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Resource Valuation of Kuala Selangor Mangrove Forest

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17.1 Introduction

Mangroves reflect a multiple-use ecosystem providing a wide range of products and services. Its produce range from firewood, charcoal, poles, tannins to sugar, dye and medicines and many more (Hamilton and Snedaker, 1984). Among the services provided by mangroves are coastal protection from storms (Muhammad Akhir, 1994) and tidal waves or tsunami, regulation of water level, nutrients, support to fisheries and preservation of gene pool (Davies and Claridge, 1993).

Although the benefits of mangroves are widespread, mangroves are still being reclaimed for various reasons. In Malaysia, one of the reasons for the loss of mangroves is their conversion to other land uses, such as agriculture and shrimp culture (Chan *et al*., 1993). Mangrove forests in Malaysia had decreased 11.8% in area from 505,000 ha to 446,000 ha since 1980 to 1990 (Chan *et al*., 1993).

The benefits of mangroves are better known for its scientific attributes (Sasekumar *et al*., 1992; Sasekumar, 1993; Singh *et al*., 1994; Chong *et al*., 1996) rather than economic worth. Hence, knowledge on the economic importance of mangroves is limited only to the resource economists and not to the public or more importantly, the policy makers. As a result, mangrove forests are being viewed as wasteland and hence, converted to other land uses despite numerous scientific studies proving its ecological importance.

Scientific evidence, it seems, is not enough to protect the mangroves and scientific knowledge could only be appreciated by the scientific community. Therefore, with the use of environmental economics as a tool, the ecological linkages between elements within mangrove ecosystems and between other systems could be presented in monetary terms. A vital sustainable economic principle is that natural resources and environments are multifunctional and possess high economic values.

In Malaysia, studies on the environmental economics subjects are rather limited. Wong (1997) emphasized on the need for economic valuation of the marine and coastal resources for tourism benefits. Chan *et al*., (1993) recorded the importance of mangrove forests and acknowledged its value although no exact figures were estimated. Muhammad Akhir (1994) emphasized on the value of mangroves in coastal protection, while Singh *et al*. (1994) focused on the

value of mangroves as nursery and feeding grounds for coastal fisheries. Bann (1996) studied both the economic and ecological benefits of mangrove relating to tourism activities, while Mohd. Shahwahid (1997) studied the incremental costs of wetland conservation.

There is a need to devise the best practicable solutions aimed at sustainable development. This is the policy design role of environmental economics, which is the ultimate objective of sustainable mangrove management. Prior to achieving the above goal, basic evaluation studies on mangrove ecosystems need to be carried out to provide the basic economic information. By having more insights on the real value of mangrove forests, decision making on issues related to mangroves will be more balanced.

This paper presents results of a valuation study of the mangrove forest at Kuala Selangor which aims to estimate the total economic value (TEV) of the mangroves and to find out public's "willingness to pay" (WTP) for mangrove conservation. This particular site was chosen due to the existing conflicting uses of the mangrove ecosystem which is under great pressure for conversion to other economic activities.

17.2 Valuation of environmental goods and services

Environmental goods and market failure

In a perfectly competitive market, the price of a particular good will increase when there is scarcity, but will decrease when there is abundant supply. This is based on the rationale that when one person consumes a good, another person is deprived of utilizing that good. However, for environmental goods, such as a nature park, the usage of one person does not exclude others from using it. In fact, most environmental goods are 'public' goods or only a nominal sum is charged for utilization. Most environmental goods are considered public goods where people have unlimited access to it. Without property rights attached, this scenario, a characteristic of environmental goods, reflects market failure; thereby indicating that classical economic theory needs to be modified to reflect the "use pattern" of environmental goods.

Valuation of environmental goods

Valuation of environmental goods such as natural resources is related to the benefits derived by human from utilization of the resources. In recent years, many valuation studies of natural resources and environmental goods have been undertaken (e.g. Lim *et al*., 1993; Dixon and Sherman, 1991; Costanza *et al*., 1997).

The concept of total economic value (TEV)

Valuation of natural resources is related to the benefits derived by humans from utilization of the resources. Therefore, total valuation of a mangrove ecosystem requires an appraisal of all the net benefits of its ecosystem. The TEV expressively incorporates the linkages between various types of exploitation as well as protection of stocks, environmental functions and biodiversity attributes of an ecosystem. These include the linkages between mangrove conversion, offshore fishery productivity, traditional uses and the benefits of erosion control and biodiversity maintenance functions.

The framework of total economic valuation of mangrove forests in Kuala Selangor is shown in Fig. 1. Estimation of the TEV was based on the aggregation of use and non-use values. Use values

include products from fisheries, resources from mangrove forests, recreational benefits, coastal erosion protection and option value. Non-use values include both existence and bequest values. Due to the differences in each component, various valuation techniques are used to value each component based on their suitability.

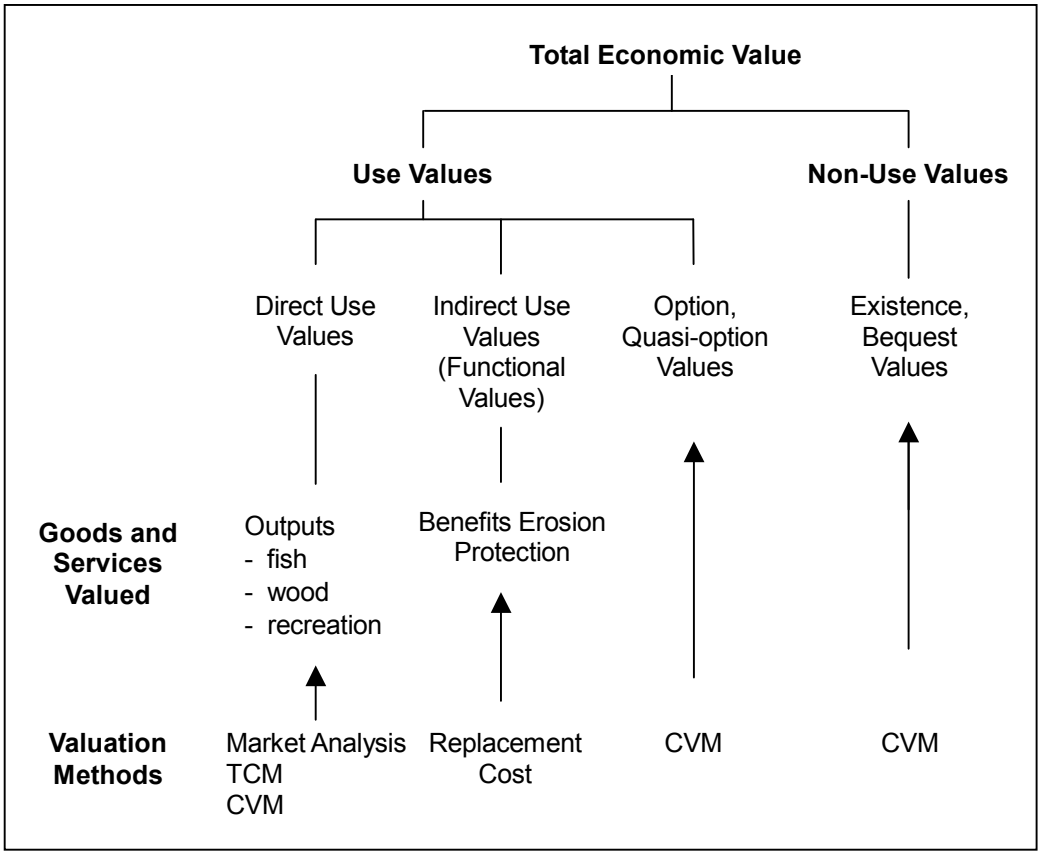

Fig. 1. Components of the TEV and various valuation techniques used. CVM = Contingent Valuation Method; TCM = Travel Cost Method.

Use values could be divided into direct and indirect use values. Direct use values are values derived from direct use or interaction with an ecosystem's resources and services. Direct uses of a mangrove ecosystem include both consumptive and non-consumptive uses. Examples of consumptive uses are mangrove poles collection, forestry activities, agriculture activities, use of water in the mangroves, hunting and fishing. Non-consumptive uses are based on the mangrove ecosystem's 'services' such as recreation, tourism, *in situ* research and education and navigation along watercourses.

Indirect use values are indirect support and protection provided to economic activity and property by the ecosystem's natural functions, or regulatory environmental services. The indirect use

value of an environmental function is related to the change in the value of production or consumption of the activity of property that it is protecting or supporting.

Within the framework of use values is the option value. Option value is regarded as the value of the environment as a potential benefit as opposed to actual present use value. It is an expression of preference or a willingness to pay, for the preservation of an environment in exchange for the probability that the individual will make use of it at a later period.

Non-use values are values derived neither from current direct nor indirect use of an ecosystem. The categories under non-use value are the existence value and bequest value.

Existence value is a value placed for an environmental good and which is unrelated to an actual or potential use of the good. There are people who value them and are willing to pay for their existence, without taking part in the direct use of the goods. What they value is the *existence* of the environmental goods such as the mangrove forests or highly endangered species of wildlife in the forests.

Bequest value relates to the idea of willing a supply of natural environments to one's heirs or to future generations in general. Although this value is categorized under the nonuse values (for the current generation), there are possibilities of the natural environments being used in the future. Pearce and Turner (1990) categorized bequest value as a motive under existence value. However, for the purpose of this study, the TEV by Barbier (1994) was adopted and bequest value is used instead of bequest motive.

Willingness to pay (WTP)

When buying goods, an individual expresses his or her WTP by exchanging money for the goods, and in return, the WTP reflects his or her preferences. The concept of benefit can be explained as individual's preferences. A positive preference for something is reflected in the form of WTP for it. However, individual's WTP will differ. In terms of social preferences, individual's WTP are aggregated to secure a total WTP. While it can be assumed that an individual will not pay for something he or she does not want, it cannot be ascertained that the WTP as measured by the market price accurately measures the whole benefit to either individuals or society. This is because there may be individuals who are willing to pay more than the market price. In this case, the benefit received is higher than the market price indicates. This excess is known as consumer's surplus.

17.3 Background information of the study site

The district of Kuala Selangor is located in the State of Selangor, on the west-coast of Peninsular Malaysia. It comprises nine sub-districts and covers an area of 117,844 ha. The estimated 1995 population of Kuala Selangor was 128,755 people (Kuala Selangor District Council, 1997).

Mangrove forest areas in the district cover approximately 379 ha, and comprises of the North Banjar (258 ha) and South Banjar (111 ha) forest reserves (Selangor State Forestry Department, 1994). A thin belt of mangrove forest also lines the Sg. Selangor estuary and further upstream of Kg. Kuantan.

According to Loh (1998), approximately 100,000 visitors come to Kuala Selangor annually. Foreigners represented 50% of the figure. The total annual income to the local community was estimated at US Dollar (USD) 0.96 million or Ringgit Malaysia (RM) 2.4 million [1 USD ≡

RM2.50]. The three main attractions at Kuala Selangor are the fireflies at Kg. Kuantan, migratory and local birds at Kuala Selangor Nature Park (KSNP), and seafood.

The firefly (*Pteroptyx tener*) colonies in Kg. Kuantan are known worldwide. At Kg. Kuantan, the mangrove trees, locally known as 'berembang' (*Sonneratia caseolaris*) line the banks of Sg. Selangor. At night, thousands of fireflies can be seen gathering on the 'berembang' trees. Their magnificent display of lights, has become a tourist attraction since 1970 (Bann, 1996). The number of tourists (local and foreign) has been steadily increasing over the years.

The KSNP, which is located on the west coast of Kuala Selangor District, south of Sg. Selangor estuary is a very well-known nature park. The major ecosystem of the park is mangrove forest, a habitat for 12 species of mangrove plants and 156 species of birds (MNS brochures on birds). Kuala Selangor is also popular for its fisheries resources and seafood. Fish landings in 1997 were recorded at 24,243 metric tonnes worth more than USD17.5 million (RM43.7 million). Cockle production for 1997 was estimated to be more than 7,500 tonnes worth more than USD3.2 million (RM8 million). The cockles were cultured on 708 ha of mudflats. Brackish-water aquaculture mainly producing tiger shrimp, sea bass and crab produced more than 300 tonnes of production worth more than USD2.64 million (RM6.6 million) (Department of Fisheries, Selangor, 1998). The aquaculture activities were carried out on 76.54 ha of former mangrove land.

Although Kuala Selangor is currently boasting a considerably good income from tourism, the coastal area of Kuala Selangor, especially the area where KSNP stands today, has been under intense pressure for development since the 1960s. During 1965 and 1966, a coastal bund was constructed to reclaim land for agricultural purpose at the site (Mohd. Shahwahid, 1997). Subsequently, the landward mature mangrove forest was logged under a State logging licence (Muhammad Akhir, undated in Mohd. Shahwahid, 1997) but the area was never developed for agricultural use. Next, in early 1970s, the mangrove forest south of the existing KSNP was cleared to create evaporational salt pans (Davison *et al*., 1989 in Mohd. Shahwahid, 1997). The project was abandoned and resulted in a loss of the mangrove forest.

Subsequently, in the mid-1980s, the State Government planned a new township located at the former salt pan area. As a result, further land was cleared prior to construction (Mohd. Shahwahid, 1997). The development of the new town site has exposed the adjacent mangrove forest to threats of other development proposals, including golf courses and housing estate projects. In 1987, the State Government of Selangor finally opted to move the new town site further south and saved part of the South Banjar Forest Reserve. The South Banjar Forest Reserve covered an area of 1,139 ha in 1963 but decreased to 257 ha in 1979 (Lim and Sasekumar, 1979). It now covers only 111 ha (Selangor State Forestry 1994 data, unpublished).

The present study began in June 1998 and a socio-economic survey was conducted at the project site from July to September 1998. The survey was carried out to gather data on the pattern of mangrove utilization by the local community as well as by the local and foreign tourists. The local community, local and foreign tourists represented the main user group. Another survey covering the Malaysian public as the non-user group was also conducted to get a more balanced result. Both descriptive and quantitative analyses were used in presenting the results. Valuation techniques, such as market survey, travel cost method and replacement costs were adopted in estimating the TEV of mangrove forests in Kuala Selangor District.

17.4 Value of the Kuala Selangor Mangrove Forest

Fisheries resources

Fisheries resources refer to the fisheries landings and aquaculture production for the state of Selangor.

Marine fisheries landing data from 1995-1997 were used as the basis of calculation to produce an average annual landing. The landings were correlated with the acreage of mangroves for the state of Selangor in order to give amount of landing per area of mangroves per year (tonnes ha^{-1} yr^{-1}). The landings were then converted into monetary value of RM $ha^{-1}yr^{-1}$ based on the retail price. Based on the study by Sasekumar *et al*. (1994), 50% of coastal fish landings was considered as mangrove dependent in Peninsular Malaysia. This assumption is close to the more recent estimate of 47% dependency for Klang Strait (see Chong *et al.*, this book).

Based on the marine fisheries landings for the state of Selangor, the average annual landings was calculated at 113,292.67 tonnes yr^{-1} in production or RM376,645,139.00 yr^{-1} (USD150,658,056 yr^{-1}) in value. Marine fisheries are considered off-shore fisheries and are only partly dependent on mangroves. Based on the 50% mangrove-dependency assumption, the marine fisheries productivity and value for the state of Selangor was calculated to be 56,646.33 tonnes yr^{-1} and worth RM188,322,569.50 yr^{-1} (USD75,329,028 yr^{-1}), respectively. Based on the total mangrove area of 15,093 ha for the state of Selangor, productivity per ha per year was estimated at 3.75 tonnes ha^{-1} yr^{-1} or RM12,477.48 ha^{-1} yr^{-1} (USD4,991 ha^{-1} yr^{-1}).

For Kuala Selangor which has a total of 379 ha of mangroves, productivity and value of landings were estimated to be 1,422 tonnes yr^{-1} and RM4,728,972.0 yr^{-1} (USD1,891,589.0 yr^{-1}), respectively.

The banks of Sg. Selangor are lined with mangrove trees, indicating some influence of saltwater. The mangrove trees can be found as far upstream as Kg. Kuantan, the home of the firefly colonies. Besides helping to control riverbank erosion, the mangrove waterways are also thought to function as breeding and nursery grounds for juvenile fishes and shrimps. It is known that fishing activities exist in the river. However, since there were no official data on riverine fisheries of Sg. Selangor, estimation carried out by Chong (1996) was used in this study.

The riverine fisheries was assumed to be supported not only by the mangrove trees lining the banks of Sg. Selangor, but also the mangrove forests in North and South Banjar area in Kuala Selangor. This is based on the assumption that without the mangroves in the North and South Banjar area, the coastal area of Kuala Selangor would be exposed to erosion and the upstream riverine resources will be affected. Therefore, productivity of the river will be correlated to the total area of mangrove forest in Kuala Selangor district (379 ha).

Based on Chong (1996), the total riverine production in 1994 was 3,320 kg worth about RM33,000 or USD13,200. Therefore, the productivity was estimated to be 8.76 kg ha^{-1} yr^{-1} which is equivalent to RM87 or USD34.8 $ha^{-1}yr^{-1}$.

The estimation of aquaculture resources considered only mangrove-compatible aquaculture activities. The compatible activities include cockle and mussel farming, while brackishwater ponds are considered as competitive activities. The main reason is that, brackishwater pond farming is constructed by clearing mangroves. Based on the observation of the present study area, it can be assumed that all brackish pond aquaculture are located on former mangrove forest. Therefore, the production from these ponds will not be included in the estimation of TEV of mangrove forests.

Aquaculture activities in Kuala Selangor include the culture of blood cockle (*Anadara granosa* or locally known as kerang) on mudflats, rearing of green mussel (*Perna viridis* or locally known as kupang or siput sudu) and mangrove crab (*Scylla* spp. or locally known as ketam batu or ketam bakau) fattening.

Based on the total aquaculture production of Kuala Selangor district for three years (1995, 1996 and 1997), the average production was estimated to be 8,240,833 kg/yr worth RM7,502,071.07/yr or USD 3,000,828.43/yr in value. Based on the total mangrove forest in Kuala Selangor (379 ha) which is assumed to support the aquaculture activities, the aquaculture production in Kuala Selangor district was estimated to be 21,744 kg/ha/yr with a value of RM19,794.38/ha/yr or USD7,917.75/ha/yr.

Mangrove resources

Data for mangrove resources were collected from the socio-economic survey; where a special section for mangrove resources was allocated within the questionnaire. Respondents were questioned on the type of resources harvested, average amount and frequency of harvest monthly and some basic socio-economic characteristics. The location of harvest activities was also identified to ascertain that the products harvested were within the mangrove area.

A total of 199 respondents were interviewed. However, only 64 samples were used for calculation as 60 samples did not have adequate data for calculation. Data collected were treated as follows:

1. Samples were divided into two groups: those who sold their harvested products and those who consumed for subsistence purpose.
2. Resources harvested for both groups were firstly identified. Next, total harvest per month was calculated based on the average and frequency of harvest per month.
3. The total net benefit for local direct use was calculated using the following formula:

   Local direct use value = net income generated for local use = $\Sigma (P_iQ_i - C_i)$

   where P_i = local market price of product $_i$

   Q_i = amount of product i being collected

   C_i = costs involved in the collection of product $_i$

Where the product was sold, gross income (P_iQ_i) was calculated based on local market price of the product (P_i). However, where the products were used for subsistence purpose, surrogate prices were used for P_i. Two approaches may be used to obtain the surrogate prices:

- use market price of the closest substitute for such a product
- use the opportunity cost of time spent in collecting the product

In this study, the first option (price of closest substitute product) was used. Substitute products used in the study were chosen based on the following criteria:

- product which provides the same needs and cost the least
- product availability in the local market
- common product consumed by the locals

The cost (C_i) was calculated using opportunity cost of time spent in collecting the product. Calculation was carried out firstly, by identifying the average monthly income per person in the local community, which was RM1,300 (USD520) based on the socio-economic survey conducted. The daily wage of RM43.00 (USD17.20) was estimated (based on 30 days per month). Respondents were assumed to collect resources during their leisure time; valued at 1/3 of the daily wage for developing country (UNEP, 1994) (cited in Sathirathai, 1998). Therefore, an opportunity cost of RM14.45 (USD 5.78) was used in the calculation of cost.

The assumption of respondents collecting mangrove products during leisure times was based on the fact that no respondents regard collecting products from the mangroves as their main occupation (based on the survey). Thus, the harvesting of mangrove products is considered as a part-time job.

Based on data provided by 61 collectors where seven types of resources were harvested, the mean annual net benefit per household was RM18,107.73/hh/yr (USD 7,243.10/hh/yr) and the total annual net benefit was RM96,574.57/yr (USD38,629.83/yr). Thus, the total annual net benefit generated by the local coastal community was estimated to be RM254.81/ha/yr (USD101.92/ha/yr).

Recreational benefits

The travel cost method adopted in this study was based on Dixon and Hufschmidt (1986). TCM were used to calculate consumer surplus for two recreational sites in Kuala Selangor, i.e., KSNP and Kg. Kuantan. The survey was carried out mainly during weekends, between 25 July and 14 September 1998. A total of 59 and 34 respondents were interviewed for KSNP and Kg. Kuantan, respectively. The recreational benefits were estimated based on the following procedures:

- Determination of zone of origin: zones of origin were divided based on the districts in the state of Selangor and other states in Peninsula Malaysia.
- Calculation of annual visitation rate: annual visitation rate was calculated based on visit/1,000 population. The calculation used the following formula:

$$\text{Visit/1,000/year} = \frac{(V_i/n)\, N \times 1{,}000}{P}$$

where V_i = visitors from zone $_i$

n = sample size

N = total local visitors per year; for KSNP = 11,520 (Mohd. Esa, 1997), Kg. Kuantan = 30,526 (Kelip-Kelip Trading Services Sdn. Bhd., 1998)

P = total population (1966) in zone (see http://www.selangor.gov.my).

- Calculation of total travel cost: average travel cost per round trip (to and from each zone to the recreation site) was calculated. Travel time which is the average time taken for the round trip was converted to monetary term based on the average per capita income of RM12,500/yr or USD5,000/yr. Calculated cost of travel time was RM0.02/minute or

USD0.008/minute. Kg. Kuantan is located about 5 km from KSNP. Therefore, an additional 20 minutes of travel time was added.

- Estimation of regression equation: regression equations for both sites were estimated by regressing visitation rate on total travel cost for all zones.
- Calculation of visitation rates at various admission fees: based on the regression equations above, visitation rates at various admission fees were calculated for all zones.
- Derivation of user's demand curve: based on the visitation rates calculated, a user's demand curve was derived for each recreation site.
- Calculation of consumer's surplus: the total area under the user demand curve was calculated to give the consumer's surplus for each site.

Recreational benefits were calculated in terms of consumer surplus for two sites, i.e., KSNP and Kg. Kuantan (KK). The estimated consumer surplus yielded from KSNP and KK were RM25,238.42/yr (USD10,095.40/yr) and RM365,352.40/yr (USD146,148.00/yr), respectively. The sum of both sites provided the total recreational benefits from mangroves which came to RM390,590.82/yr (USD156,236.30/yr) or RM2,287/ha/yr (USD915/ha/yr) based on 379 ha of mangroves in Kuala Selangor.

Coastal protection

Data on embankments constructed in erosion-prone areas in Kuala Selangor were obtained from the Drainage and Irrigation Department, Kuala Selangor. Average construction plus maintenance costs of the structure were considered. The cost of construction and maintenance of rip-rap was adopted as they were more complete. The structure was assumed to be intact for two more months (until June 1998) after the last maintenance in April 1998.

Besides constructing structural embankments, coastal protection could also be carried out by replanting mangroves. However, it is observed that the common practice in the study site (and in Malaysia) when dealing with coastal erosion, is to construct a structural embankment rather than to plant mangroves. The reason could be that, structural embankments could be constructed in much shorter time (several months or years depending on the area) than to wait 20-25 years for mangrove plants to mature. Furthermore, only the planting costs of mangroves are known, while the cost of maintenance was not known. The survival rate of the mangrove plants and the cost to replace non-surviving plants were also not known.

Therefore, in this study, the replacement cost for coastal protection used the cost of constructing and maintaining structural embankment (rip-rap), instead of the cost of replanting mangrove trees. Nevertheless, the data of mangroves replanting was shown here for comparative purpose.

Replanting data were gathered from State Forestry Department, Selangor. The data from 1992 to 1998 were recorded in RM/ha. Therefore, the estimation is rather simple where all costs from 1992 to 1998 were summed up and averaged to give the cost in RM/ha/yr.

The value of mangroves in protecting coastal areas were estimated based on replacement cost of building and maintaining a structural embankment (rip-rap) and the cost of replanting mangroves. The cost of constructing and maintaining a simple stone-piled embankment or a rip-rap was estimated to be RM34,605/ha/yr (USD13,842/ha/yr) while the cost of replanting was

RM90.59/ha/yr (USD36.24/ha/yr) (see below). Data on the cost of construction and maintenance of structural embankments in Kuala Selangor District is shown in Table 1.

Based on Table 2, the one-time cost of constructing structural embankments ranged from RM46,667 - 7,500,000/km (USD18,666.8 - 3,000,000/km) depending on the type of structure. The maintenance cost per year ranged from RM30,769 - 100,000/km/yr (USD12,307.60 - 40,000/km/yr).

The estimation on the replacement cost of mangroves by structural embankment used the rip-rap structure as model because the data on construction and maintenance for rip-rap structure was more complete as compared to other types of structures shown in Table 3.

Table 1. Data on the cost of structural embankment in Kuala Selangor District, Malaysia.

Month/1998	Length of Coastline (km)	Type of Protection	Cost USD (RM)	USD/km (RM/km)
Early 1998	1.5 (Bagan Pasir -Kg. Sg. Yu)	Rip-rap (construction)	28,000.00 (70,000.00)	18,666.80 (46,667.00)
March	0.5 (Bagan Pasir)	Rip-rap and vetiver grass (maintenance)	20,000.00 (50.000.00)	40,000.00 (100,000.00)
April	0.5 (Bagan Pasir)	Rip-rap (maintenance)	8,000.00 (20,000.00)	16,000.00 (40,000.00)
May-June	0.04 (Parit 3, Sg. Burong)	Sea pile (construction)	120,000.00 (300,000.00)	3,000,000.00 (7,500,000.00)
One year	13.0 (Tg. Karang-Sekinchan)	Maintenance	160,000.00 (400,000.00)	12,307.60 (30,769.00)

Source: Drainage and Irrigation Department, Kuala Selangor (pers. comm.).

The rip-rap at Bagan Pasir was constructed at a cost of RM46,667/km/yr (USD18,666.80/km/yr) in early 1998. The maintenance cost for March, 1998 was RM100,000.00/km (USD40,000.00/km) and in April, 1998, RM40,000.00/km (USD16,000.00/km). After April 1998, there was no further maintenance done. In order to give the replacement cost in USD/ha/yr unit, the total length of coastline in Kuala Selangor district currently covered with mangroves, which is 40.15 km (estimated using GIS map traced from 1980s topography map) was 'replaced' with rip-rap at the cost of RM326,667/km/yr or USD130,666.8/km/yr. This gave a value of RM13,115,680/yr or USD5,246,272.0/yr. Assuming that the mangroves at the coastline is supported by the total mangroves in Kuala Selangor district, which is 379 ha, the value for replacement cost in terms of RM/ha/yr was estimated to be RM34,606/ha/yr or USD13,842/ha/yr.

Based on Table 3, the total cost of planting mangrove trees for 7 years in an area of 495 ha was RM313,888.60 (USD125,555.44). Therefore, the average cost of planting mangrove trees per ha per year is RM90.59 (USD36.24/ha/yr).

Table 2. Detailed estimation of replacement cost for mangroves by rip-rap structure in Kuala Selangor District, Malaysia.

Items	Cost USD/km
Construction cost/km	RM46,667 or USD18,666.8/km
Maintenance cost/km	March: RM100,000.00 or USD40,000.00
	April: RM40,000.00 or USD16,000.00
Total maintenance cost/km for half a year	RM140,000.00 or USD56,000.00
Projection of maintenance cost/km/yr	RM280,000.00 or USD112,000.00/km/yr
Total cost (construction cost + maintenance)/km/yr	RM46,667.00 + RM280,000.00 = RM326,667.00/km/yr or USD130,666.8/km/yr
Total length of coastline currently covered with mangroves	40.15 km
Total value of mangroves protecting the coastline	RM326,667.00 × 40.15 = RM13,115,680/yr or USD5,246,272/yr
Total value of mangroves protecting the coastline in USD/ha/yr	RM13,115,680/yr ÷ 379 ha = RM34,606/ha/yr or USD13,842/ha/yr

Table 3. The cost of mangrove replanting programme in Kuala Selangor District, Malaysia (1992-1998).

Year	Location	Block	Area (ha)	Cost USD (RM)
1992	North Banjar	A	50	11,080.00 (27,700.00)
		B	60	2,969.44 (7,423.60)
1993	North Banjar	NA	50	8,000.00 (20,000.00)
1994	North Banjar	B	50	13,000.00 (32,500.00)
1995	North Banjar	NA	30	9,336.00 (23,340.00)
1996	North Banjar	C	70	19,600.00 (49,000.00)
		A	20	5,480.00 (13,700.00)
		B	25	6,850.00 (17,125.00)
1997	North Banjar	D	70	19,600.00 (49,000.00)
1998	North Banjar	F	30	15,400.00 (38,500.00)
		E	40	14,240.00 (35,600.00)
Total Cost for 7 years (1992-1998)			**495**	**125,555.44 (313,888.60)**

Source: Selangor State Forestry Department; unpublished data.

The cost of constructing and maintaining structural embankment (rip-rap) was used to reflect the cost of coast protection while the cost of mangrove replanting are shown as a comparison.

Option, existence and bequest values were gathered directly during the survey that involved the local community, local tourists, foreign tourists and Malaysian public. The mean value for each group was calculated. The percentage of respondents that were willing to pay in each group was determined. The effective population size used for projection of the total value was based on the sample size. However, only the population above 15 years old was considered in this estimation as they were considered to have the ability to pay. The proportion of this population group was 64% based on the World Factbook (http://www.odci.gov/publication/factbook/my.html). The projected values were then converted into RM/ha/yr and USD/ha/yr. Estimations of option, existence and bequest values were based on individual WTP, the results of which are shown in Tables 4, 5 and 6, respectively.

Table 4. Estimation of option value.

Option Value	Average USD (RM)	% WTP	Effective Population Size	Effective Population > 15 yrs	Value USD (RM)
Local community	7.23 (18.07)	84	142,226	91,025	552,660 (1,381,650.27)
Local tourist	14.83 (37.07)	77	11,638	11,638	132,878 (332,193.91)
Foreign tourist	16.12 (40.29)	11	3,192	3,192	5,659 (14,146.62)
Malaysian public	13.68 (34.19)	84	2,000,000	1,280,000	14,704,435 (36,761,088.00)
Total					**15,395,632 (38,489,078.80)**

Table 5. Estimation of existence value.

Option Value	Average USD (RM)	% WTP	Effective Population Size	Effective Population > 15 yrs	Value USD (RM)
Local community	4.71 (11.78)	89	142,226	91,025	381,730 (954,324.31)
Local tourist	11.85 (29.62)	74	11,638	11,638	102,036 (255,090.99)
Foreign tourist	14.60 (36.50)	13	3,192	3,192	6,058 (15,146.04)
Malaysian public	8.86 (22.16)	84	2,000,000	1,280,000	9,530,693 (23,826,432.00)
Total					**10,020,397 (25,050,993.34)**

Table 6. Estimation of bequest value.

Option Value	Average USD (RM)	% WTP	Effective Population Size	Effective Population > 15 yrs	Value USD (RM)
Local community	6.53 (16.32)	89	142,226	91,025	532,848 (1,322,119.92)
Local tourist	16.47 (41.17)	76	11,638	11,638	145,657 (364,143.71)
Foreign tourist	16.12 (40.29)	13	3,192	3,192	6,687 (16,718.74)
Malaysian public	10.82 (27.06)	87	2,000,000	1,280,000	12,053,606 (30,134,016.00)
Total					**12,734,799 (31,836,998.37)**

For the purpose of estimation of TEV, these three values were added up and averaged as preservation value, in term of hectare of mangrove. Thus the preservation value was estimated at RM83,884.85/ha/yr (USD 33,553.94/ha/yr).

The TEV of mangroves in Kuala Selangor, calculated by summing up all the use and non-use values, was estimated at RM153,392/ha/yr (USD61,357/ha/yr) (Table 7). This value is not entire as there are other values not included in the calculation such as carbon sequestration and water filtration services of the mangroves.

Table 7. Total economic value of mangroves in Kuala Selangor District, Malaysia.

TEV Components	Value (RM/ha/yr)	Value (USD/ha/yr)
Use Values		
Fisheries resources	12,477.50	4,991.00
Aquaculture production	19,794.38	7,917.75
Mangrove resources	254.81	101.92
Riverine resources	87.07	34.83
Recreational benefits	2,286.80	914.725
Coastal protection	34,605	13,842
Sub-total	**69,507**	**27,803**
Non-Use Values		
Preservation value*	83,884.85	33,553.94
Option value	(101,554.30)	(40,621.72)
Existence value	(66,097.61)	(26,439.04)
Bequest value	(84,002.63)	(33,601.05)
Sub-total	**83,884.85**	**33,553.94**
Total	**153,392**	**61,357**

*Preservation value is the average of option, existence and bequest values.

The TEV of Kuala Selangor mangroves is the highest when compared to other TEV studies carried out in Indonesia, Thailand and Mexico (Table 8). The studies in Indonesia, Thailand and Mexico estimated the TEV of mangrove forest in their respective sites to be in range of about USD2,700 to USD4,000. However, it should be noted that the studies by Meilani (1996) in Indonesia; Sathirathai (1998) in Thailand and Cabrera *et al.* (1998) in Mexico only valued a total of 4 or 5 components, while we estimated 7 components of the TEV. The type of TEV components valued by each researcher also differs. This study took into consideration the marine and riverine

Table 8. Comparison of total economic value (TEV) of different valuation studies (in terms of USD).

	TEV Components	Meilani (1996)	Sathirathai (1998)	Cabrera (1998)	This Study
	Use Values				
1.	Fisheries resources	-	83	1,578	4,991
2.	Aquaculture production	-	-	-	7,918
3.	Forestry resources	-	-	1,082	-
4.	Mangrove resources (local direct use)	765	141	-	102
5.	Riverine resources	-	-	-	35[a]
6.	Recreational benefits	-	-	-	915
7.	Coastal protection	638[b]	3,111	-	13,842
8.	Carbon sequestration	-	85	-	-
9.	Water filtration	-	-	1,193	-
10.	**Preservation Value**	1,785	-	1.02	33,554
	Option value	(15)[c]	-	-	(40,622)
	Existence value	(1,770)	-	-	(26,439)
	Bequest value	-	-	-	(33,601)
	Total Economic Value (USD/ha/yr)	**3,188**	**3,420**	**2,772**	**61,357**
	Remarks on Study				
	▪ Components valued	▪ 4	▪ 5	▪ 4	▪ 7
	▪ Area (ha)	▪ 489.1	▪ 400	▪ 127,000	▪ 379
	▪ Type of ecosystem	▪ Mangrove	▪ Mangrove	▪ Mangrove	▪ Mangrove
	▪ Site	▪ Mayangan Village, West Java, Indonesia	▪ Tha Po Village, Surat Thani, Thailand	▪ Terminos Lagoon, Campeche, Mexico	▪ Kuala Selangor, Malaysia

[a]Based on Chong (1996);

[b]Includes coastal protection (USD637.9/ha/yr) and input of organic matter for shrimp production (USD0.02/ha/yr);

[c]Based on Ruitenbeek (1994).

fisheries, aquaculture (excluding brackishwater pond aquaculture), mangrove resources and recreational components to form the direct use value. Meilani (1996) did not consider the riverine, aquaculture and recreational components while Sathirathai (1998) did not estimate the riverine and recreational components. Cabrera *et al.* (1998) only considered the marine fisheries and forestry to form the direct use value of the TEV.

One important factor that could also explain why the TEV varied between each study is that the mangroves at each study site differ physically, chemically and biologically which in turn may result in different levels of biodiversity, productivity and economic activities. This is supported by the study of Ewel *et al.* (1998) where the three types of mangrove forests identified (fringe, riverine and basin) provide different goods and services. Riverine mangroves are thought to be the most productive to animal and plant productivity. Basin mangroves are important in producing wood products while fringe mangroves are important for shoreline protection. Apart from the difference in mangroves, the method of analysis adopted in these studies differed in their estimations of the TEV.

Based on previous studies, it was observed that there is a considerable difference of mangroves usage pattern by the local community in different countries of the world. The studies in developing countries such as Malaysia (Leong, 1999), Thailand (Sathirathai, 1998), Indonesia (Ruitenbeek, 1994; Aglionby, 1995 and Meilani, 1996), India (Ghosh and Santra, 1995) and Nigeria (Eaton and Sarch, 1997) acknowledged the local direct use of mangrove forest by including this component in their estimation.

However, studies in United States (Costanza *et al*., 1989) and Mexico (Cabrera *et al*., 1998) did not really estimate the local direct use of mangroves. Most of the local direct use values of mangroves were already absorbed in the fishing and forestry activities. Gathering of mangrove products such as nipa palms, honey and firewood, and hunting for wildlife such as birds for subsistence purpose were not recorded in the studies in United States (Costanza *et al*., 1989) and Mexico (Cabrera *et al*., 1998).

The methods used in estimating certain components of the TEV of mangroves may eventually influence the overall TEV. For example, in this study, the replacement cost of structural embankment was used to reflect the value of coast protection by mangroves. Another method that can be used as a proxy to coastal protection is the value of property protected by mangroves. If the property happened to be some high-class hotel, or an historical site, the value will be very high and eventually increase the TEV.

Due to various factors influencing the estimation of TEV in all the studies (i.e. the components valued, the different productivity and functions of mangroves, the method of analysis and assumptions used), it is very difficult to make direct comparisons on the value of mangrove forests from different parts of the world, based solely on the TEV. One has to examine in more detail, the mangrove forest, socioeconomic pattern of the local population and the methodology of analysis before a convincing comparison can be made.

17.5 Analysis of components of total economic value

The high TEV value obtained from the present study could be explained by examining the detailed components as shown in Table 9 where preservation value contributed the highest percentage (54.7%) of the total TEV, followed by coastal protection (22.6%) and aquaculture (12.9%).

Preservation value

Barbier (1994) suggested a different approach to estimate the non-use value of TEV, that is, by valuing option, bequest and existence values separately. However, if these values are aggregated, then, 'double counting' will occur. Since preserving a certain area of mangroves will ensure that the option, bequest and existence values will be included simultaneously, this value was used instead of separating the three values. The preservation value was highlighted by Munasinghe and Lutz (1992) in Barton (1994). According to them, the values (option, quasi-option, existence and bequest values) originate from the same environmental asset and therefore their estimation may be inter-linked.

Aggregation will increase the preservation value and make the TEV seems more valuable, when in fact, this is not the real case. Therefore, in the present study all three non-use values were averaged to produce preservation value. All three values are non-use values where valuation comes from non-usage of the resource. As such, there is no physical product that is harvested, produced or marketed in non-use values. In deriving the non-use values, respondents expressed their WTP for the option of using the mangroves in the future (option value), just to know that the mangroves exist (existence value) and also to ensure that the mangroves are inherited by the future generations (bequest value).

Table 9. Detailed components of total economic value (TEV) analysis.

TEV Components	Productivity (kg/ha/yr)	Value USD/ha/yr (RM/ha/yr)	Percentage (%)
Use Values			
Fisheries resources	3,750	4,991 (12,477.50)	8.13
Aquaculture production	12,965	7,918 (19,794.38)	12.90
Mangrove resources	61.8	102 (254.81)	0.16
Riverine resources	8.8	35 (87.07)	0.06
Recreational benefits		915 (2,286.80)	1.49
Coastal protection (structural)		13,842(34,605)	22.6
Sub-total		**27,803 (69,507)**	**45.3**
Non-Use Values			
Preservation value (option, existence, bequest values)		33,554 (83,884.85)	**54.7**
Total Economic Value		**61,357 (153,392)**	**100.00**

According to Barton (1994), values derived from non-uses such as option, existence and bequest values (preservation values), depend on the number of people, their awareness of the resource, their level of information and their preferences for the resource and its characteristics. In the present study, there was positive trend on education level and WTP for the preservation value (Fig. 2). The percentage of respondents who were willing to pay increased with higher levels of education (secondary or tertiary level) for the option, existence and bequest values. As compared to groups with lower education level (not educated and primary education), the trend was not conclusive.

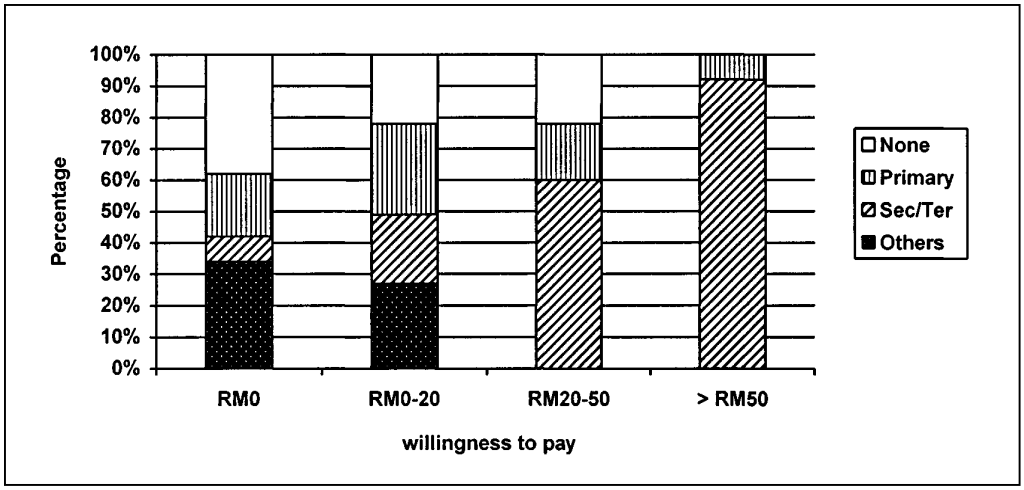

Fig. 2. Relation between education level and willingness to pay for preservation value.

There was also a tendency for all groups of respondents to place a higher WTP to bequest value, followed by option and existence values. This shows that they regard the mangroves more as a valuable piece of natural resources to be inherited by the future generations than to keep it for their own use.

Two significant factors that could influence the WTP were income and education level. Fig. 3 shows the relation between income and willingness to pay. People can afford to pay more when they have more money. However, whether they want to pay more or less depends on their preferences of a particular subject; in this case, mangrove forests. Willingness to pay may be influenced by their level of awareness. On the other hand, the level of awareness of each respondent, may be greatly influenced by his or her level of education.

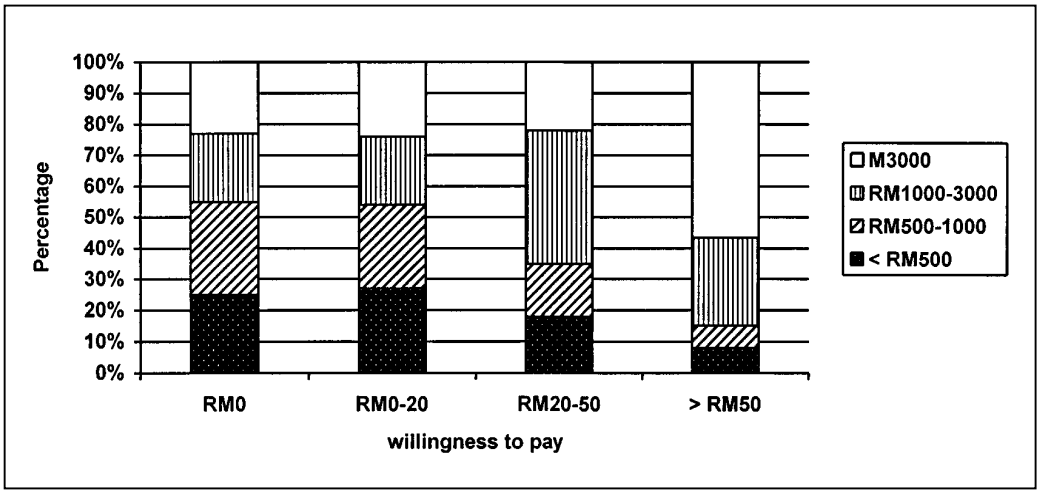

Fig. 3. Relation between income level and willingless to pay for preservation value.

The GDP per capita purchasing power parity for Indonesia, Thailand and Malaysia were USD4,600, USD8,800 and USD10,750, respectively (based on 1996 estimates as cited from http://www.odci.gov). The literacy level in all three countries varied from 83.8%, 93.8% and 83.5% for Indonesia, Thailand and Malaysia, respectively (based on 1995 estimates as cited from http://www.odci.gov).

With regards to different GDP in various countries, there was some concern that this will influence individual's WTP. Data on WTP for mangrove forest in Indonesia (Meilani, 1996) was compared against the WTP obtained from the present study. Both countries are considered developing countries. Although Malaysia's GDP was 2.34 times higher than Indonesia's (USD10,750 compared to USD4,600), the total WTP for preservation value was found to be 18.8 times higher (USD33,554 compared to USD1,785). Based on this simple comparison, it could be concluded that other factors, apart from GDP, may play an important role in determining the WTP for preservation value of mangrove forests in each country.

Compared to a developed country in Asia, such as Japan, the GDP per capita purchasing power parity of Japan was very much higher, at USD24,500 with 100% literacy level (1996 estimates as cited from http://www.odci.gov). A study of WTP for headwater conservation of the Tanagawa river basin (Japan) by Yoshida (1997) found that the average WTP/household/yr was USD925/household/yr (RM2,312 or ¥7,708). In comparison, the average WTP per household for the present study was very low, at about USD8/household/yr. Based on this scenario, it is thought that the WTP could be influenced by the income and education level of respondents.

The CVM method used in the present study did not consider the effect of multiple destination visitors on the WTP due to limitation in technical knowledge. It is also not the objective of the study to conduct a very detailed analysis on this aspect. However, a study by Sorg *et al.* (1985) (cited in Beal, 1998) indicated that multiple destinations visitor placed higher value than single destination visitor.

Aquaculture

In the present study, aquaculture resources contributed about 13% of the total TEV, amounting to about RM19,794.38/ha/yr (USD7,918/ha/yr). Blood cockles contributed to about 99.7% of the total aquaculture production and 98.5% of the total value of aquaculture in Kuala Selangor. The coastal mudflat area from Kuala Selangor to Sg. Buloh is home to the second largest cockle bed in Malaysia.

Blood cockle culture is an important sector in Kuala Selangor mainly due to the availability of natural spatfall beds in the coastal area of Kuala Selangor. Between 1995 and 1997, Kuala Selangor produced about 65 to 70% of the total cockle production in Selangor worth RM6.5 to 9.0 million/yr (USD2.6 - USD3.6 million/yr) (DOF Selangor, 1996 and 1997; DOF Selangor, 1998), and supplied almost 10.0% of the total blood cockle production in Malaysia (DOF Malaysia, 1998).

Marine, riverine and mangrove forest resources

Although the marine fisheries resources contributed only 8.13% of the total TEV of Kuala Selangor mangrove forest, it is important in terms of employment. There was a total of more than 1,000 licensed fisherman in Kuala Selangor. Unlicensed fishermen exist and were substantial but there was no available information.

Riverine and mangrove forest resources do not really contribute much to the total TEV (less than 0.3%). The reason could be that fishing and harvesting activities in rivers and mangrove forests are more for subsistence rather than commercial exploitation.

However, based on the income gained from harvesting mangrove resources, which was estimated at RM18,107.73/household/yr (USD7,243.10/household/yr), the average monthly income from harvesting mangrove forest resources was calculated to be about USD603. 6/month (RM1,509/month) for each household. This figure is considered high as compared to the average fisherman's income in the west coast of Peninsular Malaysia which was estimated at RM1,110/month (USD444/month) for commercial fisherman and RM642/month (USD257/month) for traditional fisherman (LKIM, 1998).

Recreational benefits

Recreational benefits estimated in this study was found to be RM2,287/ha/yr (USD915/ha/yr) for both KSNP and Kg. Kuantan. Recreational benefits for each of the site were calculated at RM712.50/ha/yr (USD285/ha/yr) and RM1575.00 ha/yr (USD630/ha/yr), respectively. There were two studies on consumer surplus carried out earlier in KSNP (Zuraidah, 1996 and Mohd. Esa, 1997). However, consumer surpluses estimated by both studies were very far apart. Mohd. Esa (1997) estimated an annual consumer surplus of RM1,530/ha/yr (USD612/ha/yr) while Zuraidah (1996) estimated a very low value at only RM12.50/ha/yr (USD5/ha/yr). This study also estimated a low consumer surplus value of RM712.50/ha/yr (USD285/ha/yr).

The major reason for the differences in all three studies could be due to the slightly different methods used to analyze the data. Although all three studies used the TCM in principle, Mohd. Esa (1997) used a model where the visitation rate was a function of the travel cost, income, age, education level, time spent in recreational area etc. Zuraidah (1996) used a modified travel cost demand function where visitation rate was a function of travel cost and income. The modified travel cost demand function was compared with the Gum-Martin approach. The difference between the two is the former approach computed consumer surplus using predicted values of visit per capita, while the latter used the actual individual visits per capita. The present study used only the travel cost as a function of visitation rate to the recreational area.

Kennedy (1998) and Beal (1998) discussed the effect of length of time spent by visitors in a national park and their travel cost. The TCM assumed that visitors from a further zone of origin incurred a higher travel cost to a recreational area compared to a visitor from a nearer zone. However, it was found that visitors staying for a longer period of time (a few days) might actually incur less travel cost than daily visitors. The other reason could be due to the low number of respondents sampled in the present study (59 respondents). Mohd. Esa (1997) based his estimation on a total of 96 local tourists as respondents, while Zuraidah (1996) based her estimation on 121 respondents (105 locals and 16 foreigners).

Coastal protection

The total value of shoreline protection by mangroves estimated in this study, RM34,605/ha/yr (USD13,842/ha/yr), made up a substantial 22.6% of the TEV. However, the annual value per km at RM326,667/km/yr (USD130,668/km/yr) is considered quite low as compared to the figure of RM1,175,000 - RM1,593,000/km/yr (USD470,000/km/yr - USD637,200/km/yr) estimated by Hiew and Lim (1994). The estimation by Hiew and Lim (1994) was based on the cost of construction and maintenance of SAUH and rock revetment in the state of Selangor. SAUH is a Malay name for anchor. It is actually made of concrete slabs designed to interlock with each other, creating a

concrete cover on erosion prone area. It is usually used for coastal erosion. This study used the cost of construction and maintenance of rip-rap structure which is actually rocks placed in an interlocking manner. This structure is much simpler compared to SAUH revetment.

17.6 Conclusions

The TEV of the Kuala Selangor mangrove forest was estimated to be in the region of RM153,392/ha/yr (USD61,357/ha/yr). The estimation did not consider other usage components of the TEV such as carbon sequestration and filtration services. TEV of mangrove forests from different regions may vary due to differences in the physical, chemical and biological properties of the mangroves.

The education level of the local coastal community in Kuala Selangor, dominated by Malays and Chinese, is generally low. However, the number of people receiving primary and secondary education is still higher compared to the national fisherman. The average monthly income is also relatively higher than the average for coastal communities on the west coast of Peninsular Malaysia as well as the national fisherman's income.

Majority of the local community in Kuala Selangor were already aware of mangroves at childhood and primary school age, and would object strongly to development that will destroy mangroves in their area. Many also felt very strongly for conservation of the remaining strip of mangroves in Kuala Selangor as evident from the high WTP to manage the forests properly (about 85%). The study also showed that they regarded mangroves as a valuable piece of natural resource to be inherited by their future generations. Therefore, judging by these indications, it is imperative that the current and future planning of the coastal area of Kuala Selangor should take into account the value of the mangrove forest to all stakeholders.

In valuing natural resources such as mangrove forest, using TEV alone will not really reflect the actual value of the forest. In more practical terms, a cost-benefit analysis should be undertaken to view the value of the resources in terms of a period of time where opportunity costs are considered. At present, there is also a tendency to study the management options of certain natural resources. Using this approach, different management options can be appraised and therefore will provide a more reliable result. This way, more justice could be done to the mangrove forest. However, TEV as a valuation methodology, can be used to provide the basic information on the value of components of natural resources.

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