

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

AWANG NOOR, A.G.<sup>1</sup>, NORINI, H.<sup>2</sup>, KHAMURUDIN, M.N.<sup>1</sup>,  
AHMAD AINUDDIN, N.<sup>1</sup> AND ISMARIAH, A.<sup>2</sup>

<sup>1</sup> Department of Forest Management, Faculty of Forestry  
Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia

<sup>2</sup> Forest Research Institute of Malaysia (FRIM), 52109 Kepong,  
Selangor Darul Ehsan, Malaysia

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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 Lebu 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 <sup>1</sup>	70.4

<sup>1</sup> 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 <i>Orang Asli</i>	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:

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

where *SV* is the stumpage value (RM/ha), *P* is the ex-forest log price (RM/m<sup>3</sup>), *C* is the logging cost (RM/m<sup>3</sup>), *PM* is the profit margin (RM/m<sup>3</sup>), and *V* is the estimated timber volume (m<sup>3</sup>/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<sub>ij</sub>*) varies due to variations in log price (*P<sub>ij</sub>*) 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<sup>3</sup> (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):

$NV = \sum Q_i \times (P_i - C_i)$ , 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:

$NB_i = \sum Q_i \times VMP_i$ , 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 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  $\alpha$ ,  $\beta_1$ ,  $\beta_2$ , and  $\beta_3$  will be estimated parametrically. The mean maximum WTP for forest conservation can be calculated using the following formula:

Mean maximum WTP =

$$\frac{1}{-\beta_1} [\ln(e^{\alpha + \beta_2 AGE_i + \beta_3 INCOME_i})] \quad (3)$$

The formula for median WTP is:

Median maximum WTP =

$$WTP = \frac{1}{-\beta_1} [\alpha + \beta_2 AGE_i + \beta_3 INCOME_i] \quad (4)$$

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:

$$LEV = SV + SV^* \left[ \frac{1}{(1+r)^{30} - 1} \right], \text{ where } SV \text{ is the}$$

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* (tongkat 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:

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

The median maximum WTP is:

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

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:

$$EV = \text{RM13} * 3.2 \text{ million} = \text{RM42 million}$$

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

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

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

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

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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