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Fisherman's Willingness to Pay for Sustainable Lagoon Ecosystem Management: A Locality Study in Jaffna Lagoon of Sri Lanka

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This study estimates willingness to pay (WTP) for different sustainable ecosystem management measures in the Jaffna lagoon. For this study, 118 fishermen were randomly selected along the lagoon. Choice modelling approach was employed and a conditional logit model was developed. This study found that fishermen from village communities are willing to pay more for increasing the number of mangroves and improving tourist facilities. The availability of land for planting mangroves and improving tourist facilities and increasing income from other sources positively influence the fisherman's WTP for sustainable ecosystem management. Establishing fishing harbour facilities, properly planned multi-storey housing units in town areas would increase fishermen's support for planting mangroves and developing tourist spots. Increasing income from other sources and fishermen's awareness on the impact of inappropriate fishing gears and enforcing mechanism would increase fishermen's support to ban the inappropriate fishing gears. Based on this study, government authority could make appropriate policy for urban and village coastal lagoon ecosystem management.

Keywords: Choice modelling; conditional logit model; sustainable lagoon ecosystem management.

Introduction

Sri Lanka has few lagoons along the coastline. Sri Lankan coastal lagoons vary in size, shape, ecosystem values and services. The heterogeneous nature of coastal lagoons is primarily determined by geomorphology of the surrounding area, tidal fluctuation, monsoon weather and human interventions. Most of the coastal lagoons were formed due to marine transgression in mid-Holocene and spit development encircling the water. This lagoon formation has differed along the coastal line. In certain Sri Lanka's coastline, elongated lagoons were formed due to active shore-face dynamics. These elongated lagoons are the most productive ecosystem among the coastal lagoons. They provide essential habitats for many marine fish species, seagrasses, mangroves and salt marshes and contribute to the production of coastal ecosystem. As high nutrients are available in coastal lagoon, the primary and secondary production of coastal lagoon is very high compared to other aquatic ecosystems (Nixon *et al.*, 1995). However, some coastal lagoons become seasonally more saline due to lack of rainfall and high evaporation. Coastal lagoons produce use values such as shrimp, fish, salt, fodder, recreation and fuelwood and non-use values such as habitat preservation and biodiversity and contribute to improving human well-being. Coastal lagoons provide natural services such as storm protection, controlling soil erosion and flood, climate regulation, ecotourism and recreation (Gönenç and Wolflin, 2005). Ecosystem provides benefits to the society such as carbon storage, water supply and recreational activities (Balmford *et al.*, 2011; Boavida-Portugal *et al.*, 2016). In several cases, these coastal lagoon ecosystems were over-exploited due to poverty, population growth and urbanisation.

The status of natural resources in many Sri Lankan coastal lagoons is maintained at acceptable levels. However, lagoons in Sri Lanka are managed to extract use values such as fish and shrimp. Management of ecosystem varies from zero management to co-management through community and state involvement. Most of the lagoons can generate high extractive and non-extractive use values while maintaining resource sustainability. Coastal lagoons are considered as socio-ecological entities because it is associated with the production of aquatic habitats and mangrove vegetation. They became vital for cultural viewpoints and human settlements around them. However, due to their location and shallow depth, they face natural constraints; wind, tides and oceanic waves and rainfall water fluxes. These natural constraints result in abrupt changes in the chemical and physical environment of the ecosystem. Lagoon ecosystems are increasingly exploited for several purposes such as commercial, industrial, agricultural and residential development and become a dumping place for waste. These developments had ecological, economic and social consequences on ecosystems and the livelihood of poor families. Due to land-use changes and management, the ecosystem functions of natural resources have gradually weakened. Therefore, coastal lagoon sustainable management became important due to its biodiversity, and fundamental economic and social importance. Protection and the sustainable use of coastal ecosystem are a major concern of many international institutions. Therefore, studies on policies related to land use, environmental protection and development became a public concern (Liekens *et al.*, 2013).

Jaffna lagoon is a coastal lagoon and the largest lagoon system in Sri Lanka. Jaffna lagoon is degraded by wastewater pollution, illegal dumping, removal of mangroves and over-exploitation. This degradation became a problem because local livelihood depends on the ecosystem provided by this lagoon. The lack of understanding of the economic value of coastal lagoon and ecosystem services by policymakers and the public is the reason for the continuous degradation of lagoon ecosystems (Fanning *et al.*, 2011). Waite *et al.* (2015) demonstrated that economic valuation could be an effective way to improve coastal ecosystem management.

Along the lagoon, there are some towns with high densely populated fishing communities and some villages with less densely populated fishing communities. The characteristics and nature of the area of these fishing communities may influence their perception of different sustainable lagoon ecosystem management and willingness to pay (WTP) for different sustainable lagoon ecosystem management practices. The main source of income of the fishing community along Jaffna lagoon is fish catching, but overfishing in lagoon ecosystem became a significant challenge for sustainable lagoon ecosystem management (Silva *et al.*, 2013). Even though several programs were launched to control overfishing and over-exploitation of lagoon ecosystem, fishermen are still reluctant to implement mitigation practices due to economic and environmental uncertainty. Therefore, the government needs more information to design a cost-effective policy to adopt the needs of fishermen and promote sustainable ecosystem management. The purpose of this study is to estimate WTP for different sustainable lagoon ecosystem management practices. Since the Jaffna costal lagoon and the area along the coastal line including agriculture and fishermen's housing area have a unique ecosystem character and fishermen living along this coastal line have a specific socio-economic character, fishermen's priority for different sustainable lagoon ecosystem management practices will be different from other coastal lagoon areas. Therefore, WTP for different sustainable lagoon ecosystem management practices would be useful to identify the fishermen's priority and could be helpful for policymakers in developing policy to achieve sustainable lagoon ecosystem management. The main income of the households in this study area is from fishing activities. Other income-generating economic activities such as agriculture influence the fisherman's WTP for the different sustainable lagoon ecosystem management practices. Agricultural land is available more for crop production in the village area than in the town area along the lagoon. Income-generating activities from agriculture are more in the lagoon area that is close to village area where agricultural land is available. Therefore, this study investigates the impact of fishermen's neighbourhood on WTP for different sustainable lagoon ecosystem management practices. This study would be useful to develop sustainable lagoon ecosystem management for village and town lagoon areas separately. Choice modelling (CM) has the ability to estimate the WTP for different sustainable lagoon ecosystem management practices and the trade-offs between these management practices. CM is used to study the preferences for natural resource conservation as well as valuating non-market goods (Rudd, 2009). CM is used to estimate the use and non-use values for landscape conservation and natural development, using questionnaires to explore people's preferences (Liekens *et al.*, 2013).

Methodology

Non-market valuation method is used to assess environmental goods and services. Contingent valuation method (CVM) is one of the non-market valuation methods that are used to assess the value of a natural resource (Koteen *et al.*, 2002). The CVM proposes a market to draw out value of environmental goods. The CVM is generally used to value non-market environmental goods through asking respondents on their WTP for an attribute of environmental goods and services (Mitchell and Carson, 1989; Haab and McConnell, 2003). The CVM is a simple survey method to estimate WTP for non-market goods. Many studies have indicated that this contingent valuation approach is not most appropriate to measure WTP for multidimensional changes in the attributes of a good. CM approach estimates consumers' WTP for attributes of goods or services. CM has several advantages compared to the CV method. CM is most suitable method to estimate WTP of consumers when there are changes in the multidimensional attributes of a commodity. CM has the ability to value the attributes of a commodity and to estimate marginal value for the changes in attributes of a commodity accurately and the trade-offs between attributes. As CM offers multiple options to state respondents' preferences, it is more informative than CVM. As cost is included as one of the attributes of the good in the CM approach, WTP can be derived from respondents' choices. The CM is a modified version of conjoint analysis that was developed by Louviere and Hensher (1982) and Louviere and Woodworth (1983). This CM has originated from Lancaster's theory that consumer makes choice based on utility derived from the attributes of a commodity (Lancaster, 1966; Hanley *et al.*, 1998). CM is one of the stated preference methods employed to assess the values of a commodity that has no market (Adamowicz *et al.*, 1998; Hanley *et al.*, 2001).

Since most ecosystem services of coastal lagoons do not have market price, these ecosystem services are frequently undervalued by policymakers. This undervaluation of ecosystem services contributes to unsustainable use of these ecosystems (Velasco *et al.*, 2018). One of the main advantages of the choice modelling method is the estimation of economic values for specific ecosystem services. Therefore, this study could provide an important contribution to the existing knowledge of coastal lagoon ecosystem management.

The CM estimates not only the value of a commodity but also the relative value of the attributes of that particular commodity (Hanley *et al.*, 1998). CM persuades consumer to disclose their WTP for a non-market good (Ribaudo and Hellerstein, 1992). CM is consistent with demand theory and utility maximisation (Hanemann, 1984). The inclusion of payment as a choice attribute makes it possible to estimate WTP for other attributes in this choice experiment (Koetse *et al.*, 2015).

As cost is included as an attribute in the choice set, WTP for sustainable lagoon ecosystem management practices can be derived. The objective of this study is to estimate WTP for different sustainable lagoon ecosystem management practices. Therefore, we applied the choice modelling technique. The application of choice modelling has become popular among the stated preference method to value environmental goods. Choice modelling assesses the utility derived from the attributes of environmental goods. More details of CM were given in Hensher *et al.* (2005) and Kanninen (2007). The CM has been developed in a random utility framework. The utility (U) has two components: observable component (V) and a random error component (ε).

$$U = V + \varepsilon, \tag{1}$$

where the observable component (V) is the indirect utility function and ε is the stochastic error. Indirect utility function is assumed as a linear function,

$$V_i = \beta_i X_{ki} + \alpha m = \beta_1 + \beta_2 x_{2i} + \beta_3 x_{3i} + \cdots + \beta_k x_{ki} + \alpha_i m_i, \tag{2}$$

where X_{ki} is a vector of k attributes of alternative i, β is a coefficient vector of k attributes, α is the coefficient vector of income and m_i is the income of the person choosing the alternative i. As the stochastic error term is assumed logistically Gumbel distributed, the probability for choosing the alternative i can be given by

$$\Pr(i) = \frac{\exp(\rho V_i)}{\sum_{j \in C}^{J} \exp(\rho V_i)}, \tag{3}$$

where C is a set of alternatives for an individual and ρ is a positive parameter. For convenience, it is generally assumed that $\rho = 1$. The respondent's WTP for a change from the status quo alternative to the selected alternative can be estimated using the following formula:

$$V_i(X_i, y) + \varepsilon_i = V_j(X_j, m - \mathrm{CV}) + \varepsilon_j, \tag{4}$$

where V_i and V_j are the utility derived from the status quo alternative and the chosen alternative, respectively. CV is the quantity of money (compensating variation) that makes an individual indifferent between the status quo alternative and the chosen alternative. Conditional logit model has been employed to estimate the CV. Equation (4) could be rearranged as follows:

$$\beta_i X_{ki} + \alpha_i m + \varepsilon_i = \beta_j X_{kj} + \alpha_j(m - \mathrm{CV}) + \varepsilon_j. \tag{5}$$

α_i and α_j are assumed equal because marginal utility of money is constant for the respondent. Coefficient of k attributes is assumed to be same across all alternatives, $\beta_i = \beta_j$. However, the attribute levels vary across the alternatives. Therefore, CV can be estimated by the following equation:

$$\mathrm{CV} = -\frac{1}{\alpha}[(\beta(X_{ki} - X_{kj}) + (\varepsilon_i - \varepsilon_j)]. \tag{6}$$

The attributes of lagoon ecosystem management in this study were fishing method, mangroves and tourist facilities. Each attribute has a number of discrete levels. For the fishing method, there were two levels present to respondents: Banning inappropriate fishing gears (BIFG) and no change in the current fishing method. The attribute of mangroves is limited to three levels: Big increase in the number of mangroves (50% increase in the number of mangroves), small increase in the number of mangroves (20% increase in the number of mangroves) and no change. The third attribute, tourist facilities, is limited to two levels: improving tourist facilities and no change. Definitions of selected lagoon ecosystem management attributes are given in Table 1.

The survey questionnaire contains multiple-choice sets of management practices to improve lagoon ecosystem. Before interviewing the respondents in this survey, respondents were explained regarding the attributes of lagoon ecosystem management, cost to the fishing household and the payment method. The payment was described as an annual payment to the central environmental office for the management of lagoon ecosystem. The six levels of cost attributes given to respondents were LKR 0, 50, 100, 200, 400 and 800. As there are two levels in the attribute of fishing method, three levels in the attribute of mangroves, two levels in the attribute of tourist facilities and six levels in the cost to household, 72 orthogonal alternative combinations ($2^2 \times 3 \times 6$ factorial designs) are available. However, it is difficult to ask the respondent to select alternatives among the alternative sets. Therefore, the number of alternatives was reduced by half

Table 1. Definitions of selected lagoon ecosystem management attributes.

Attribute	levels	Definitions
Fishing method	Banning inappropriate fishing gears (BIFG)	Implementing full ban on inappropriate fishing gears
	No change	No change in the current fishing gears
Number of mangroves	Big increase (BIM)	50% increase in the number of mangroves
	Small increase (SIM)	20% increase in the number of mangroves
	No change	Maintain the current number of mangroves
Tourism	Improving tourist facilities (ITF)	Developing tourist spots with boating facilities
	No change	Maintain current level of tourist facilities
Cost to household	0, 50, 100, 200, 400, 800	Annual payment to regional office

assuming interaction effects between attributes are insignificant. In order to have efficient designs, a D-efficient design was adapted to exclude unrealistic cases from each of the choice questions. Among 36 alternatives, 21 alternatives were selected for this study after excluding unrealistic alternatives.

Respondents were asked to choose an alternative they preferred out of the three alternatives provided in the choice questions. Each alternative contained a combination of various levels of four attributes. The cost to the household was designed to be higher in alternative A than in alternative B and C. Alternative C that is no change in the current attribute levels (status quo) was included in each alternative set. Respondents were asked to choose an alternative they preferred from similar sets of choice questions multiple times. Levels of the attributes have been changed from one alternative to the other alternative except alternative C. A pilot study was conducted with randomly selected few fishermen to develop the questionnaire for this survey. Each alternative in the alternative set has different level of lagoon ecosystem management practices. A sample of alternative sets from 10 alternative sets was given in Appendix A. Along the lagoon, there are more than 12,000 fishing families engaged in fishing activities in this lagoon. For this study, four town and five village communities were randomly selected. Sixty-nine fishermen from four densely populated towns such as Kurunagar, Passiyoor, Navanthurai and Koiyathotam and 49 fishermen from five less densely populated villages such as Kachchai, Kovilakandy, Thanankalappu, Thetpaeli and Chavachcheri were randomly selected.

For this study, 118 fishermen were randomly selected and interviewed personally to collect data, using a questionnaire. The questionnaire included fishermen's demographic socioeconomic characteristics such as age, education, income from fishing and other sources, residents in village or town area, household size, environmental problems in their area and the 21 alternatives for lagoon ecosystem management. The attribute levels, cost to the household, payment vehicle, the benefits of sustainable lagoon ecosystem management, and different alternatives of lagoon ecosystem management were explained to the respondents during the

Table 2. Effect codes: Choice modelling.

Attributes	Variables
Fishing method	BIFG 1 if banning inappropriate fishing gears; −1 if no change
Number of mangroves	BIM 1 if big increase; 0 if small increase; −1 if no change
	SIM 1 if small increase; 0 if big increase; −1 if no change
Tourism	ITF 1 if improving tourist facilities; −1 if no change

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survey. After giving explanation regarding alternative sets, the respondents were asked to choose the most preferred alternative from each alternative set. Definitions of the effect codes for the levels of each attribute and variable description are given in Table 2. Conditional logit model was developed for the fisherman's choice and to estimate the fisherman's WTP for sustainable lagoon ecosystem management.

Results and Discussion

The descriptive statistics of socioeconomic demographic variables of fishing communities from town and village areas are given in Table 3.

The descriptive statistics show that fishermen from village averagely earn higher monthly income than fishermen from town. This is due to other sources of income in village areas such as coconut, mangoes and other annual and perennial crops. Fishermen from village are averagely younger than fishermen from the town. Older fishermen in the village have an alternative source of income and are not engaged in risky fishing activities. Fishermen from the village have higher education level than fishermen from town area. Since there is no other source of income to the fishing families in town area, young male children stop their schooling early and help their families in fishing activities. The coefficients of conditional logit model and WTP are shown in Table 4.

Coefficient of cost is negative and significant at 5% level. Big increase in the number of mangroves (BIM) and improving tourist facilities (ITF) variables are significant at 5% level, and banning inappropriate fishing gears (BIFG) is not significant at 5% level in both fishing communities. The interaction term of town and BIM and interaction term of town and ITF are negative and significant at 5% level. The negative sign of these interaction terms indicates that the coefficients of BIM and ITF of fishermen from town fishing communities are relatively smaller in magnitudes than that of fishermen from village communities. Results show that village fishermen are willing to pay Sri Lankan Rupee (LKR) 804 and LKR 1442 per year and town fishermen are willing to pay LKR 335 and LKR 557 per year for BIM and ITF, respectively. Since there is very limited land available along the coastal line in town area, higher competition for this limited land for fishing, anchoring boats and housing along the lagoon shore in town area and no other sources of income in town area, fishermen from town area are willing to pay less for BIM and ITF than fishermen from village area. Fishing is the main source of income to meet their daily living expenditure in both communities. Fishermen's awareness of the long-term impact of inappropriate fishing gears on fish stock in lagoon is low. There is no enforcing mechanism to prevent the usage of

Table 3. Descriptive statistics of socioeconomic demographic variables of the sample study area.

Variable	Unit	Town				Village			
		Mean	Std.	Min	Max	Mean	Std.	Min	Max
Age	Years	46.42	14.57	18	75	34.49	12.36	20	70
Education	Years	6.85	3.65	0	13	9.38	2.72	2	14
Family size	Number	15	1.51	1	8	4.83	1.80	2	9
No. of children	Number	2.00	1.54	0	6	1.70	1.70	0	6
Monthly income	LKR (Sri Lankan Rupee)	31692	14447	10000	100000	40037	25730	5000	135000
No. of fishermen	Number	69				49			

Table 4. Conditional logit model and willingness to pay.

Attribute level Coefficent	*p*-value	Village	Town	
			WTP (LKR)	WTP (LKR)
BIFG	−0.083	(0.108)		
SIM	0.182*	(0.042)	444	
BIM	0.330*	(0.000)	804	335
ITF	0.592*	(0.000)	1442	557
Cost	−0.0008*	(0.000)		
Town*BIFG	0.037	(0.589)		
Town*SIM	−0.145	(0.221)		
Town*BIM	−0.192*	(0.055)		
Town*ITF	−0.363*	(0.000)		
No. of observations	3,540			
Likelihood ratio (x^2)	241.08			

inappropriate fishing gears. Therefore, fishermen from both communities are not willing to support for banning inappropriate fishing gears.

Conclusion and Policy Recommendation

This study concludes that fishermen from village communities are averagely willing to pay more for increasing the number of mangroves and improving tourist facilities. It indicates that the availability of land for planting mangroves and improving tourist facilities along the lagoon and opportunities for other sources of income positively influence the fisherman's WTP for sustainable lagoon ecosystem management practices. Costal lagoon that is close to town area was highly polluted by wastewater pollution, illegal dumping of waste, removal of mangroves and over-exploitation. Establishing fishing harbour facilities to accommodate fishing boats, properly planned multi-storey housing units in town area to make land available for planting mangroves and developing tourist spots would increase fishermen's support for these sustainable lagoon ecosystem management practices. Increasing employment opportunities for fishermen in town area from manufacturing and service sectors and increasing the fishermen's awareness of long-term impact of inappropriate fishing gears on fish stock in lagoon and enforcing mechanism to prevent the usage of inappropriate fishing gears would increase fishermen's support to ban the inappropriate fishing gears. Based on this study, government authority could make appropriate policy for sustainable lagoon ecosystem management for urban and village coastal lagoon ecosystem.

Appendix A

Please choose the most preferred option

	Option A	Option B	Option C
Fishing method	Implementing full ban on inappropriate fishing gears	Implementing full ban on inappropriate fishing gears	No change in the current fishing gears
Number of mangroves	20% increase in the number of mangroves	50% increase in the number of mangroves	Maintain the current number of mangroves
Tourism	Developing tourist spots with boating facilities	No change in the current tourism facilities	No change in the current tourism facilities
Cost to household	LKR 200	LKR 100	LKR 0

Please choose the most preferred option

	Option A	Option B	Option C
Fishing method	Implementing full ban on inappropriate fishing gears	Implementing full ban on inappropriate fishing gears	No change in the current fishing gears
Number of mangroves	20% increase in the number of mangroves	50% increase in the number of mangroves	Maintain the current number of mangroves
Tourism	Developing tourist spots with boating facilities	No change in the current tourism facilities	No change in the current tourism facilities
Cost to household	LKR 200	LKR 100	LKR 0

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