited influence on decision-making at the national level. As a separate entity reporting directly to the Ministry, FRIM is now able to contribute more effectively to the formulation and implementation of forest-related policies. This paper, therefore, not only sheds light on the organizational structure usually associated with forestry research and development (R&D) institutions, but also examines how such an organizational structure can contribute more positively to the formulation and implementation of forest policies.

INTRODUCTION

An individual country's forest policy and its implementation may be seen as a localized subject matter if their impact is viewed as affecting only the local community. For instance, a forest policy on harvesting of logs may be drawn at the federal level, whereas its implementation is under the jurisdiction of the local state government. Since forest harvesting directly affects the local dependent community, not to mention a chain of other goods and services, the need to continuously manage the forest in a sustainable manner is crucial. Stated differently, harvesting may be seen as a localized activity, but its effects, especially on the environmental functions of the forest, such as carbon sequestration, conservation of biological resources and other related functions, actually are borderless. To ensure that the implementation of forest policies does not jeopardize the existing goods and services provided by the forests, the formulation of such polices must consider all stakeholders who will be directly affected by the decisions. The stakeholders in this context include the local community, the society at large, planners, decision-makers, implementers (i.e. forest managers), non-governmental organizations (NGOs) and others who may have direct and indirect interests in the subject matter.

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Together with these stakeholders, the research community also has an important role in decision-making on matters related to forestry. The importance of the contribution of a research and development (R&D) institution through its research activities in formulating and implementing forestry matters cannot be denied. Even though, at times, the R&D institution does not have a direct say in matters related to forestry, research inputs from such an organization are crucial in decision-making. Based on scientific evidence from research findings, the decisions made are more realistic and acceptable. What is important at this juncture is to determine whether and to what extent research findings have influenced decisions related to forestry matters. Above all, if linkages already exist among researchers, stakeholders, and policy-makers, could the tie be further improved to ensure that the decisions that are made benefit the stakeholders?

The current organizational structure has improved the role of the R&D institution, such as the Forest Research Institute Malaysia (formerly known as the Forest Research Institute (FRI)), in contributing to the overall formulation and implementation of forest policies in Malaysia. Under the current organizational structure, the Forest Research Institute Malaysia (FRIM) is now able to contribute more positively toward all issues pertaining to forestry matters. Nonetheless, before discussing the various advantages of the current organizational structure, it is worthwhile to review the situation that existed when FRIM was one of the units under the Department of Forestry Peninsular Malaysia. Such an experience can be considered a lesson to be learned by other R&D institutions to ensure their active participation in decision-making regarding forest policies.

This paper examines the past and current organizational structures of FRIM as a research institution. It also suggests various means to encourage a more proactive role in formulating and implementing forest policies. In examining FRIM's organizational structure, the development of forest policies and other related issues will also be discussed.

THE ORGANIZATIONAL STRUCTURE– PAST AND PRESENT

As in most developing countries, Malaysia's research entities in the past always were part and parcel of a larger organizational structure. At first, FRIM was only a unit under the organizational structure of the Department of Forestry Peninsular Malaysia (*Fig. 1*). Different from other units, FRI in the early days and until 1984 was directly responsible to the Deputy Director-General of Research and Industrial Development. At that time, the Department of Forestry Peninsular Malaysia was directly answerable to the Ministry of Primary Industries, Malaysia.

If one were to trace the development of the Department of Forestry Peninsular Malaysia one would find that the concept of establishing the department started way back in 1883. It was only in 1901 that the Department of Forestry Peninsular Malaysia was officially set up with the appointment of the first Chief Forest Officer (Forest Department Peninsular Malaysia 2003). Historical records also show that the Forest Research Institute was initiated in 1918 with the appointment of a Forest Research Officer in Peninsular Malaysia (known formerly as Malaya). In 1985, FRI became a statutory body and its name was changed to FRIM. A similar structure is also reported to exist in India, except that the forest research institute there started slightly earlier than the one in Malaya, i.e. in 1906 (Sharma, 2002). According to Sharma, the forest research institute in India was formerly under the control of the Ministry of Agriculture/ Ministry of Environment and Forests and became a full-fledged research institute in 1986, i.e. a year later than FRIM.

Disadvantages of the Earlier Organizational Structure

There were disadvantages of being under the earlier organizational structure and the following points are worth mentioning.

First, being such a small unit among larger units under the Department of Forestry Peninsular Malaysia indeed limited FRI's capacity and capability to engage in large-scale R&D projects. Research conducted by FRI in the early days was focused on testing aspects of various timber species, such as their physical properties, seasoning qualities, woodworking characteristics, durability and amenability to preservative treatment. In short, FRI then was solely a timber research laboratory. A revised research programme based on that of the New Zealand Forest Service was published in 1954 (Federation of Malaya 1948). With the revised programme,

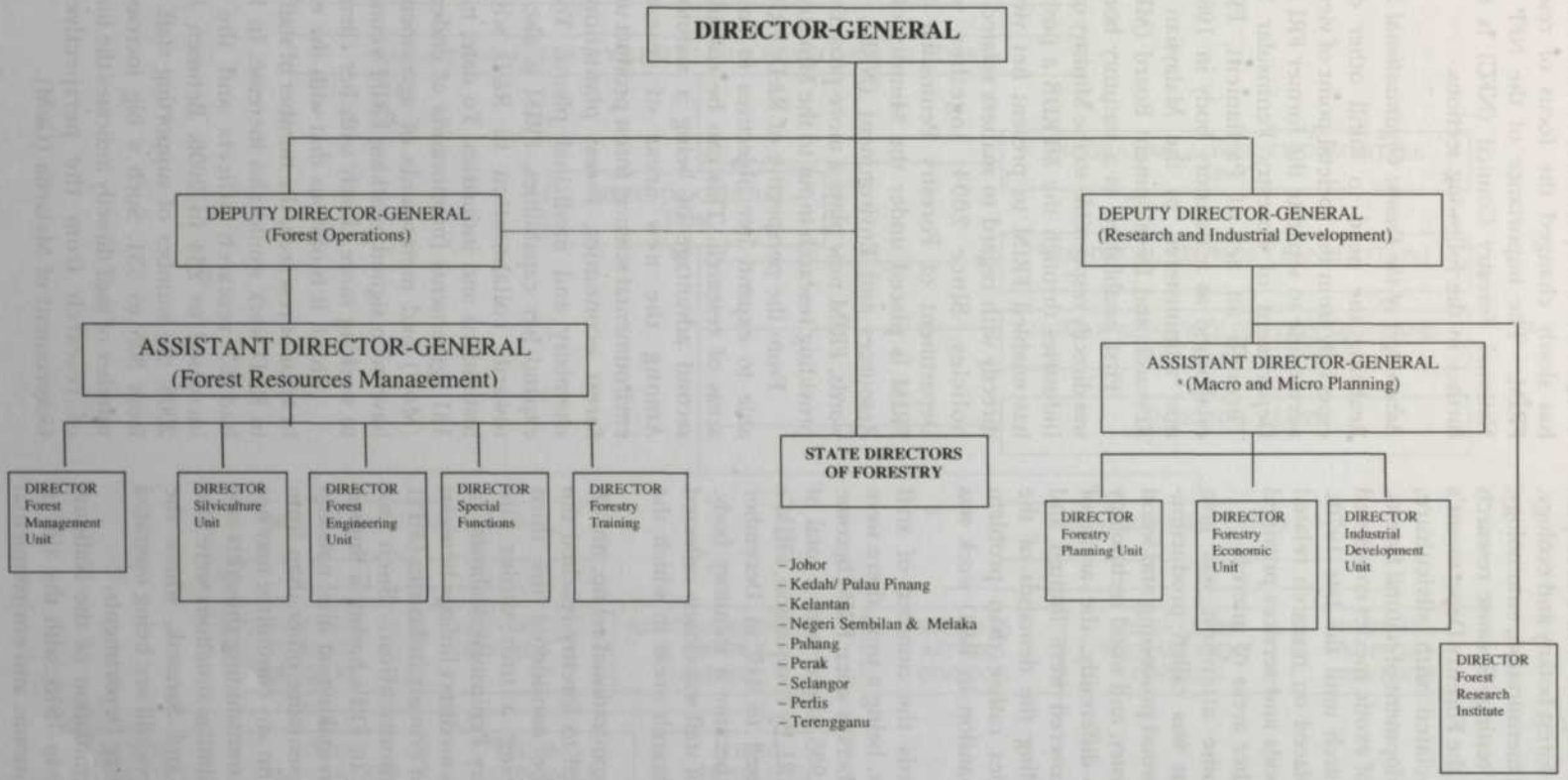

Fig. 1: Organization of the Forestry Department, Peninsular Malaysia, Ministry of Primary Industries, Malaysia (1980)
Source: Forestry Department Peninsular Malaysia (1980)

the research focus was expanded to encompass other fields, including forest botany and ecology, soil and ecology, forest mensuration, entomology, chemistry and timber testing. Because research was part and parcel of the Forestry Department's activities, work associated with silviculture, regeneration and development of natural forests, and the introduction of exotic species continued to dominate the research until the late 1970s. Little emphasis was placed on research related to the community, goods and services provided by the forests, and other areas of interest.

Nevertheless, some attention was also directed towards what was called production-oriented research on wood processing and wood products, wood chemistry, and wood technology and fibre. To say it differently, the areas of research that were covered were limited and were geared to fulfilling the demands of the timber-based industries rather than problem solving. As such, expansion in R&D work was slow and restricted.

Second, as regards the number of staff engaged in R&D work, being a unit, there were not as many staff members as when FRIM become a statutory body. In 1985, there were a total of 372 staff members in FRI. By comparison, FRIM's staff members increased to 410 in December 1986, a year after it became a statutory body. The smaller number of staff was closely reflected in the number of research areas in which the institute was involved.

Because of the organizational set-up, not all pertinent issues related to forestry reached the institute. This can be considered the third disadvantage of being a unit under the Department of Forestry Peninsular Malaysia. In other words, there was no direct linkage between FRI and the Ministry of Primary Industries (MPI) in terms of communication. Such an arrangement resulted in FRI's having a limited influence on decision-making at the national level. To have a representative other than from FRI's own staff sitting on any committee may not be an effective way of transmitting thoughts and ideas on R&D work. Similar situations were also observed for Sabah and Sarawak, where the Forest Research Centres still are being operated under the State Forestry Departments.

However, the formulation of the National Forestry Policy (NFP) in 1978, with the aim of maximizing social, economic and environmental benefits from the permanent forest estates (PFE), has slowly changed the focus of research in FRIM. The importance of the NFP and the National Forestry Council (NFC) is discussed further in the following sections.

Advantages of the Present Organizational Structure

Realizing the need to fulfill other demands, especially from the societal point of view, efforts were made to separate the former FRI from the Department of Forestry Peninsular Malaysia. Through an act of Parliament, FRIM was established as a statutory body in 1985 and is now administered by the Malaysian Forestry Research and Development Board (MFRDB).

First established as a statutory body, FRIM was directly responsible to the Ministry of Primary Industries through the MFRDB a position that has enabled FRIM to present her views more directly with regard to matters related to forest policies. Since 2004, together with the Department of Forestry Peninsular Malaysia, FRIM is placed under the Ministry of Natural Resources and Environment (NRE). In other words, FRIM now plays a more proactive role in providing research input to the Ministry (*Fig. 2*).

From the perspective of R&D, FRIM is now able to expand her objectives to cover more areas of research. This can be considered the second advantage of being a statutory body. Among the new areas of research are environmental science, forest product utilization, forest economics, forest plantations, wood chemistry and medicinal plants. To further expand her capabilities, FRIM is also pushing towards collaboration in R&D with other institutions and industries. To date, more than 161 agreements (memoranda of understanding (MoU) and memoranda of agreement (MoA) have been signed, marking FRIM's commitment to working more closely with her clients.

Third, it is obvious that with the expansion in areas of research, the number of staff engaged in R&D work would also increase. In 1985, FRI had 67 research officers and the number increased to 234 in 2006. Between 1985 and 2006, the number of supporting staff also rose from 305 to 531. Such a big increase in the number of staff directly indicates the importance of research from the perspective of the Government of Malaysia (GoM).

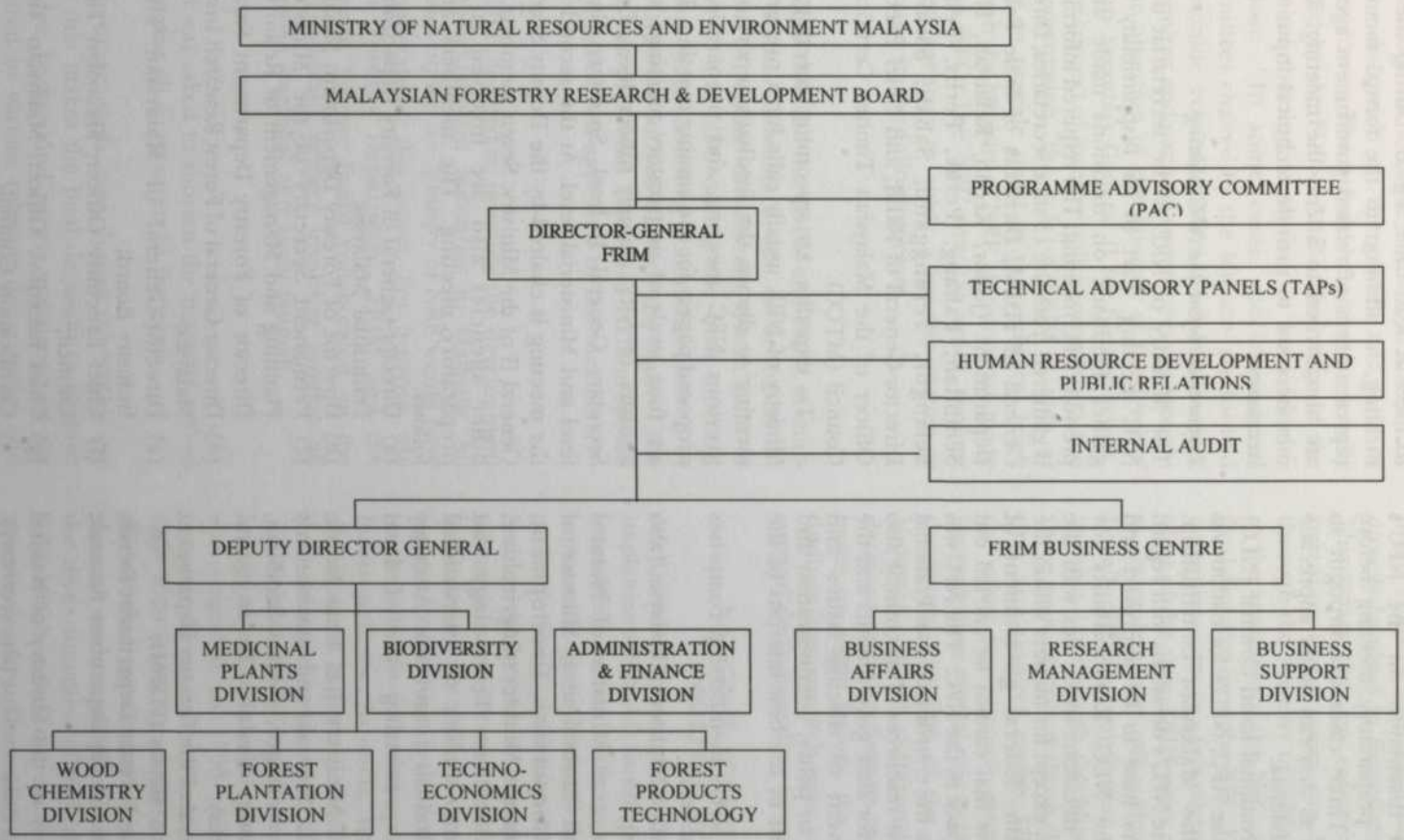

Fig. 2: FRIM Organization Chart 2003

NATIONAL FORESTRY COUNCIL

The following paragraphs highlight the formation of the National Forestry Council (NFC) and continue with a discussion on the NFC's membership and preparatory meeting before the NFC meets. Three cases are brought to readers' attention so they can better appreciate the situation in Malaysia.

In 1971, the National Land Council (NLC) decided to form the NFC. NFC's formation was not based on the Malaysian constitution. Therefore all of the NFC's decisions with regard to forestry matters have to be approved and confirmed by the NLC. Responsibility for implementing all decisions made lies with the state governments, except for matters within the jurisdiction of the federal government of Malaysia. Decisions that cannot be carried out must be referred back to the NFC. The NFC was formed to facilitate the coordination and rational utilization of forest resources. This council also provides a forum for state governments and the federal government to discuss issues and problems related to policy, administration and forest management in the best interests of the nation.

To date, the NFC's membership comprises the following members:

(a) the Deputy Prime Minister of Malaysia (also the Chairman);
(b) six ministers (i.e. Minister of Natural Resources and Environment; Minister of Land and Cooperative Development; Minister of Finance; Minister of Agriculture; Minister of Science, Technology and Innovation; and Minister of International Trade and Industry) and the Attorney General (representing the federal government);
(c) all four Chief Ministers (i.e. from Sabah, Penang, Melaka, Sarawak) and nine Menteris Besar (Johor, Selangor, Negeri Sembilan, Perak, Pahang, Kedah, Terengganu, Kelantan, Perlis);
(d) Director-General of the Forestry Department of Peninsular Malaysia (FDPM);
(e) Director of the Forestry Department Sabah;
(f) Director of the Forestry Department Sarawak; and
(g) Chief Secretary of the Ministry of Natural Resources and Environment (the secretary).

The secretariat of the NFC is based in the Ministry of NRE; its secretary general is the secretary of the NFC. The NFC is programmed to meet at least once a year. During the NFC meeting, in addition to the formal members, representatives of related government agencies are also invited to attend the meeting. These members are to provide technical input when necessary.

Preparation before the NFC Meeting

The Ministry of NRE is the secretariat of the NFC meeting. Part of its responsibility is to gather feedback on decisions made at the previous NFC meeting. The required information is gathered from the 13 state secretaries, Director-General of FDPM, Directors of State Forestry Department (Johor, Kedah, Kelantan, Negeri Sembilan, Pahang, Perak, Perlis, Penang, Selangor, Terengganu, Sabah, Sarawak), Director-General of FRIM, and Chief Executive Officer of the Malaysian Timber Certification Council (MTCC).

To expedite an upcoming meeting, the Ministry of NRE usually calls for a preparatory meeting to discuss the feedback report of the previous NFC meeting and preparation of proposed papers for the coming meeting. There are four levels of preparatory meetings at the Ministry of NRE, namely officer level, Deputy Secretary General II level, Secretary General level and Ministerial level. At the second level, the meeting is chaired by the Deputy Secretary General II of the Ministry. Seven members from other agencies also are involved in this preparatory meeting. The members are as follows:

(a) Director-General of Forestry Department of Peninsular Malaysia;
(b) Director of Forestry Department Sabah;
(c) Permanent Secretary of the Ministry of Planning and Management of Resources / Director of Forestry Department Sarawak;
(d) Director-General of Forest Research Institute Malaysia;
(e) Director-General of Malaysian Timber Industry Board;
(f) Chief Executive Officer, Malaysian Timber Council;
(g) Chief Executive Officer, Malaysian Timber Certification Council.

Before the preparatory meeting at the Deputy Secretary General II level, the relevant agencies work together through various technical committees. For example, FRIM and FDPM may hold a discussion on the growth and yield of natural forests. The technical meeting is normally chaired by the FDPM. At the final stage of the technical meeting, a seminar is held for this purpose. In some cases, special national committees chaired by the Ministry are formed to examine related matters. The outcomes of the seminar and national committees are brought to the attention of the Ministry at the level of Deputy Secretary General II for further action. In the context of forestry policy formulation and implementation, the role of FRIM is seen as being to provide input at the technical level; through the Ministry of NRE, decisions are made at the NFC. The NFC may, at times, request related agencies to study a specific matter as indicated in the following cases.

Case 1

The NFC directed the FDPM and FRIM to study the "annual allowable coupe to be based on volume to replace the current system" and to report to the NFC during the next meeting. Subsequently, a working committee chaired by the FDPM was formed to study the matter. The result was presented later in a NFC proposed paper, which was approved by the members.

Case 2

The NFC decided to promote the development of medicinal-plant industries in Malaysia. All agencies under the Ministry of NRE would have to cooperate in this aspect. For instance, the Johor Forestry Department, FRIM and the Malaysian Rubber Board collaborated on the medicinal-plant project involving tongkat ali (*Eurycoma longifolia*) and kacip fatimah.

Case 3

FRIM was asked to shorten the maturity period of tongkat ali from seven to five years.

In other words, even though the NFC is the body that makes the final decision, to support the idea, background papers and proposals are prepared by various relevant departments and agencies. Once a decision is made, the various state governments are required to cooperate in implementing the decisions.

From the preceding paragraphs, it is clear that a research institution such as FRIM is not directly involved in formulating forest policies. This means that any comments or suggestions regarding forest policy can be extended only through the Ministry of NRE and later brought to the attention of the NFC. Depending on the final directive from the NFC, FRIM can be either an implementer or a formulator of forest policies. Most of the time FRIM plays a more direct role as an implementer rather than as a formulator. Usually, FRIM's contribution as a formulator is indirect, i.e. through the Ministry of NRE. The three cases described above clearly demonstrate that, as a research centre, FRIM together with the other two research centres in Sabah and Sarawak has a crucial role to play in determining the future direction of the forestry sector in Malaysia. Stated differently, even though decisions made on forestry and other fields are based on many factors, the fact remains that findings from research serve as hard evidence to support decision-making in any field of interest.

NATIONAL FOREST POLICY AND LEGISLATION

A discussion on the formulation and implementation of forest policies would be incomplete without referring to other related topics such as the National Forestry Act (NFA) of 1993. The main reason behind this is that, besides the restricted organizational structure (there is no representative from the research institute in the NFC), the NFP as well as legislation determines the research institution's participation in formulating and implementing forest policies. As such, understanding the development of these policies and legislation is a fundamental issue.

Before the NFA is discussed further, it is helpful to examine briefly the NFP 1978, which was amended in 1993. A major difference between the amended forest policy of 1993 and NFP 1978 is the emphasis on management of the so-called permanent forest estates (PFE) for research and education. This is well and above the three functions of PFE that were listed in 1978, which included protective, productive and amenity forestry. The inclusion of research and education in the amended version of the NFP

indirectly indicates the important role given to other multiple uses of forests, besides timber, in the context of sustainable management of forest resources. The areas of research have also been expanded as a result of its inclusion in the amended version of the NFP.

Implementation of the various provisions contained in the NFP is within the jurisdiction of the state governments. At this juncture, the federal government (FG) plays only an advisory role. For example, the FG may prescribe a certain target area for logging each year, but the decision as to the size of area to be logged still is made by the state government. Nonetheless, the difference in sizes of areas to be logged, especially those under the PFE, is usually not that substantial. A major area open for logging usually comes from state lands, which are converted into various development projects.

NFA 1993, an amendment of NFA 1984, allows for a more efficient enforcement of the principles of forest management through higher fines for unlawful logging activities. Na'aman (2002) quoted a minimum fine of RM10,000 (approximately USD2,632) or imprisonment for a period not exceeding three years and a maximum fine of RM500,000 (approximately USD131,579) or imprisonment for a period not less than one year but not exceeding 20 years for activities such as illegal logging and timber theft. If one were to trace the development of forest management in Malaysia, one would discover that enactments and ordinances were formulated and enforced by state authorities as early as 1910. It was through NFA 1984 that the legislation with regard to forest planning and operations was standardized and strengthened. Together with NFA 1984, another important development in the Malaysian forestry sector is the so-called Wood-based Industries Act (WIA), also endorsed in 1984. The NFP and the other two acts (NFA and WIA) further ensure the sustainable management of natural forest resources.

The concept of sustainable forest management is not a new issue in the field of forestry at either the local or international level. Because the forest is viewed not only for its timber value but also for its non-timber values, such as environmental protection, biodiversity conservation, socio-economic contribution and watershed protection to name just a few, the importance of research to fulfill these functions is more critical than ever. Findings derived from research would then serve as important inputs in decision-making processes.

Other legislation that is of direct relevance to the development of the forestry sector in Malaysia includes:

- National Land Code 1965
- Penal Code (FMS Cap. 45), 1948 (Amended 1993)
- Criminal Procedure Code (FMS Cap.6), 1903 (Amended 1995)
- Evidence Act, 1950 (Amended 1993)
- Financial Procedure Act 1967
- Water Enactment 1935
- Land Conservation Act 1960
- Protection of Wildlife Act 1972
- Malaysian Timber Industry Board Act 1973
- National Park Act 1980 (Amended 1983)
- Malaysian Forestry Research and Development Board Act 1985
- Mining Enactment 1926
- Local Government Act 1976

Another policy related to the development of the forestry sector is the National Policy on Biodiversity (NPB), which was endorsed in 1998. Based on its 11 main principles, the NPB is aimed at transforming Malaysia into a world centre of excellence in conservation, research and sustainable utilization of tropical biological diversity by 2020. Clearly, excellence in tropical research is one of the focal points of the NPB. To achieve this challenging goal, all categories of communities have to be involved directly or indirectly with formulating and implementing the NPB.

CHALLENGES IN IMPLEMENTING FOREST POLICIES AND LEGISLATION

The endorsement of all policies and legislation was meant to sustain the existing role of the forest as a provider of both goods and services for society. Nonetheless, it is not an exaggeration to say at this juncture that some, if not all, of the countries in this world are facing challenges in implementing their forest polices and legislation in one way or another. The difference between these countries perhaps lies in the extent of the so-called challenges. In fact, implementing such forest polices and legislation becomes more challenging when it involves the social issues, especially indigenous people. Malaysia is no exception to this situation.

For instance, in implementing the NFP, Malaysia faces several challenges. First is with regard to the effectiveness of implementing the policy at the state government level (in contrast to the federal government). As mentioned earlier in this section, implementing provisions contained in the NFP is within the jurisdiction of the state. A similar challenge may also arise at the district level. Besides the question of effectiveness, the way research findings are presented to policy-makers also plays a major role in the formulation of forest policies.

Abdul Razak *et al.* (2002) pointed out overlapping roles of ministries with regard to issues such as flora and fauna, which may also hinder the effectiveness with which said policies are implemented. According to Abdul Razak *et al.* (2002), the Ministry of Primary Industries was responsible for implementing the NFP through the Department of Forestry, whereas the Ministry of Science, Technology and Environment was responsible for implementing the Protection of Wildlife Act through the Department of Wildlife and National Parks (DWNP). The NFP itself is aimed at sustainable management of natural forest resources, which include both flora and fauna found on site. The creation of another policy, which is supposed to be handled by another department, would obviously hinder the effectiveness of the implementation of such a policy, as too many departments are involved. However, with the establishment of the Ministry of NRE in 2004, the Forestry Department of Peninsular Malaysia and Department of Wildlife and Natural Parks are now placed in the same ministry. The issue of overlapping roles does not exist for Sabah and Sarawak because the two states are responsible for managing their own flora and fauna. A similar issue regarding the ineffectiveness of the concept of sustainable forest management was also raised by Abdul Razak *et al.* (2002) with regard to the Environmental Impact Assessment (EIA) of forest areas opened for logging. Exemption of areas less than 500 hectares from the EIA is considered inappropriate because an area of less than this size is also expected to have a major impact on the fauna and flora once it is subjected to logging activity (Lim and Shamsudin, 2006).

Another challenge worth mentioning is the issue of the two separate regions, West and East Malaysia (Abdul Razak *et al.*, 2002). West Malaysia includes all 11 states and 1 Federal Territory, whereas East Malaysia comprises Sabah and Sarawak. Table 1 indicates the legislation pertaining to both forestry and biological diversity in the two regions. Clearly, both Peninsular Malaysia and Sabah and Sarawak have their own legislation, insofar as efforts to manage their own flora and fauna are concerned.

TABLE 1
Legislation relevant to forestry and biological diversity in the two regions

Region	Legislation
West Malaysia	Taman Negara* (Kelantan) Enactment 1938
11 States and 1 Federal	Taman Negara* (Pahang) Enactment 1939
Territory in Peninsular	Taman Negara* (Terengganu) Enactment 1938
Malaysia	Aboriginal Peoples Act 1954
	Land Conservation Act 1960
	National Land Code 1965
	Protection of Wildlife Act 1972
	National Parks Act 1980
	National Forestry Act 1984
East Malaysia,	Parks Enactment 1984
Sabah	Forest Enactment 1968
	Fauna Conservation Ordinance 1963
East Malaysia, Sarawak	National Ordinance 1956
	Wildlife Protection Ordinance 1958
	Forests Ordinance 1954
	Natural Resources Ordinance 1949 as amended by Natural Resources and Environmental (Amendment) Ordinance 1993
	Public Parks and Green Ordinance 1993
	Water Ordinance 1994

Source: Abdul Razak *et al.* (2002).
*Taman Negara denotes National Park. The State Parks of Kelantan, Pahang and Terengganu form Taman Negara.

Earlier in the text, it was mentioned that there are three separate bodies dealing with research in forestry in Malaysia, namely FRIM, the Forest Research Centre (Sabah) and the Forest Research Institute (Sarawak). Sabah's Forest Research Centre and Sarawak's Forest Research Institute are under the Department of Forestry of the each particular state. Obviously, the focus of research that is carried out also varies, depending on the demand in each state. In short, what may be a priority for FRIM may not be so for Sabah's Forest Research Centre and Sarawak's Forest Research Institute. Usually, research carried out by FRIM is aimed at achieving national benefits, whereas research by the Sabah and Sarawak Research Centres is aimed primarily at solving local problems. Today, FRIM is stepping up efforts to bridge the areas of research for the three separate entities.

CONCLUSION AND RECOMMENDATIONS

From the various discussions highlighted in several sections of this paper, R & D institutions such as FRIM will have a much larger role to play as more emphasis is placed on research as a means of achieving sustainable management of natural forest resources. The demand to carry out the multiple roles of providing goods and services to society calls for more coordinated efforts between not only research institutions (i.e. at the federal and state levels) but also stakeholders that have either direct or indirect interest in the forest.

The current organizational structure has enabled FRIM to participate actively in the formulation and implementation of forest policies in one way or another, as compared with the old structure. Nonetheless, such a proactive role can be further improved if FRIM is a member of the NFC. FRIM, formerly known as FRI, was not a member of the NFC when it was formed in 1971. With the current set-up, i.e. being directly responsible to the Ministry of NRE, it is highly timely that some consideration be given to include FRIM in the NFC. Such an opportunity will allow all matters pertaining to forestry to reach FRIM directly, without going through a second or even a third party. To accommodate a research institution such as FRIM, the NFC may need to create another layer, called the Technical Committee. The Technical Committee could act as the right arm of the NFC by providing R&D findings as and when required.

Besides the organizational structure, other areas that need immediate attention include repackaging of R&D findings, a more proactive role of research officers in presenting their views to policy-makers, and inclusion of all stakeholders in decision-making processes. Many publications of R&D findings are too technical and difficult for the ordinary layperson to grasp. As such, efforts to repackage these R&D findings should, among other things, use less technical jargon and give down-to-earth examples. Road shows would be a good channel through which R&D information is disseminated to interested clients. This means that the role of a research officer does not stop once she or he has completed the study. A much bigger task is to disseminate the research findings, especially to policy-makers. With the current demand for more input from the research community, the research officer has no choice but to play a proactive role in disseminating R&D findings. This can easily be done through networking.

In all, to ensure the effectiveness of the formulation and implementation of forest policies, all stakeholders must be involved in decision-making processes. This can easily be done through public participation. Nevertheless, active public participation does not guarantee that there will be no more problems, but rather it may help reduce unnecessary conflicts or even lead to more accommodating solutions (Canadian Institute of Forestry, 2003).

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Understanding the Direction of Forest Plantation Management in Malaysia: A Cognitive Mapping Approach

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ABSTRACT

Forest plantation industry is one of the components in forestry industry which is being developed to ensure continuing supply of timber and fibre resources. Currently, the total area of forest plantation is 250,000 ha and in the future Malaysia aims to double this area to 500,000 ha. In order to achieve this target, strategies need to be developed. With this in mind a multi-stakeholder analysis was undertaken. The objectives of the multi-stakeholder analysis were: to discuss the trend in forest plantation management in Malaysia, to understand the opportunities and obstacles present in the forest plantation management, and to formulate recommended actions for forest plantation management in Malaysia. The multi stakeholder analysis was conducted using the cognitive-group-mapping approach where a network of concepts and issues are linked to form chains of argumentation. The concepts and issues were aggregated, linked and prioritized to form strategy statements. From the strategy statements, recommended actions were proposed. The recommended actions can be used to help chart the future direction of forest plantation management in Malaysia.

INTRODUCTION

The forestry sector is important to the Malaysian economy and continues to play an important role in the country's socio-economic development. In 2004, about RM19 billion of timber and wood-based products were exported overseas. In order to sustain and provide raw materials to the manufacturers, a steady supply of timber is needed. One of the strategies of ensuring supply of timber is by planting fast-growing timber species.

In 1982, the Malaysian Government launched the Compensatory Forest Plantation Project (CFFP) with the target to establish approximately 188,000 ha of forest plantation within 15 years (Lim *et al.*, 2002). Currently the total area of plantation forests is 250,000 ha and in the future, Malaysia aims to double this area to 500,000 ha. In order to achieve this target, more efforts need to be done to encourage government-linked companies and the private sector to participate in this activity (Krishnapillay and Ong, 2003). With this in mind a multi-stakeholder analysis was undertaken. The objectives of the multi-stakeholder analysis were: to discuss on the trend of forest plantation management in Malaysia; to understand the opportunities and obstacles present in the forest plantation management, and to formulate recommended actions for forest plantation management in Malaysia.

METHODOLGY

The multi-stakeholder analysis was conducted using the cognitive-group-mapping approach where a network of concepts and issues are linked to form chains of argumentation. The concepts and issues were aggregated, linked and prioritized to form strategy statements. From the strategy statements, an action plan was developed. This approach has been used by many authors to analyze policy (Eden and Ackermann, 2004), public participation (Hjortso, 2004) and stakeholder analysis (Ahmad Ainuddin *et al.*, 2005).

The critical success factor in ensuring meaningful outcomes of the cognitive-group-mapping approach is the participation of all relevant groups of stakeholders. This is to make sure that issues, trade-offs, conflicting interests and their justifications, constraints, opportunities and other influential factors are all taken on board and thoroughly deliberated in the discussion, before consensus building is achieved. In this multi-stakeholder analysis, efforts were taken to bring in relevant stakeholders of various backgrounds. Nevertheless, a number of important stakeholders could not make it to the multi-stakeholder analysis. Yet, the deliberations have been very open and productive. A sequel and more detailed multi-stakeholder analysis could be suggested to further enrich the outcomes.

The first task of the participants was to discuss the issues concerning the industry from the group's perspectives. The participants were asked to write the issues on yellow Post-its and paste them on the wall. An hour was allotted for activity followed by a 15-minute break. A facilitator was appointed to guide the discussions and the activity. All the facilitators have been trained in this technique.

After the break, all the issues were aggregated. This was to avoid overlapping and redundancy among the issues. For each aggregated issue, a statement to represent the issue was created so that the issue could be transformed into a strategy statement.

After the aggregation of the issues and formulation of strategy statements, a prioritization process was done. This was to ensure that the strategy statements were categorized according to their importance. At the end of the activities, each group presented its results for the multi-stakeholder analysis. The multi stakeholder analysis ended with a note of thanks by the organizer.

RESULTS AND DISCUSSION

The group raised many issues related to the production, silviculture and management of forest plantation species. Among the issues raised were those related to:

- existing information available on rubber and *Acacia mangium;*
- potential of non-timber species such as bamboo and kenaf;
- policy on focal species using New Zealand's focus on *Pinus radiata* as an example;
- mass production techniques;
- species selection;
- species-site matching; and
- plantation forestry for protection.

The issues were aggregated and ranked into four strategic statements i.e.

1. to recommend three important existing timber and non-timber plantation species;
2. to recommend policy on focal species to cater for different needs;
3. to develop sound techniques for mass production of improved and quality materials;
4. to develop a sustainable and viable management system (silviculture and management).

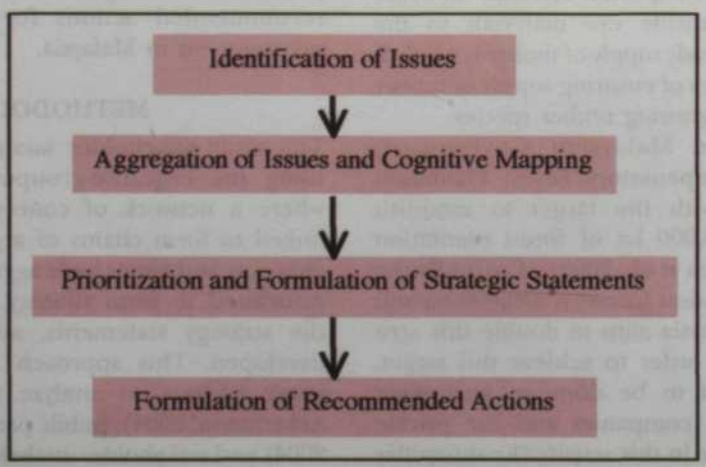

Fig. 1: Flowchart in formulation of the action plan

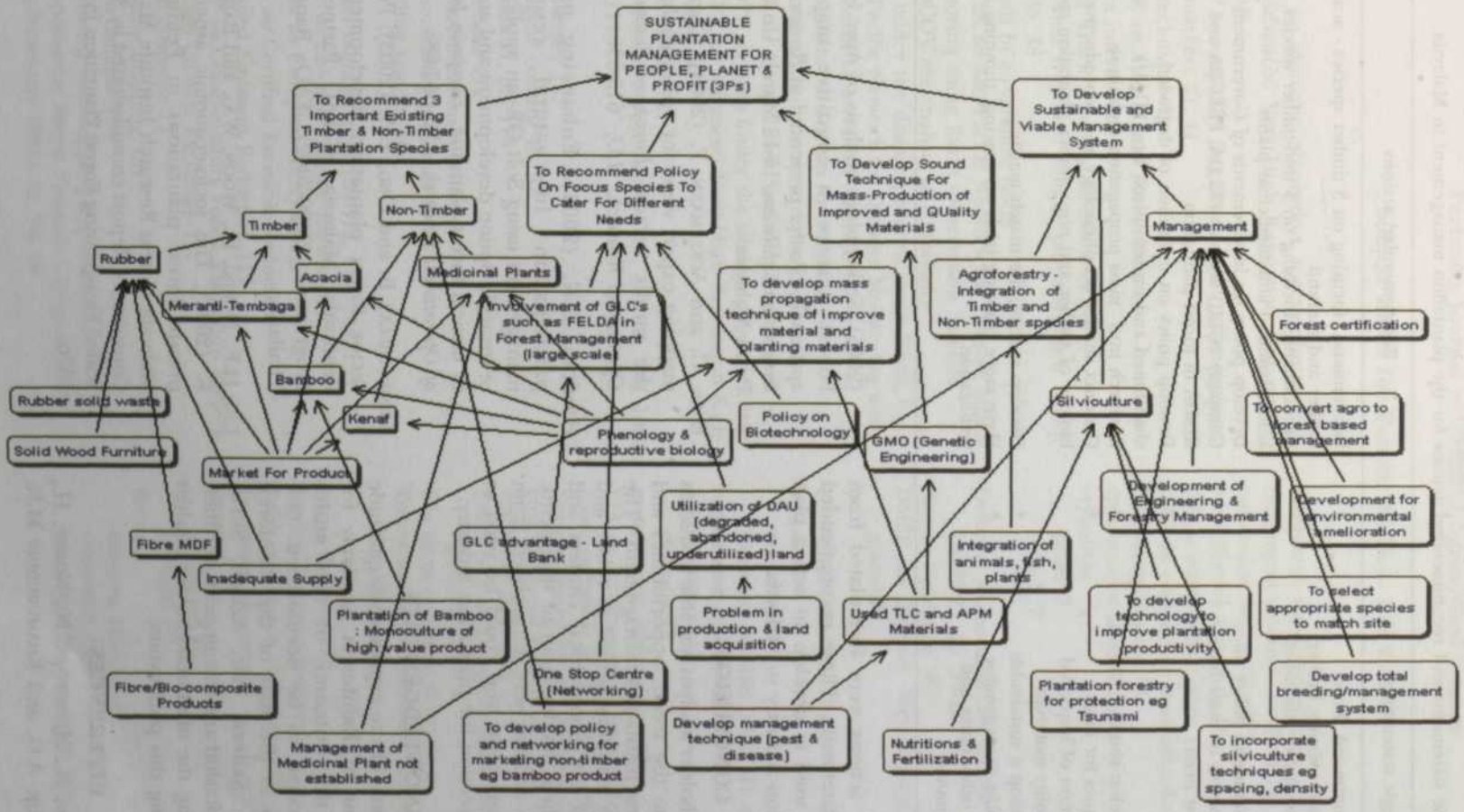

Fig 2: Cognitive map from multi stakeholder analysis

TABLE 1
Strategic statements and recommended actions for the plantation management in Malaysia

	Strategic statements		Recommended actions
1.	To recommend three important existing timber and non-timber plantation species	*	Recommend focusing on 3 timber species - acacia, rubber and meranti
		*	Recommend focusing on 3 non-timber species, i.e. kenaf, bamboo and medicinal plants
2.	To recommend policy on focal species to cater for different needs	*	Develop policy on involvements of Government Link Company (GLC) such as FELDA, FELCRA and RISDA in forest plantation
		*	Develop policy on utilization of degraded, abandoned and underutilized land (DAU)
3.	To develop sound techniques for mass production of improved and quality materials	*	Research into mass propagation technique
		*	Conduct studies on phenology and reproductive biology of timber and non- timber plantation species
4.	To develop a sustainable and viable management system (silviculture and management)	*	Develop species/site match matrix
		*	Have more planting trials on spacing, thinning and fertilization

Recommended actions were formulated from the strategic statements. These recommended actions can be used to develop an action plan for the plantation industry in Malaysia.

CONCLUSION

The multi-stakeholder analysis was able to discuss issues related to the trend, opportunities and obstacles of forest plantation management. The cognitive group mapping helped to relate and link issues and the hierarchical clusters and aggregation help to develop strategic statements. Recommended actions were formulated from the strategic statements and could be used to chart future direction for plantation industry.

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Manuscript review: Manuscripts deemed suitable for publication are sent to the Editorial Advisory Board members and/or other reviewers. We encourage authors to suggest the names of possible reviewers. Notification of the editorial decision is usually provided within to six weeks from the receipt of manuscript. Publication of solicited manuscripts is not guaranteed. In most cases, manuscripts are accepted conditionally, pending an author's revision of the material.

Author approval: Authors are responsible for all statements in articles, including changes made by editors. The liaison author must be available for consultation with an editor of The *Journal to answer* questions during the editorial process and to approve the edited copy. Authors receive edited typescript (not galley proofs) for final approval. Changes cannot be made to the copy after the edited version has been approved.

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Manuscript preparation

Pertanika accepts submission of mainly four types of manuscripts. Each manuscript is classified as **regular** or **original** articles, **short communications**, **reviews**, and proposals for **special issues**. Articles must be in **English** and they must be competently written and argued in clear and concise grammatical English. Acceptable English usage and syntax are expected. Do not use slang, jargon, or obscure abbreviations or phrasing. Metric measurement is preferred; equivalent English measurement may be included in parentheses. Always provide the complete form of an acronym/abbreviation the first time it is presented in the text. Contributors are strongly recommended to have the manuscript checked by a colleague with ample experience in writing English manuscripts or an English language editor. Lingually hopeless manuscripts will be rejected straightaway (e.g., when the language is so poor that one cannot be sure of what the authors really mean). This process, taken by authors before submission, will greatly facilitate reviewing, and thus publication if the content is acceptable.

The instructions for authors must be followed. Manuscripts not adhering to the instructions will be returned for revision without review. Authors should prepare manuscripts according to the guidelines of Pertanika.

1. Regular article

Definition: Full-length original empirical investigations, consisting of introduction, materials and methods, results and discussion, conclusions. Original work must provide references and an explanation on research findings that contain new and significant findings.

Size: Should not exceed 5000 words or 8-10 printed pages (excluding the abstract, references, tables and/or figures). One printed page is roughly equivalent to 3 type-written pages.

2. Short communications

Definition: Significant new information to readers of the Journal in a short but complete form. It is suitable for the publication of technical advance, bioinformatics or insightful findings of science and engineering development and function.

Size: Should not exceed 2000 words or 4 printed pages, is intended for rapid publication. They are not intended for publishing preliminary results or to be a reduced version of Regular Papers or Rapid Papers.

3. Review article

Definition: Critical evaluation of materials about current research that had already been published by organizing, integrating, and evaluating previously published materials. Re-analyses as meta-analysis and systemic reviews are encouraged. Review articles should aim to provide systemic overviews, evaluations and interpretations of research in a given field.

Size: Should not exceed 4000 words or 7-8 printed pages.

4. Special issues
Definition: Usually papers from research presented at a conference, seminar, congress or a symposium.

Size: Should not exceed 5000 words or 8-10 printed pages.

5. Others
Definition: Brief reports, case studies, comments, Letters to the Editor, and replies on previously published articles may be considered.

Size: Should not exceed 2000 words or up to 4 printed pages.

With few exceptions, original manuscripts should not exceed the recommended length of 6 printed pages (about 18 typed pages, double-spaced and in 12-point font, tables and figures included). Printing is expensive, and, for the Journal, postage doubles when an issue exceeds 80 pages. You can understand then that there is little room for flexibility.

Long articles reduce the Journal's possibility to accept other high-quality contributions because of its 80-page restriction. We would like to publish as many good studies as possible, not only a few lengthy ones. (And, who reads overly long articles anyway?) Therefore, in our competition, short and concise manuscripts have a definite advantage.

Format

The paper should be formatted in one column format with the figures at the end. A maximum of eight keywords should be indicated below the abstract to describe the contents of the manuscript. Leave a blank line between each paragraph and between each entry in the list of bibliographic references. Tables should preferably be placed in the same electronic file as the text. Authors should consult a recent issue of the Journal for table layout. There is no need to spend time formatting your article so that the printout is visually attractive (e.g. by making headings bold or creating a page layout with figures), as most formatting instructions will be removed upon processing.

Manuscripts should be typewritten, typed on one side of the ISO A4 paper with at least 4cm margins and double spacing throughout. Every page of the manuscript, including the title page, references, tables, etc. should be numbered. However, no reference should be made to page numbers in the text; if necessary, one may refer to sections. Underline words that should be in italics, and do not underline any other words.

Authors are advised to use Times New Roman 12-point font. Be especially careful when you are inserting special characters, as those inserted in different fonts may be replaced by different characters when converted to PDF files. It is well known that 'μ' will be replaced by other characters when fonts such as 'Symbol' or 'Mincho' are used.

We recommend that authors prepare the text as a Microsoft Word file.

1. Manuscripts in general should be organised in the following order:
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   - *Authors of Short Communications should state the total number of words (including the Abstract)
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     Footnotes. Current addresses of authors if different from heading.
   - **Page 3: Abstract.** Less than 250 words for a Regular Paper, and up to 100 words for a Short Communication.
     For papers submitted to Pertanika Journal of Tropical Agricultural Science (JTAS) and Pertanika Journal of Science and Technology (JST), submissions should be made in English. Pertanika Journal of Social Sciences and Humanities (JSSH) accepts submissions in both English and *Bahasa Melayu*. However, if the paper is submitted in *Bahasa Melayu*, an abstract in English should be provided by the author submitting the paper.
     Keywords. Not more than eight in alphabetical order. Include the common name or scientific name, or both, of plant materials, etc.
   - **Page 4 and subsequent pages:** Text - Acknowledgments - References - Tables - Legends to figures - Figures.

2. **Authors' addresses.** Multiple authors with different addresses must indicate their respective addresses separately by superscript numbers:
   George Swan[1] and Nayan Kanwal[2]
   [1]Department of Biology, Faculty of Science, Duke University, Durham, North Carolina, USA.
   [2]Research Management Centre, Universiti Putra Malaysia, Serdang, Malaysia.

3. **Text.** Regular Papers should be prepared with the headings **Introduction, Materials and Methods, Results and Discussion, Conclusions** in this order. Short Communications should be prepared according to *"9. Short Communications."* below.

4. **Tables.** All tables should be prepared in a form consistent with recent issues of Pertanika and should be numbered consecutively with Arabic numerals. Explanatory material should be given in the table legends and footnotes. Each table should be prepared on a separate page. (Note that when a manuscript is accepted for publication, tables must be submitted as data - .doc, .rtf, Excel or PowerPoint file- because tables submitted as image data cannot be edited for publication.)

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   Swan and Kanwal (2007) reported that ...
   The results have been interpreted (Kanwal et al. 2006).
   - References should be listed in alphabetical order, by the authors' last names. For the same author, or for the same set of authors, references should be arranged chronologically. If there is more than one publication in the same year for the same author(s), the letters 'a', 'b', etc., should be added to the year.
   - When the authors are more than 11, list 5 authors and then et al.
   - Do not use indentations in typing References. Use one line of space to separate each reference. For example:
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     - Jalaludin, S. (1997b). The use of different vegetable oil in chicken ration. *Mal. Agriculturist*, 11, 29-31.
     - Tan, S.G., Omar, M.Y., Mahani, K.W., Rahani, M., Selvaraj, O.S. (1994). Biochemical genetic studies on wild populations of three species of green leafhoppers *Nephotettix* from Peninsular Malaysia. *Biochemical Genetics*, 32, 415 - 422.
   - In case of citing an author(s) who has published more than one paper in the same year, the papers should be distinguished by addition of a small letter as shown above, e.g. Jalaludin (1997a); Jalaludin (1997b).
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   Chapter in Book: Kanwal, N.D.S. (1992). Role of plantation crops in Papua New Guinea economy. In Angela R. McLean (Eds.), *Introduction of livestock in the Enga province PNG* (p. 221-250). United Kingdom: Oxford Press.

   Proceedings: Kanwal, N.D.S. (2001). Assessing the visual impact of degraded land management with landscape design software. In N.D.S. Kanwal and P. Lecoustre (Eds.), *International forum for Urban Landscape Technologies* (p. 117-127). Lullier, Geneva, Switzerland: CIRAD Press.

9. **Short Communications** should include **Introduction, Materials and Methods, Results and Discussion, Conclusions** in this order. Headings should only be inserted for Materials and Methods. The abstract should be up to 100 words, as stated above. Short Communications must be 5 printed pages or less, including all references, figures and tables. References should be less than 30. A 5 page paper is usually approximately 3000 words plus four figures or tables (if each figure or table is less than 1/4 page).

   *Authors should state the total number of words (including the Abstract) in the cover letter. Manuscripts that do not fulfill these criteria will be rejected as Short Communications without review.

STYLE OF THE MANUSCRIPT

Manuscripts should follow the style of the latest version of the Publication Manual of the American Psychological Association (APA). The journal uses British spelling and authors should therefore follow the latest edition of the Oxford Advanced Learner's Dictionary.

SUBMISSION OF MANUSCRIPTS

All articles submitted to the journal must comply with these instructions. Failure to do so will result in return of the manuscript and possible delay in publication.

The original manuscript and one copy, four copies of photographic figures, as well as a disk with the **electronic copy** (including text and figures) and a **declaration form** and **referral form A**, together with a **cover letter** need to be enclosed. They are available from the Pertanika's home page or from the Executive Editor's office. Please do **not** submit manuscripts directly to the editor-in-chief or to the UPM Press. All manuscripts should be submitted through the executive editor's office to be properly acknowledged and rapidly processed:

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The cover letter must also contain an acknowledgement that all authors have contributed significantly, and that all authors are in agreement with the content of the manuscript.

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As articles are double-blind reviewed, material that might identify authorship of the paper should be placed on a cover sheet.

Note When your manuscript is received at Pertanika it is considered to be in its final form. Therefore, you need to check your manuscript carefully before submitting it to the executive editor (see also **English language editing** below).

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Peer review

In the peer-review process, three referees independently evaluate the scientific quality of the submitted manuscripts. The Journal uses a double-blind peer-review system. Authors are encouraged to indicate in **referral form A** the names of three potential reviewers, but the editors will make the final choice. The editors are not, however, bound by these suggestions.

Manuscripts should be written so that they are intelligible to the professional reader who is not a specialist in the particular field. They should be written in a clear, concise, direct style. Where contributions are judged as acceptable for publication on the basis of content, the Editor or the Publisher reserves the right to modify the typescripts to eliminate ambiguity and repetition and improve communication between author and reader. If extensive alterations are required, the manuscript will be returned to the author for revision.

The editorial review process

What happens to a manuscript once it is submitted to Pertanika? Typically, there are seven steps to the editorial review process:

1. The executive editor and the editorial board examine the paper to determine whether it is appropriate for the journal and should be reviewed. If not appropriate, the manuscript is rejected outright.

2. The executive editor sends the article-identifying information having been removed to three, reviewers. Typically, one of these is from the Journal's editorial board. Others are specialists in the subject matter represented by the article. The executive editor asks them to complete the review in three weeks and encloses two forms: (a) referral form B and (b) reviewer's comment form. Comments to authors are about the appropriateness and adequacy of the theoretical or conceptual framework, literature review, method, results and discussion, and conclusions. Reviewers often include suggestions for strengthening of the manuscript. Comments to the editor are in the nature of the significance of the work and its potential contribution to the literature.

3. The executive editor, in consultation with the editor-in-chief, examines the reviews and decides whether to reject the manuscript, invite the author(s) to revise and resubmit the manuscript, or seek additional reviews. Final acceptance or rejection rests with the Editorial Board, who reserves the right to refuse any material for publication. In rare instances, the manuscript is accepted with almost no revision. Almost without exception, reviewers' comments (to the author) are forwarded to the author. If a revision is indicated, the editor provides guidelines for attending to the reviewers' suggestions and perhaps additional advice about revising the manuscript.

4. The authors decide whether and how to address the reviewers' comments and criticisms and the editor's concerns. The authors submit a revised version of the paper to the executive editor along with specific information describing how they have answered' the concerns of the reviewers and the editor.

5. The executive editor sends the revised paper out for review. Typically, at least one of the original reviewers will be asked to examine the article.

6. When the reviewers have completed their work, the executive editor and the editor-in-chief examine their comments and decide whether the paper is ready to be published, needs another round of revisions, or should be rejected.

7. If the decision is to accept, the paper is in press and the article should appear in print in approximately three to four months. The Publisher ensures that the paper adheres to the correct style (in-text citations, the reference list, and tables are typical areas of concern, clarity, and grammar). The authors are asked to respond to any queries by the Publisher. Following these corrections, page proofs are mailed to the corresponding authors for their final approval. At this point, only essential changes are accepted. Finally, the article appears in the pages of the Journal and is posted on-line.

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Authors are responsible for the linguistic accuracy of their manuscripts. Authors not fully conversant with the English language should seek advice from subject specialists with a sound knowledge of English. The cost will be borne by the author, and a copy of the certificate issued by the service should be attached to the cover letter.

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Lag time

The elapsed time from submission to publication for the articles averages 6-8 months. A decision of acceptance of a manuscript is reached in 1 to 3 months (average 7 weeks).

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