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Environmental values and resource management options: a choice modelling experience in Malaysia

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ABSTRACT. The management of the Matang Mangrove Wetlands in Perak State, Malaysia is under review. To assist decision makers in determining the optimal management strategy, a choice modelling application was undertaken to estimate the non-market values provided under different management options. Implicit prices for environmental attributes including the area of environmental forest protected, the number of bird species protected and the recreation use of the area were estimated. In addition, the implicit price of a social, non-market attribute, the employment of local people in wetland based extractive industries, was estimated. Compensating surplus estimates for a number of alternative wetland management scenarios were also calculated.

1. Introduction

The Matang mangrove wetlands are located in the subdistrict of Matang in the state of Perak, Malaysia. The wetlands measure about 40,000 hectares and represent 40 per cent of the total mangroves in Malaysia. The mangroves have been gazetted as a protected forest since the 1920s.

Current government policy requires that the 'Management Plan for the Matang Mangroves' is reviewed and renewed by the Department of Forestry once every ten years. Loggers and charcoal producers have lobbied the Department of Forestry to increase the allocation of forest area for

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timber production. Currently, 20 per cent of the total forest area is reserved for environmental functions (total protection). No logging is permitted in this area. The basis for determining the allocation of forest areas for timber production and environmental functions has been largely historical. The management authorities of the Matang wetlands are also interested in developing wetland-based recreation, encompassing riverine boating, sport fishing, bird watching, and archeological site visits.

Decisions regarding the future management of the Matang mangroves are focused on changes to the various service flows that emanate from the forest and wetlands under alternative management strategies. The values held by society for the alternative outcomes – including environmental service flows such as logging forest area, recreational opportunities, and number of endangered species – are key to an understanding of which alternative will yield society the greatest net benefit.

This study is specifically aimed at generating data on non-market values so that policy-makers can better ascertain if the forest resources have been managed in the most desirable way from the perspective of society at large. In other words, this study attempts to inform the process of determining a more desirable (Pareto improving) management plan, relative to the current plan, from the public point of view. The analysis is important, as it seeks to identify and reduce any mismatch between what the public wants and the levels of environmental services that have been considered desirable from the technical and commercial perspectives of the Department of Forestry. An appropriate non-market valuation technique is required to estimate the welfare impacts of each management alternative. The choice modelling (CM) technique was selected for this role.

The second section of this paper provides information on the various service flows that emanate from the Matang mangroves. This is followed by an overview of the various non-market valuation techniques that are available in order to gain an appreciation of the appropriateness of CM. Subsequent sections present the theoretical framework and method of CM, followed by a literature review of environmental valuation in Malaysia, the design of CM questionnaires and application, and discussion of results and interpretation. The paper concludes with a discussion on some policy implications based on the findings of the study.

2. The Matang mangroves

The Matang mangroves are classified by the Matang Forest Management Plan into two forest types – the 'production forest' and 'unproductive forest'. The production forest comprises 80 per cent (32,746 hectares) of the total forest area in the mangroves. Whilst production forests may yield some environmental values, the focus of their management is the sustainable production of timber outputs. The timber is used mainly for the production of charcoal. Currently, 1,261 people are employed in forestry-related activities in the production forests.

The unproductive forests constitute some 20 per cent of the Matang mangroves (7,405 hectares). The term 'unproductive' is a legal definition which means that no amount of timber extraction is allowed in this forest area. This forest type provides mainly environmental protection and

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conservation functions. Hence, in this paper, we use the term environmental forests to refer to the term unproductive forests. The environmental forests (unproductive forests) comprise three main compartments – 'dryland forest', 'new forest', and 'functional forest'.

The dryland forest provides shelter for agricultural crops and houses next to the Matang mangroves. The new forest stabilizes new mudflats in the coastal and estuarine areas. Mudflats are areas where many species of fish, prawns, shellfish, and other marine fauna spawn and feed. Mudflats are also used as culture beds for cockles. The mudflats along the shores of Matang are refuelling and roosting sites for large numbers of migratory birds. The new forest also provides a food source for fruit bats that pollinate durian flowers. Matang is one of the largest durian (a popular native fruit) producing areas in Perak. The functional forest includes virgin jungle reserves, research forest, archaelogical reserves, bird sanctuary, ecotourism forest, and educational forest.

Bird watching has become an increasing popular recreational activity in the Matang mangroves. The mangroves are habitat to 154 species of birds out of a total of 650 species recorded in Peninsular Malaysia. Of the 154, 49 species are migratory birds. Two species of migratory birds are the highly endangered Milky Stork (numbering about 130–150) and the Lesser Adjutant. The mangroves also support a large population of migratory coastal waterbirds – in the range of 75,000 to 180,000 during the northern winter months. The riverine areas in the mangroves offer potential for sport fishing. Currently there are about 100 recreationists weekly. Given better access and facilities like jetty, boat ramps, and chalets, visitation is expected to increase substantially.

Apart from the production of charcoal and construction poles from the forestry sector, the Matang mangroves also produce various commercial species of fishes and shrimps. The number of people employed in both the forestry and fishery sectors currently stands at around 4,000.

3. Overview of non-marketed goods valuation techniques

A wide variety of non-market valuation techniques has evolved in the literature. Each of these techniques has its own characteristics and hence capabilities.

The travel cost method (TCM) (Ward and Beal, 2000) has the advantage of capturing environmental values, based on actual market data. However, its application has been limited to assessing on-site current use values of recreational resources. It cannot be used to assess non-use values.

The contingent valuation (CV) method is capable of yielding estimates of all types of environmental values, including non-use values (Mitchell and Carson, 1989). However, CV is less flexible in estimating the values of multiple changes in individual attributes that make up a resource. In a typical CV study, respondents and policy-makers are left with the decision as to whether or not they will gain or lose the whole environmental good. Frequently, resource managers are more interested to know the marginal values of changes (either partial or simultaneous) in the levels of attributes, such as forest area, forest harvest, the number of forest species, and recreational opportunities.

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The CM method has the capacity to estimate values for alternative multi-attribute resource use options and marginal changes in each individual attribute. It therefore has the ability to produce estimates for a range of alternative resource management options from a single application (Bennett and Blamey, 2001). Therefore, in this study, CM was chosen to examine the welfare impacts of multiple resource use options for Matang mangroves wetlands.

4. Theoretical framework and method of CM

In CM questionnaires, respondents are asked a series of questions in which 'choice sets' are presented. Each choice set usually contains three or more resource use options. Respondents are asked to choose their preferred option from each choice set. The options in each choice set are described using common attributes, which take on various levels. The combinations of attribute levels for each option in each choice set are established using experimental design techniques. Similar to a CV study, before the choice sets are presented to respondents, there is a description of the study site, the research issues, the proposed policy changes, and the implications for the environmental attributes that are being modelled.

Choice modelling has evolved from conjoint analysis in the marketing and transport literature. Recently it has been developed and applied in the environmental economics context by Opaluch *et al*. (1993), Adamowicz *et al*. (1994), Rolfe *et al*. (2002), Morrison *et al*. (1999), and others.

The theoretical basis of CM is random utility theory (RUT) (McFadden, 1986). Under RUT it is assumed that the utility function of a good can be broken down into two parts, one deterministic (V) and one stochastic (ε). Utility of an option i for individual n (U_{in}) is assumed to depend on environmental attributes of the option (Z_i) and the socio-economic characteristics of the individual (S_n).

$$U_{in} = V(Z_i, S_n) + \varepsilon(Z_i, S_n) \tag{1}$$

The probability that individual n will choose option i over another option j is given by

$$\text{Prob}(i|C) = \text{Prob}\{V_{in} + \varepsilon_{in} > V_{jn} + \varepsilon_{jn}\,;\, j \in C\} \tag{2}$$

where C is the complete choice set. It is assumed that the error terms of the utility function are independently and identically distributed (IID). A consequence of this assumption is the property of independence of irrelevant alternatives (IIA). The IIA property requires that the probability of choosing one alternative over another is entirely dependent on the utility of the respective alternatives.

The probability of choosing option i is given by

$$\text{Prob}(i) = \frac{\exp^{\mu V_i}}{\sum_{j \in c} \exp^{\mu V_j}} \tag{3}$$

where $V_i = V(Z_i, S)$ is the indirect utility function, Z_i is a vector of environmental attributes, S is a vector of socio-economic characteristics,

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and μ is a scale parameter, which is usually assumed to be equal to 1 (implying constant error variance). Equation (3) is estimated by means of a multi-nomial logit regression, which assumes that choices are consistent with the IIA property.

The most basic form of V_i is an additive structure, which includes the attributes from the choice sets only, e.g.

$$V_i = ASC + \sum \beta_k Z_{ik} \tag{4}$$

where *ASC* is an alternative specific constant, β is a vector of coefficients, and Z are attributes from the choice sets. The effects of attributes in the choice sets are captured by the Z variables, while the *ASC* captures any systematic variations in choice observations that are associated with an alternative that are not explained either by the attribute variation or respondents' observed socio-economic characteristics. In a multi-nomial logit with l options there are $l - 1$ *ASC*s.

It is possible to include socio-economic as well as attitudinal variables into the utility functions by estimating the variables interactively, either with the *ASC* or with any of the attributes from a choice set, e.g.

$$V_i = ASC + \sum_n \gamma_n ASC^* S_n + \sum_k \beta_k Z_k + \sum_{kn} \delta_n^* Z_k \tag{5}$$

where S_n represents socio-economic or environmental attitudinal variables for the nth individual.

In the event of a violation of the IID assumption, a nested logit estimation procedure may be appropriate. This involves an explanation of respondents' choices by way of a step-wise process that can be depicted as a decision tree. This allows for correlations among error terms within subsets of alternatives in each branch of the decision tree. In a two-level nested logit model, the probability of an individual choosing the hth alternative in class r (P_{hr}) is represented as

$$P_{hr} = P(h \mid r) P(r) \tag{6}$$

where $P(h \mid r)$ is the probability of the individual choosing the hth alternative conditional on choosing the rth class of outcome, and $P(r)$ is the probability that the individual chooses the rth class. Following Kling and Thompson (1996)

$$P_i(h \mid r) = \frac{\exp[V_{ihr}/\alpha_r]}{\exp[I_r]} \tag{7}$$

$$P_{ir} = \frac{\exp[\alpha_r I_r]}{\sum_{k=1}^{R} \exp[\alpha_k I_k]} \tag{8}$$

where

$$I_r = \log \left[\sum_{i=1 \text{ to } J\, r} \exp(V_{ir}/\alpha_r) \right] \tag{9}$$

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is referred to as the inclusive value. This is a measure of the expected maximum utility from the alternatives associated with the *r*th class of alternatives. The coefficient of inclusive value α_r measures substitutability across alternatives.

The results of the CM application can be used to estimate the 'implicit prices' of the attributes used to describe the resource use options. These are the marginal rates of substitution between the non-marketed attributes and a monetary attribute. They can be used to understand better the relative values of the non-marketed attributes, *ceteris paribus*.

Depending on how the CM application is designed, it is also possible to use the results to derive estimates of the compensating surplus (CS) or the equivalent surplus (ES) that results from a change in resource use. The former measures the change in income that would make an individual indifferent between the initial (lower environmental quality) and subsequent situations (higher environmental quality) assuming the individual has the right to initial utility level. This change in income reflects the individual's willingness to pay (WTP) to obtain an improvement in environmental quality. On the other hand, ES assumes an individual has implied rights to the subsequent utility level. Hence, it represents individuals' WTP to avoid degradation in environmental quality.

Based on the indirect utility functions, the compensating surplus can be illustrated as follows

$$V_0(G_i, Z_0, M) = V_1(G_i, Z_1, M - CS) \tag{10}$$

where M is income, Z_0 and Z_1 represent different sets of environmental attributes (Z_0 being usually interpreted as the set of attributes prior to a policy change), and G_i represents other marketed goods.

Using the results from the multi-nomial logit model, the *CS* can be estimated by employing the following equation (Adamowicz *et al.*, 1994).

$$CS = -1/(\beta_M)\left\{\ln\left(\sum_i \exp^{V_0}\right) - \ln\left(\sum_i \exp^{V_1}\right)\right\} \tag{11}$$

where β_M is the coefficient of the monetary attribute and is assumed to be the marginal utility of income. Equation (11) allows for the valuation of multiple sites. This study considers only one site. Therefore, following Boxall *et al*. (1996) and Morrison *et al.* (1999), equation (11) is reduced to

$$CS = \left\{-1/\left(|\beta_M|\right)\right\}(V_0 - V_1) \tag{12}$$

where V_0 and V_1 represent the initial and subsequent utility states, respectively.

Kling and Thompson (1996), Herriges and Kling (1997), and Choi and Moon (1997) discuss the required adaptations for the nested logit case. For a two-level nested logit model, the compensating surplus for a change from the initial utility state of $Wc(V_0)$ to the subsequent state of $Wc(V_1)$ is given by

$$CS = Wc(V_0) - Wc(V_1) \tag{13}$$

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where

$$Wc = \frac{1}{\lambda}\ln\left\{\sum_{r=1}^{R}\left[\sum_{hr\in Cr}\exp\left(\frac{Vr}{1-\alpha r}\right)\right]^{(1-\alpha r)}\right\} \tag{14}$$

With CM, it is thus possible to estimate the value of attributes constituting the environmental good, such as forest area, recreational opportunities, etc. An advantage of CM is its flexibility to incorporate, simultaneously, the importance of economic, social and environmental factors in a valuation exercise. Portney (1994) argues that individuals may derive non-use values attached to socio-economic as well as environmental conditions, arguing that public benefit spillovers can result from both factors. Following this line of reasoning, Morrison *et al*. (1999) explicitly include employment as one of the attributes in the choice sets. Furthermore, van Bueren *et al*. (2001) use 'number of people leaving countries communities' as an attribute to capture the non-use benefits enjoyed by Australian city people from the continued existence of viable country populations.

CM also allows the estimation of the value of changes in the aggregate level of environmental quality. Therefore the CM can be used to produce estimates of the value of multiple resource use alternatives. The main weaknesses of CM relative to CV are possible additional cognitive burden placed on respondents, and its complexity in design and econometric estimation.

The method has been subjected to tests of validation both in comparison with other stated preference methods (Lockwood and Carberry, 1998), and revealed preference technique estimates (Blamey and Bennett, 2001).

5. Overview of environmental valuation in Malaysia

There have been very few published works on environmental valuation involving Malaysian cases. Most studies have applied the TCM to estimate the benefits of nature-based recreation – for instance, Shuib, 1991; Willis *et al*., 1998; Othman and Othman, 1998; Othman, 2000. To date, there has been fewer published examples of a CV application: Mustapha (1993) and Othman (2001) employed the dichotomous choice and open-ended CV formats to estimate the benefits of lake recreation and non-use values of forest resources, respectively.

Methods like the TCM are readily applicable in any cultural setting so long as the relevant market data are available. However, for stated preference method applications (such as CV and CM), cultural differences across application sites may require specific design considerations. In particular, the selection of payment vehicles and even the notion of associating monetary values with goods that may be regarded as free or God-given, may present specific challenges. In the case of Malaysia, local cultural settings pose few additional conceptual problems. This is because Malaysians in general are well acquainted with the concept of payment to a trust fund for a variety of socio-religious objectives. Various trust funds exist in the country. Examples include the government initiated Environmental Trust Fund and the Poverty Alleviation Fund where members of the public are encouraged to contribute. At the local level, it is also very

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common for places of worships throughout the country to establish their own Community Welfare Fund to finance activities for the well being of their members. In rural communities, particularly among native Malays, there has been a long tradition of community members contributing a predetermined payment annually to the community 'Charity Fund': If a community member dies, the Fund disburses a specific amount of money (so-called 'charity') to the next of kin or relatives of the deceased.

Malaysians have become even more accustomed to paying for public goods since the initiation of the national privatization policy in the early 1990s. Under the policy, some public services including water supply, sewerage services, and municipal solid waste collection and disposal were privatized as part of the government's efforts to increase efficiency and reduce federal budgetary outlays. There are also instances where the management of wetlands and nature-based recreational parks (such as Paya Indah and Kuala Selangor Nature Park, both located in the state of Selangor) have been privatized.

Hence, not only are Malaysians well-accustomed to paying into voluntary trust funds, the localization of the trust funds ensures the minimization of incentives to free ride (Olson, 1965). Voluntary payment into a trust fund is therefore a culturally accepted payment vehicle for stated preference applications in Malaysia and is also incentive compatible.

6. Implementing choice modelling

A CM design, which is consistent with local cultural values and mind set, is critical. The questionnaire employed in this study was developed on the basis of two focus groups, literature reviews and expert opinions. The focus groups were used to determine *inter alia* the plausibility of the suggested attributes, their levels and the form of the questionnaire. This information was also used to formulate the training module for field enumerators.

The first focus group comprised of some eight persons from various backgrounds – academics, graduate students, laypersons, school teachers, and religious officials. They were all residents of Bangi, a township 40 km to the south of Kuala Lumpur, and were selected for participation on a 'friend-of-a-friend' approach. The participants, who were paid to attend the focus group, were invited to the Universiti Kebangsaan campus and briefed about the roles of mangrove forests, and given background information on the Matang mangroves wetlands. They were further informed that the managers of the Matang mangrove forest were considering a new management plan for the next ten years. Participants were given a list of forest attributes and they were requested to help identify the attributes that they considered important in the choice of future management strategies.

In general, the group agreed on attributes such as flood protection, fish/prawns breeding, recreational quality, migratory bird species, and forest area. From the focus group discussions, seven choice sets with three options in each choice set were constructed. The attributes were allowed to vary across three chosen levels (representing an improvement to or an equivalence to the status quo) across the options. The participants were requested to list the problems they faced in choosing their preferred option.

Before the management options were posed to respondents, they were told that the Perak State government may not be able to increase future

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Implications	Option 1 (current management regime)	Option 2 (new management option)	Option 3 (new management option)
Environmental forest area (currently 7000 ha)	No change	No change	Increase by 20 per cent
Breeding function of fish/cockles	Good	No change	Very good
Storm protection	Good	No change	Very good
Charcoal production	100 tons monthly	No change	120 tons
Recreational quality	Moderate	Increase by 5 per cent	Increase by 50 per cent
Number of migratory bird species	49	52	55
Annual contribution to Matang Mangroves Fund	RM0	RM50	RM10

Figure 1. Focus group choice set

funding to the Matang mangroves, due to the financial crisis which had engulfed the country at the time. To keep the mangroves in an environmentally sound condition given the rising management costs and depleting public funds, it was suggested that households in the state may be required to pay an annual contribution to a Matang Mangrove Trust Fund. An example of the choice set presented to the first focus group respondents is shown in figure 1.

In general, the participants did not indicate any problems with the design of the 'hypothetical market', payment vehicle as well as the specification of attribute levels as changes from the baseline option. However, there was some confusion and difficulty among the participants in selecting their preferred management option. Some of the more frequently made general comments and examples of respondents' concerns are noted below.

- 'Why are the levels of the attributes changing?'
- 'How certain is the environmental change? For instance, will increased environmental forest area actually increase environmental functions and the number of migratory bird species?'
- 'How is the mix of levels determined? The change in levels is not logical – for instance, an increase in environmental forest (implying increased logging forest area) of 20 per cent leads to no change in charcoal

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production, but no change in environmental forest leads to increases in charcoal production.'
- 'What has happened to the other attributes – the number of bird species, bats, etc.?'
- 'There are too many choices to make. It poses a mental burden and we are impatient.'
- 'Who else is paying?'
- 'Is the government serious about collecting the money from us?'

The issues raised are fundamentally similar to those reported in CM applications in developed countries (Bennett and Blamey, 2001). Hence questionnaire design strategies developed in other applications were implemented. These included limiting the number of choice sets to five, reinforcing the independence of each choice set, and explaining the logic behind what could initially appear to be incongruous combinations of attribute levels. Ways of handling the difficulties experienced by focus group participants were highlighted in the later enumerator training sessions before the actual survey was conducted.

On the basis of the first focus group findings and policy relevance inputs from those involved in the management of the Matang wetlands, the following attributes were selected for inclusion in the questionnaire.

Environmental forest area
This is used to incorporate both the causal attribute (environmental forest area) and the 'impact' attributes, such as the various environmental functions (fish breeding, storm protection, etc.) Although the levels of these functions can be made independent of environmental forest area, from the focus group responses it was considered appropriate to use just the upstream attribute so as to reduce respondent confusion.

Visitation rates
Rather than using recreational quality, visitation rate was employed. This is a more objective measure of recreational attributes. It encompasses the various recreational activities, such as sport fishing, riverine boating, visitation of archeological sites, and bird watching.

Number of migratory bird species
This is a key feature of Matang mangroves and of international interest.

Number employed
This is to reflect the importance of the employment opportunities provided to the local populace by the various commercial activities undertaken in the wetlands. Those not directly affected by the businesses might derive non-use values from local employment.

The most important factor in the choice of the above attributes is that they cover all aspects of wetland benefits and can be described so that their levels are perceived to vary independently by respondents. For instance, number of bird species can be made independent of environmental forest area

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by explaining that different management strategies would yield different densities of bird species in the forest.

Charcoal was not included as an attribute in the choice sets because the estimation of values associated with changing charcoal availability can be achieved using market data.

The number of attribute levels was maintained at three, following the focus group's findings and was consistent with most applications of CM in non-market valuation studies. The ranges of levels for all the attributes were determined in consultation with officials in the Matang Forestry Department and forest economists, while unequal changes in attribute levels were employed to create a larger number of potential tradeoffs.

The first management option presented in each choice set involved the continuation of the current management regime (Z_0 in equation (10)). Under this option, the area of production forest would be increased by 3 per cent (1000 ha). This would raise more money through premium and royalty collection from timber harvest and charcoal production. An increase in the production forest area inevitably decreases the environmental forest area. A reduction in the latter was expected to reduce the number of migratory bird species by 3 per cent. Other environmental features and recreational access and facilities would not change. There would also be an increase of 3 per cent in the number of forest-related jobs as the production forest area was increased. However, no contribution to the trust fund was required under this option.[1]

Both the second and third management options (alternative Z_1 settings) involved maintaining or increasing the environmental forest area while maintaining or decreasing the production forest area.[2] Under these options, recreational access and facilities would be enhanced. These options were expected to increase the number of both resident and migratory bird species as well as visitation rates to the forest. However, the total number of people employed in the various sectors of the forest would decline and a trust fund cost would be required to provide compensation payments to displaced workers.

Options 2 and 3 were varied systematically according to an experimental design,[3] across the five choice sets that respondents were asked to consider, by changing their attribute levels. Specifically, options 2 and 3 in the choice sets had five attributes with three levels for each attribute. The attributes and levels (in parentheses) were:

[1] The change from the current attribute levels inherent in the current management strategy are those that are required to ensure a zero trust fund contribution. That is, if current attribute levels were maintained through time, additional external funding would be required to manage the forest.

[2] Total forest area remained unchanged in all options.

[3] The design used was a fractional factorial design. This design is most commonly used in commercial applications. It did not allow for the estimation of attribute interactions but was selected to reduce the number of choice sets and options that each respondent would need to face in each questionnaire. The choice sets were formed using the simultaneous approach L^{MN} design.

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- environmental forest area (no change, increase by 14 per cent, increase by 24 per cent);
- number of people employed (no change, decrease by 3 per cent, decrease by 5 per cent);
- number of migratory bird species (no change, increase by 3 per cent, increase by 5 per cent);
- visitation rate (increase by 20 per cent, increase by 50 per cent, increase by 100 per cent); and,
- contribution to a trust fund (RM10, RM20, RM50).[4]

Option 1 was kept constant across all the choice sets.

The attribute levels used for this 'business as usual' option were (in parentheses):

- environmental forest area (decrease by 14 per cent);
- number of people employed (increase by 3 per cent);
- number of migratory bird species (decrease by 3 per cent);
- visitation rate (no change); and,
- trust fund contribution (RM0).

An example of the choice set used in the questionnaire is shown in figure 2.

The first option was designed such that it reflected the consequences of the continuation of the current management regime. This allows for the estimation of the CS of options relative to this 'baseline'. The CS estimates reflect households' WTP to obtain an improvement from the 'baseline' situation.

The final design was presented to the second focus group consisting of nine rangers from the Forestry Department in Matang. Some of the salient features from the first focus group were highlighted before the choice sets were displayed. The second focus group demonstrated improved understanding of the choice sets. No changes in the design of the choice sets were made for the final questionnaire.

Survey logistics

The final questionnaire – available from the lead author on request – was 21 A4 pages long. The survey enumerators were given two stages of intensive training, which included a role-play for a face-to-face interview with respondents. The focus of the training was on methods to address the general comments and cognitive burden that were identified in the focus groups.

The targeted population of this study were households residing in the district of Larut Matang and Selama, in Perak state where the Matang mangroves are located. The survey was restricted to respondents who had knowledge of the existence of Matang mangroves, but had no direct

[4] The exchange rate at the time of the survey was RM3.8 = US$1.00.

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Suppose Options 2 and 3 below are the only possible alternatives to the current management practice (Option 1). Do you prefer to choose Option 1(environmental forest area decreases by 14 per cent, direct employment increases by 3 per cent, etc.), Option 2 (no change in environmental forest area, no change in direct employment, etc.) or Option 3 (environmental forest area increases by 24 per cent, direct employment decreases by 3 per cent, etc.)?
[Enumerator has to caution the respondent that choosing either Option 2 or 3 would require them to pay the prescribed amount to the Matang Wetlands Fund annually. Enumerator needs also forewarn the respondent that the payment will affect budgetary allocation for other household expenditures]

Implications	Option 1 (current management regime)	Option 2	Option 3
Environmental forest area (currently 7,000 ha)	Decrease by 14 per cent	No change	Increase by 24 per cent
Direct employment (currently 4,000 jobs)	Increase by 3 per cent	No change	Decrease by 3 per cent
Number of migratory birds species (currently 49 species)	Decline by 3 per cent	No change	No change
Visitation rates for recreation (currently 100 per week)	No change	Increase by 20 per cent	Increase by 50 per cent
Annual contribution to Matang Mangroves Fund	RM0	RM50	RM10
	3		

If the above three management options were the only ones possible, which one would you prefer? If you choose Option 1, simply tick the first box as shown above.

Figure 2. Example of a choice set from the Matang Mangroves Wetlands Questionnaire

consumptive relationship with the resource.[5] The Larut Matang and Selama district had a population of some 56,000 households in 2000.

A stratified random sampling framework was adopted. Stratification was based on ethnic groups in three selected sub-districts, including Taiping town. Taiping is the administrative and commercial center for the Larut-Matang and Selama district. Targeted sample size was 600 households (five questionnaire blocks at 120 households per block) from across the various sub-districts. The sampling plan requires that only the heads of

[5] This sampling strategy has implications for the process of extrapolating the results of the study.

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Table 1. *Socio-demographics of the respondents*

Variable	*Sample average*
Age	42.5
Monthly income (respondent)	RM1496
Education	Completed high school*
Malays	86 per cent
Non-Malays	14 per cent
Male	77 per cent

Note: *Modal class.

households or their spouse constitute the relevant respondents. If the targeted respondent was not available or uncooperative, the next household was chosen to ensure that the needed sample size was achieved.

The survey was conducted on the third and fourth week of July 1999. Respondents were shown several A4-sized cards depicting the various forest management scenarios. Respondents were forewarned that the annual contribution to the Trust Fund they may choose to make would affect their budgetary allocation for other items.

We managed to interview 600 respondents, as planned. Out of these, 29 responses were unusable, mainly due to incomplete answers to the choice set questions. Therefore 571 responses (95 per cent) were used in the data analysis. The socio-demographics of the respondents are shown in table 1.

Malays formed the bulk of the respondents (86 per cent). Districtwide in 2000, Malays formed 57 per cent of total population, while statewide in Perak, they represented 49 per cent. The disparity between sample and district statistic was due to the marked lack of cooperation among non-Malays. Another disparity is in terms of gender. Male respondents constituted 77 per cent, compared with the district and statewide statistic of some 50 per cent. Due to the disparity in terms of ethnic representativeness, the results of this study should be treated with caution, particularly when making inferences on the aggregation of values that are derived.

7. Model results

Two multi-nomial logit (MNL) models were first run for the data collected. The first model is a basic specification which shows the importance of the choice attributes in explaining respondents' preferences for the three different management options: continue with the current plan (Option 1) and increase environmental forest area (Options 2 and 3). The second model incorporates socio-economic and environmental attitudinal variables. The models were estimated using the LIMDEP software package.

The basic model

There are three indirect utility functions derived from the multi-nomial logit model, each representing the respective resource use option. Option 1 is the status quo, while Options 2 and 3 involve an improvement in environmental attributes, relative to the 'Business as Usual' Option 1. The utility for each

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Table 2. *Definitions of variables*

Variable	*Definitions*
*C*0	Alternative specific constant taking the value of one for Option 1 and zero for Options 2 and 3
*C*1	Alternative specific constant taking the value of one for Options 2 and 3 and zero for Option 1
INCOME	Respondent's household monthly income
AGE	Respondent's age
ENVAWARE	Dummy variable equaling one if respondent has strong environmental awareness
EDU	Dummy variable equaling one if respondent has at least completed high school
ENVFAREA	Environmental forest area (per cent change)
EMPLOY	Number of direct employment (per cent change)
MIBIRDSP	Number of migratory bird species (per cent change)
VISITRATE	Visitation rate for recreation (per cent change)
CONTRIB	Annual payment to a Matang Trust Fund

of the functions is determined by the level of attributes in the choice sets.

$$V_i = C0 + \beta_1{}^*\text{ENVFAREA} + \beta_2{}^*\text{EMPLOY} + \beta_3{}^*\text{MIBIRDSP} + \beta_4{}^*\text{VISITRATE} + \beta_5{}^*\text{CONTRIB} \quad (15)$$

for $i = 1, 2, 3$ and where $C0 = 0$ for $V_i = 1$ and other variables are defined in table 2.

The results for this model are shown in the first section of table 3. They show that the coefficients for all of the attributes in the choice sets are significant at the 1 per cent level and all have the *a priori* expected signs. However, the Hausman–McFadden test (1984) indicated that the estimation violates the IID assumption at the 1 per cent level. Hence, the estimates of compensating surplus from these results are biased.

Model 2: an extended MNL model with socio-economic and attitudinal interactions

In Model 2 it is assumed that several socio-economic and attitudinal variables influence individual's intentions and behaviour. Model 2 is specified:

$$V_i = C0 + \gamma_1 C0{}^*\text{AGE} + \gamma_2 C0{}^*\text{INCOME} + \gamma_3 C0{}^*\text{ENAWARE} + \gamma_4 C0{}^*\text{EDU} + \beta_1{}^*\text{ENVFAREA} + \beta_2{}^*\text{EMPLOY} + \beta_3{}^*\text{MIBIRDSP} + \beta_4{}^*\text{VISITRATE} + \beta_5{}^*\text{CONTRIB} \quad (16)$$

for $i = 1, 2, 3$ and where $C0 = 0$ for $V_i = 1$.

The socio-economic and attitudinal variables were modelled through the interactions of the variables (AGE, INCOME, ENAWARE, EDU) with the alternative specific constant *C*0. These interactions attempt to capture

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Table 3. *Results of multi-nomial logit model*

	Basic model (Model 1)		*Extended model (Model 2)*	
Variables	*Coefficients*	*Standard errors*	*Coefficients*	*Standard errors*
C0	0.43938	0.18238**	−0.29966	0.26640
C0*AGE			−0.00715	0.00366**
C0*INCOME			0.00053	0.00009***
C0*ENVAWARE			0.53538	0.08857***
C0*EDU			0.14530	0.14777
ENVFAREA	0.03228	0.00327***	0.03595	0.00332***
EMPLOY	0.04021	0.01497***	0.05048	0.01513***
MIBIRDSP	0.04241	0.01471***	0.04262	0.01470***
VISITRATE	0.00334	0.00847***	0.00278	0.00083***
CONTRIB	−0.05084	0.00205***	−0.05077	0.00206***
Summary statistics				
Log-likelihood	−2,781		−2,709	
RsqAdj	0.143		0.165	
Iterations completed	5		6	
Number of observations	2,958		2,958	

Notes: *Significant at the 10 per cent level.
**Significant at the 5 per cent level.
***Significant at the 1 per cent level.

the influence of the variables on the probability for a respondent to choose either Option 2 or 3. The results for Model 2 are set out in table 3. All the attributes and socio-economic variable parameters (AGE, INCOME, ENAWARE) are again strongly significant in explaining the preference of respondents for the improved plan relative to the status quo. Analysis of responses to the choice sets revealed that only 28 per cent of all responses were in favour of the status quo. However, the Hausman–McFadden test also showed that the extended model violated the IID assumption at the 1 per cent level. Hence, like the basic model, the derived estimates could be biased.

To avoid the problem of IIA violation a nested logit model was developed. In the nested logit model, respondents were hypothesized to choose their preferred option using a two-stage process. In the first stage, respondents make a choice between supporting or not supporting a changed management plan. If a changed plan was chosen, they then choose between Option 2 and 3. Figure 3 shows the choice path for each respondent.

The choice between supporting an improved plan or the business as usual option is hypothesized to be influenced by respondents' socio-economic variables such as age, income and education, and attitudinal variable represented by whether or not respondents favour resource conservation over conversion in the face of conflicting resource use. Choices at the second

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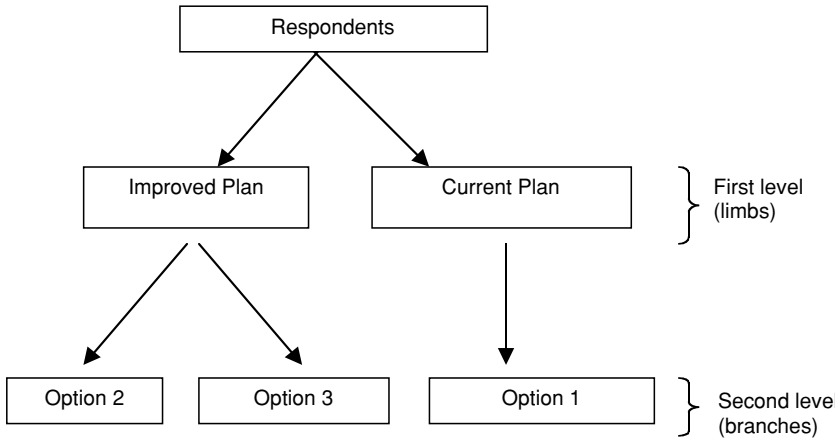


Figure 3. The choice path for the nested logit model

level are modelled by variations in the environmental, employment, and monetary attributes.
Branch choice equation

$$C0 + \gamma_1 C0^{*}\text{AGE} + \gamma_2 C0^{*}\text{INCOME} + \gamma_3 C0^{*}\text{ENAWARE} + \gamma_4 C0^{*}\text{EDU} \quad (17)$$

Utility function

$$C1 + \beta_1{}^{*}\text{EMVFAREA} + \beta_2{}^{*}\text{EMPLOY} + \beta_3{}^{*}\text{MIBIRDSP} + \beta_4{}^{*}\text{VISITRATE} \quad (18)$$

The results for the nested logit model are presented in table 4.

All environmental and social attribute variable parameters in the model show positive signs and are significant at the 1 per cent level. In other words, options with more area devoted to environmental forests, more migratory bird species, more employment and visitation rates are preferred. The significant employment attribute reveals benefits enjoyed through satisfaction or concerns associated with others being employed. Similarly, the significant visitation rate indicates utility derived by respondents from others being able to visit the site. The negative cost coefficient implies that respondents were less likely to choose the more costly option. The explanatory power of the model (adjusted rho square) is satisfactory at 24 per cent. The nested structure of the model is also highly significant, evidenced by the significance of the inclusive value parameter at the 1 per cent level.

The coefficients for the socio-economic and attitudinal variables are also statistically significant, except for AGE, and the signs are consistent with expectations. All the signs are negative. Since the alternative specific constants for these variables relate to the baseline option (Option 1) in the nested logit model, negative coefficients reflect that respondents who had

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Table 4. *Results of nested logit model*

Variables	*Coefficients*	*Standard errors*
Utility functions		
*C*1	0.04452	0.03518
ENVFAREA	0.03077	0.00342***
EMPLOY	0.05192	0.01119***
MIBIRDSP	0.03497	0.01133***
VISITRATE	0.00214	0.00063***
CONTRIB	−0.03821	0.00312***
Branch choice equations		
*C*0	1.58803	0.33205***
*C*0*INCOME	−0.00028	−0.00008***
*C*0*AGE	−0.00635	0.00411
*C*0*ENVAWARE	−0.48305	0.08761***
*C*0*EDU	−0.27525	0.04853***
Inclusive value parameters; (*mu*(*j* | *i*),*gamma*(*i*))		
Support	1.49611	0.13869***
No support (fixed parameters)	1	
Summary statistics		
Log-likelihood	−2680	
Chi-squared, dof	1,676,12	
RsqAdj	24 per cent	
Iterations completed	23	
Number of observations	2,958	

Notes: *Significant at the 10 per cent level.
**Significant at the 5 per cent level.
***Significant at the 1 per cent level.

higher income and education levels, and were pro-environmental were less likely to choose Option 1 or the current management regime. Interestingly, these findings compare very well with that of the MNL model.

8. Estimation of values

Implicit prices reflect the marginal rates of substitution between each attribute and the monetary attribute. They are calculated as the ratio of the coefficients for the attribute of interest and that of the monetary attribute. Implicit prices thus reflect individuals' willingness to pay for an additional unit of an attribute of interest to be present, *ceteris paribus*. Estimates of implicit prices for each of the attributes in the choice sets in the MNL and nested logit are set out in table 5. The estimates of implicit prices from the two models do not differ substantially. Other CM studies have shown that the heterogeneity of preferences of respondents has little effect on the estimates of implicit prices (see Morrison *et al*., 1999).

Using the nested logit model, these implicit prices suggest that, for instance, non-user households were, on average, willing to pay RM0.81 for an additional 1 per cent of environmental forest area and RM1.36 for an additional 1 per cent of migratory bird species to be present in the Matang

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Table 5. *Estimates of implicit prices (RM)*

Attribute	*MNL (Model 2)*	*Nested logit*
ENVFAREA (per cent increases)	0.71	0.81
EMPLOY (per cent increases)	0.99	1.36
MIBIRDSP (per cent increases)	0.84	0.92
VISITRATE (per cent increases)	0.05	0.06

mangroves, *ceteris paribus*. The same process can also be used to identify the tradeoffs between the non-monetary and social attributes. For example, in terms of the utility generated:

Environmental forest area increases by 10 per cent

= 6 per cent increases in employment

= 8 per cent increases in the number of migratory bird species

= 140 per cent increases in visitation rates.

The models also enable the estimation of welfare changes (compensating surplus) associated with an array of changes in wetland management away from the 'business as usual' scenario depicted in Option 1. The attribute levels that characterize a number of alternative wetland management scenarios are listed below, along with the Option 1 attribute levels:

'Business as usual' scenario

- Environmental forest area decreases by 14 per cent
- Number employed increases by 3 per cent
- Number of migratory bird species decreases by 3 per cent
- Visitation rate unchanged

Alternative management scenario 1

- Environmental forest area increases by 10 per cent
- Number employed unchanged
- Number of migratory bird species unchanged
- Visitation rate increases by 50 per cent

Alternative management scenario 2

- Environmental forest area increases by 10 per cent
- Number employed unchanged
- Number of migratory bird species unchanged
- Visitation rate unchanged

Alternative management scenario 3

- Environmental forest area increases by 10 per cent
- Number employed decreases by 10 per cent

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Table 6. *Estimates of household CS*

Alternative management scenario	*WTP (RM per annum) (MNL Model 2)*	*WTP (RM per annum) (nested logit)*
Scenario 1	13.4	12.7
Scenario 2	10.6	8.5
Scenario 3	0.7	−11.8

- Number of migratory bird species unchanged
- Visitation rate unchanged

The compensating surplus (CS) estimates for each of these plausible and policy-relevant scenarios are reported in table 6. For comparisons, the estimates were calculated using both the MNL and nested logit. Based on the nested logit model, it can be concluded that, on average, non-user households were willing to pay RM12.7 per annum to achieve alternative management scenario 1 instead of the Option 1 'business as usual' outcome. A negative CS (scenario 3) implies that respondents on average experience negative utility, demanding compensation instead. This outcome demonstrates the significance of the reduced employment that characterizes scenario 3. The results show that the CS estimates from both models differ significantly, while the order of magnitude remains consistent.

9. Concluding remarks

In this paper, an application of CM to the case of forest resource planning in a developing country setting has been demonstrated. It has been shown that the CM can be successfully employed in a developing country with careful construction of the choice sets and effective field data collection. In this regard, close consultation with the stakeholder (the Matang Forestry Department) was critical to understanding the nature of the resource problem and consequently the selection of attributes, and levels that are key to the CM design. It is also essential that focus groups be conducted to gain insights on the level of apprehension among respondents and to identify issues that might affect the effectiveness of the field survey. This includes insights on the plausibility of the environmental market, payment vehicle, type of attributes, levels of attributes, and the maximum number of choice sets to be presented. Respondents in this study had difficulty in understanding a number of CM features including the intransitivity of the attribute levels across the various options in a given choice set. This demonstrated the importance of proper training for survey enumerators. The salient components derived from the focus groups and the resultant responses became the focus of enumerator training.

Most importantly, the focus group analysis performed as a component of this study has demonstrated that the cultural differences between Malaysia and countries where CM has been more widely applied have not presented any additional obstacles to its application. The concerns expressed by focus

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group respondents were remarkably similar to those expressed during the course of other CM applications.

Estimates of the non-use economic values of potential environmental improvements in the Matang wetlands have been presented. These estimates are important in the identification of a socially optimal resource management plan. It has been shown that CM has the flexibility to evaluate both the marginal values of environmental attributes and the welfare impacts of an array of alternative management options. This is important, since resource managers are often concerned with marginal changes in attribute levels between management alternatives rather than losing or gaining the environmental resource as a whole.

The CM framework can be used to value a range of resource use scenarios. The per non-user respondent household estimates derived from this study can be aggregated to determine the total non-market value accrued to the wider community in the Larut Matang and Selama districts for each wetland management plan. By weighing up these values along with the market values of benefits and costs for the available alternative plans, the relevant authority can identify a management plan that yields the greatest net benefit to society.

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