Pertanika J. Trop. Agric. Sci. 30(2): 83 - 96 (2007) ISSN: 1511-3701

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

AWANG NOOR, A.G.[1], NORINI, H.[2], KHAMURUDIN, M.N.[1], AHMAD AINUDDIN, N.[1] AND THORSEN, B.J.[3]

[1]*Department of Forest Management, Faculty of Forestry Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia*

[2]*Forest Research Institute Malaysia (FRIM), 52109 Kepong, Selangor Darul Ehsan, Malaysia*

[3]*The Royal Veterinary & Agricultural University, Rolighedsvej 23, 1958 Fredeiksberg, Copenhagen, Denmark*

Keywords: Economic valuation, **market evidence, regression analysis,** residual value technique, **stumpage value**

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.

ACKNOWLEDGEMENTS

The authors are grateful for financial support from the Danish International Development Agency (DANIDA), without whose help it might not have been possible to conduct this study. The permission to use the inventory data by the Faculty of Forestry is also acknowledged.

REFERENCES

AHMAD FAUZI, P., SALLEH, M., MOHD. SHAHWAHID, H.O., ABDUL RAHIM, N., AWANG NOOR, A.G. and MUHAMAD FARID, A.R. (2002). Cost of harvesting operations in compliance with ITTO guidelines. In N. Abdul Rahim (Eds.), *A model project for cost analysis to achieve sustainable forest management* 2: 63-84. Kuala Lumpur: FRIM/ITTO.

AWANG NOOR, A.G. and MOHD. SHAHWAHID, H.O. (1995). Estimation of stumpage values in three concession compartments of MUDA/ PEDU watershed area. Paper presented at the First Workshop on "Kaji*an kesan pembalakan terhadap waduk di Hutan Simpan Ulu Muda*", 23 January, Universiti Teknologi Malaysia, Skudai, Johor, Malaysia.

AWANG NOOR, A.G. and MOHD. SHAHWAHID, H.O. (1997). *Forest valuation: Malaysia-AIFM Pilot Project.* Final Report Submitted to ASEAN Institute of Forest Management and Forestry Department Peninsular Malaysia, Kuala Lumpur.

AWANG NOOR, A.G. and MOHD. SHAHWAHID, H.O. (2003). *Forest pricing policy in Malaysia* (EEPSEA Research Report No. 2003-RR2). Economy and Environment Program for Southeast Asia, Singapore.

AWANG NOOR, A.G., VINCENT J.R. and YUSUF H. (1992). *Comparative economic analysis of forest revenue systems in Peninsular Malaysia.* Final report submitted to Osborn Center Forestry Policy Grants Program, Washington D.C.

AWANG NOOR, A.G. and MOHD. RADHI, C. A. (2002). Perbandingan isi padu Pre-F, tagging dan Balai Pemeriksa Hutan dengan sifir isi padu setempat Hutan Simpan Ulu Jelai, Lipis, Pahang. Paper Presented at *MAJURUS*, 14th August, Seremban.

CHE ROSLAN, C.D. (1996). *Stumpage valuation in three logging blocks of Kelantan Timber Complex (KTC) Agreement Area* (B.S. For. Project. Faculty of Forestry, Universiti Pertanian Malaysia. Serdang, Selangor).

DAVIS, L.S. and JOHNSON, K.N. (2000). *Forest Management* (4th ed.). New York: McGraw Hill.

DOMINIC, E. (1995). Stumpage appraisal for timber concession in Johor, Malaysia (B.For.Sc. Thesis. Faculty of Forestry, Universiti Pertanian Malaysia, Serdang, Selangor, 1995).

DUERR, W.A. (1993). *Introduction to Forest Resources Economics.* New York: McGraw Hill.

GRAY, J.W. (1983). Forest revenue systems in developing countries. FAO Forestry Paper No. 43. Rome: Food and Agriculture Organization.

GRUT, M., GRAY, J.A. and EGLI, N. (1991). Forest pricing and concession policies: Managing the high forest of west and central Africa. World Bank Technical Paper No. 143.

HUSSIN, T. (2003). Stumpage valuation of logged-over dipterocarp forest within the Kalabakan Forest Reserve, Sabah (M.S. Project Report, Faculty of Forestry, Universiti Putra Malaysia, Serdang, Selangor, 2003).

KLEMPERER, W.D. (1996). *Forest Resource Economics and Finance.* New York: McGraw Hill.

LEHUJI, P. L. (2003). Stumpage valuation of Compartment 40, Deramakot Forest Reserve, Ulu Kinabatangan, Sabah (M.S. Project Report. Faculty of Forestry, Universiti Putra Malaysia, Serdang, Selangor, 2003).

LEUSHNER, W.A. (1984). *Introduction to Forest Resource Management.* New York: John Wiley and Sons.

NUR HAJAR, Z.S. (1999). Stumpage appraisal using tender price in Pahang, Peninsular Malaysia (M. S. Project Report, Faculty of Forestry, Universiti Putra Malaysia, 1999).

PAIMAN, B. and AMAT RAMSA, Y. (n.d.). Hutan Simpan Ayer Hitam: Warisan komuniti Koridor Raya Multimedia. Faculty of Forestry, Universiti Putra Malaysia. Serdang, Selangor.

PIUS, P. (1995). Biodiversity at one hectare plot in Air Hitam Forest Reserve (B.For.Sc. Thesis, Faculty of Forestry, Universiti Pertanian Malaysia. Serdang, Selangor, 1995).