Economic Valuation of Mangroves in Mannar Region: A Discrete Choice Experiment

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Abstract

The mangrove ecosystems all over the world are being destructed due to anthropogenic activities including in Sri Lanka. Lack of information on environmental values of mangroves, especially the non-market values, has contributed to mangrove degradation. The conservation of mangroves is not successful without the support of the local people who live in the vicinity because they are the beneficiaries as well as the culprits. In this context, an attempt has been made to value the ecosystem services and analyze the trade-offs among different mangrove management options in Mannar region, using a Discrete Choice Experiment (DCE). The objectives of the study were to estimate the economic values of mangrove through willingness to pay (WTP) for conservation and relative importance of management options of mangroves. The necessary attributes and levels of the DCE were obtained through focus group discussion with the Government officers and NGOs. Four attributes Community Based Management, Replanting, Area to be protected and Penalty, each with three levels were evaluated in 3^4factorial, using a fractional factorial experimental design. Where higher order interactions were sacrificed, four different choice sets were obtained under PBIBD (Partially Balanced Incomplete Block Design). The data were collected through a face-to-face interview with 81 respondents in Mannar region. The collected data were analyzed using a Conditional logit model. Marginal willingness to pay values for each attribute and level and relative importance of the each management options attribute were found. The highest WTP was associated with the area to be protected at 100% level followed by the attribute replanting with the level of high density and higher growth rate plants. The attributes, area to be protected followed by replanting had the highest relative importance as perceived by the respondents. Results are useful to the policy makers who involve in mangroves management.

Keywords: Discrete Choice Experiment, Mangrove management, Non-market valuation, Willingness to pay, Conditional logit model.

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Introduction

Mangroves are the woody plants that live between the sea and land, in inter-tidal area which are flooded by tides for part of the time. Mangroves are various kinds of trees up to medium height and shrubs that grow in saline sediment area in tropical and sub-tropical area. The total extent of mangroves in the world is approximately

181,000km^{2}in 112 countries and 40% of mangroves occur in South and Southeast Asian regions (Giri et al., 2011). The largest mangrove forest is the Sundarbans, which is located in India. In Sri Lanka the total extent area of mangroves about 12189 ha, it is less than 0.01% of total land area (IUCN, 2009). A total of 20 species of true mangroves and 23 species of associate mangroves have been recorded in Sri Lanka. The largest mangrove forest occurs in Puttlam- Kalpitiya lagoon area (Dayaratne et al., 1997). In Mannar region the total extent of mangroves are approximately 874 ha (CCD, 2009). The main reasons for destruction of mangroves are due to, shrimp cultivation, illegal fishing, over exploitation, introduction of Invasive Alien Species and Climate change. In Mannar region,

Lagoon fishing was the main livelihood of the poor fishermen when the mangrove area was high but due to destruction of mangroves now the poor fishermen have lost their livelihood and are now working for the rich fishermen, the loss of biodiversity and sea water intrusion to the villages are the major problems due to the destruction of mangroves. The conservation of mangroves cannot be successful without the support of the local people who live in the vicinity because they are the beneficiaries as well as culprits. In this context, an attempt has been made to value the ecosystem services and analyze the trade-offs among different mangrove management options in Mannar region, using a Discrete Choice Experiment (DCE). The objectives of the study were to estimate the economic value of mangroves through willingness to pay (WTP) for conservation and relative importance of mangrove management options needed for the management of mangroves.

Materials and Methods

Choice modelling method is used to evaluate the economic value of natural resources (Crouch and Louviere, 2004). Different stages are included for designing the CM questionnaire: Selection of Attributes and Levels, Choice of experimental design, Construction of choice sets, Measurement of preferences. This research was conducted using Discrete Choice Experiment (DCE) method. DCE is a quantitative technique for getting individual preferences. It requires respondent to state their choice over set of hypothetical alternatives. Each alternative is described by several characteristics known as attributes and their different levels. This method has its theoretical foundation in Random Utility Theory and relies on the assumptions of economic rationality and utility maximization (Holmes and Adamowicz, 2003). This method used to determine the significance of attributes that describe the mangrove management options and the extent to which individuals are willing to trade one attribute for another. The necessary

attributes and levels of the DCE were obtained through focus group discussion with the Government officers and NGOs.

Attributes	Levels
Community based management	Poor Medium High
Replanting	Low dense with low growth rate plant Medium dense with high growth rate plant High dense with high growth rate plant
Area to be protected	No area 50% 100%
Penalty	Rs.5000 Rs.2000 Rs.8000

These attributes and levels were evaluated in 3^4factorial, using a fractional factorial experimental design, where higher order interactions were sacrificed, four different choice sets were obtained. The data were collected through a face-to-face interview with 81 respondents in Mannar region. The collected data were analyzed using a Conditional logit model.

Results and Discussion

According to the Conditional logit model which is shown in the Table 1, all the attributes are significant except penalty and the community based management with moderate level. And also the socio-economic characteristics of respondent, how it affects on the choice of the respondents in choosing the given management option were analyzed with the interaction and the penalty which is the monetary value of this research. Age is one of the socio-economic characteristic that only affects the choice of the respondent.

Table 1: Results of the Estimation of Conditional Logit Model

Variable	Coefficients	Std. error	Z	P > IzI
Penalty	-0.0003794	0.0005	-0.64	0.522
CBM - moderate	0.2830	0.3208	0.88	0.378
CBM- high	1.3942*	0.4619	3.02	0.003
Replanting-medium	1.2041*	0.3154	3.82	0.000
Replanting-high	1.7587*	0.2832	6.21	0.000
Area – 50%	1.1911*	0.2901	4.1	0.000
Area – 100%	1.8534*	0.2798	6.62	0.000
Penalty*sex	-0.00001	0.0002	-0.05	0.962
Penalty*age	7.71e-06*	3.06e-06	1.99	0.046
Penalty*family size	0.00002	0.00001	1.05	0.293
Penalty*education	0.00007	0.00005	1.42	0.156
Penalty*Income	-0.00003	0.0001	-0.28	0.783
Constant	0.3445	0.2903	1.19	0.235
Log likelihood = -145.5487 Pseudo R^2 = 0.3511				

Note: * indicates statistical significance at 95 percent significance level.

According to the Marginal Willingness to Pay, Mannar people are more willing to pay for the attribute Area to be protected with 100% level, the second higher WTP goes to replanting with the level of high dense with higher growth rate plant and the least one goes to the community based management with the level of moderate.

Table 2: Willingness to Pay for Attributes

Attributes	WTP (LKR)
CBM- Moderate	746
CBM- high	3674

Replanting-medium	3173
Replanting- high	4635
Area- 50%	3139
Area-100%	4885

The relative importance of each attribute was computed based on part-worth estimates of the logit regression following Halbrendt et al. (1991). The relative importance of the attribute is defined as [(Utility range/Σ utility ranges of all attributes)*100]. According to the results of relative importance of mangrove management option, the highest importance goes to the area to be protected, the next one goes to replanting and the least one goes to the penalty.

Table 3: Relative Importance of Management Options

Attributes	Utility range	Relative importance
Community Based Management	1.3642	18.83%
Replanting	2.9628	40.02%
Area to be protected	3.0446	41.13%
Penalty	0.0003	0.005%

Conclusion

The four management options, community based management, replanting, area to be protected and penalty were obtained, which are useful for the conservation of mangroves from destruction. The total WTP for attributes were around Rs. 19,000. Mannar people are more concern about the area of mangrove forest which has to be declared as a protected area by the government as a main management option. These results can be used by the policy makers who are taking action for conserve the mangroves from the destruction.

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