

## **Economic Valuation of Urban Coastal Ecosystem Services and Scenic Beauty**

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### **ABSTRACT**

A lagoon ecosystem provides a variety of ecological functions that directly or indirectly translate to economic services and values. The impact of the loss of cultural services is scarce in literature and particularly difficult to measure. This study generates monetary value for urban ecosystem services specifically the aesthetic value of a natural asset according to the perception of the adjacent community. The data were gathered by using a pre-structured, questionnaire-based personal interview carried out with 300 households representing 15 'Thotupola' areas adjacent to the estuary. Choice Experiment (CE) was used to determine the preferences and the willingness to pay for conservation of urban ecosystem services and natural view. Highest value (530.75) was recorded for provisioning services. Marginal willingness to pay (MWTP) for prawns (272.25) was higher than the value of (258.50) crabs. Second highest MWTP (309.50) was acquired by recreation attribute, scenic beauty of the lagoon. Moreover, local fishing community does not willing to pay for regulatory services such as reduction of flood damage by mangrove and cleaning of polluted lagoon water. Understanding the degree and order of importance of ecosystem non-use values for its direct users is critical for planning for optimum and sustainable management, as properly managed ecosystem can provide continued returns to future generation without diminishing its productivity. The study generates information for decision makers with regard the monetary values for conservation of different ecosystem services and estuary view, to protect the estuary ecosystem through implementing policies and management plans, on urban estuaries and mangrove environment protection.

**KEYWORDS:** Choice experiment, Ecosystem services, Scenic beauty

### **Introduction**

An ecosystem is a dynamic complex of living and nonliving environment interacting as a functional unit. Ecosystem services are the benefits from ecosystems to support sustainable human well-being (Barbier and Strand, 1998). According to the ecology and economy the ecosystem services can be classified in to four major categories namely; 'Provisioning', 'Regulating', 'Cultural' and 'Supporting' services.

In literature the researchers have attempted to value the ecosystem as a bundle of services where they ignored the value of some attributed services separately. Impact

of the cultural services is scarce in literature and particularly difficult to measure. But it is especially important as they are the nonmaterial benefits people obtain from ecosystems.

Different habitats provide different types of ecosystem services. Therefore, general classifications need to be adapted to specific types of ecosystems. Services provided by the urban ecosystems have direct impact on human health and security such as air purification, noise reduction, urban cooling and run off mitigation. Negombo is a major city in Western Province Sri Lanka, on the West coast of the island and at the mouth of the Negombo lagoon. The Negombo lagoon was selected for this study as there is a clearly defined cultural landscape, i.e. the lagoon at the heart of the city have cultural and religious significance for the fishing community and symbolize the spiritual links between this community and its environment. The local community demand for lagoon view is not just for aesthetic purposes, but essentially for cultural purposes.

The valuations of ecosystem services assess the relative contribution of ecosystem services towards sustainable human well-being. Human have changed the ecosystems extensively to meet the rapidly growing demand for augmented goods and services. The changes that have been made to ecosystems have contributed to substantial fulfillment of human well-being while the gains have been achieved at an increasing cost in the form of the degradation of many ecosystem services. Some of these assessments are based on individual's perceptions of the benefits they derive. But support towards sustainable human well-being is a much larger goal. Therefore, it is essential to improve valuation methods to assess benefits to individuals that are not well perceived and incorporate benefits to whole communities and to sustainability (Costanza, 2000).

Market fails due to incapability of identifying these costs and benefits and it has been a major problem in managing the estuary. Understanding the degree and order of the non-use value of an ecosystem for its direct beneficiaries is critical for planning for the sustainable environment management (Wattage and Mardle, 2005). Therefore when implementing policies rules and regulations for environmental conservation, it is necessary to consider the perception of the adjacent community.

Monetary valuation of natural resources can be easily understood by all the residents to initiate conservation activities from the adjacent community.

The specific objective of this study was to determine monetary value for urban ecosystem services according to the perception of the adjacent community, to assess the importance of diverse ecosystem functions. The general purpose of this research is to generate information for decision makers with regard to the costs and benefits to protect the estuary ecosystem through implementing policies and management plans, on urban estuaries and mangrove environment protection.

## **Methodology**

Choice Experiment (CE) was carried out to estimate the stated preferences where the conservation of these ecosystem services was priced. Choice experiment is a technique

that provides respondents with multiple choice sets, in which each choice set usually contains two or more management options. The options in each choice set contain common attributes, which can be at various levels. The respondents were asked to choose their most preferred option.

**Theoretical Framework to Assess the Value of Ecosystem Services (ESS)**

Choice Experiment is based on two fundamental building blocks: Lancaster’s characteristics theory (Lancaster 1966) and random utility theory (Adamowicz et al. 1994, Boxall et al. 1996). Lancaster’s theory posits that choices can be modelled as a function of attributes of the alternatives relevant to a given choice problem. Random utility theory assumes that the alternative with the highest overall utility is selected. The utility function for a representative consumer can be decomposed into a systematic component or observable component and a random component or unobservable component by the analyst. The random utility function is shown as follows:

$$u_i = v_i + \varepsilon_i \tag{1}$$

Where;

Utility of the option  $i = (u_i)$

Utility of the other option  $j = (u_j)$

However, since the overall utility is random and  $p\{i \text{ chosen}\} = p\{V_i + \varepsilon_i > V_j + \varepsilon_j\}c$

The probability of an individual choosing an alternative such  $i$  as;

$$P_{[i]} = \frac{e^{v_i}}{\sum_{j \in c} e^{v_j}} \tag{2}$$

$V_j$  is assumed to be linear and additive functions in the attributes and then  $V_j$  can be written as;

$$V_{iq} = \sum_{k=1}^K \beta_{jk} X_{jkq} \tag{3}$$

$\beta_{jk}$  = Estimates of the weight of attribute in the utility expression  $v_j$  of alternative  $j$  and  $v_{iq}$  estimates of the (relative) utility  $u_{i,q}$  of the individual.

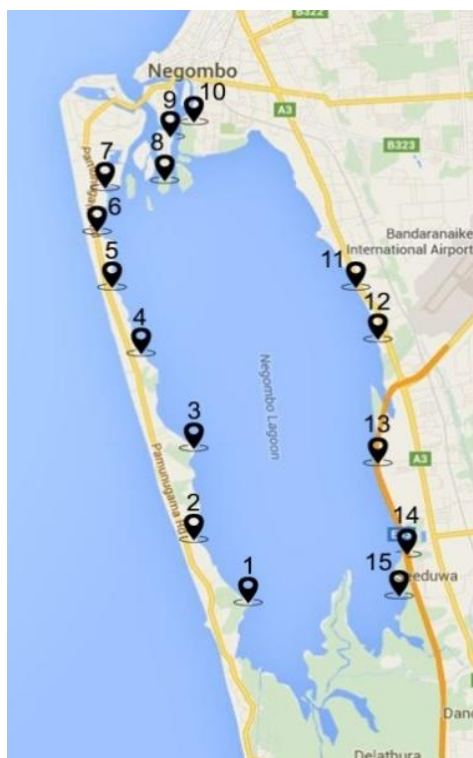
The marginal value of an attribute change could be given by the ratio of the coefficients of the attribute in question and that of the monetary attribute, holding all else equal. This can be conceptualized as the part-worth or marginal willingness to pay (MWTP) for the attribute calculated as;

$$MWTP_{\text{attribute}} = - \frac{\beta_{\text{attribute}}}{\beta_{\text{monetary attribute}}} \tag{4}$$

Where MWTP represent the marginal rate of substitution between the monetary attribute and the attribute in question, and  $\beta$  refers to the parameter estimates of the attribute levels.

## Data Collection

The lagoon area is geographically segregated in to areas known as ‘Thotupola’ where the fisherman can easily launch their fishing boats in to lagoon (Figure 1).



**Figure 1. Fifteen “Thotupola” Areas in Negombo Lagoon**

*Note: 1-Kepungoda, 2-Settappaththuva, 3-Dungalpitiya, 4-Thalabena, 5-Basiyawatta, 6-Aluthkurruwa, 7-Pitipana South, 8-Siriwardana Pedesa, 9-Munnakaraya, 10-Telwatta, 11-Katunayaka, 12-Katunayaka South, 13-Liyanagemulla, 14-Mukalangamuwa, 15-Bandarawatta.*

Data collection was done within two phases. During the first phase of this research program; a pilot survey was conducted to identify the levels of ecosystem services which are crucial for households around Negombo lagoon. Questions were asked from 30 respondents representing five ‘Thotupola’ areas for the pilot survey. According to the pilot survey findings; five attributes and three levels for each attribute, were selected as crucial for this study (Table 1).

**Table 1. Findings of the Pilot Survey**










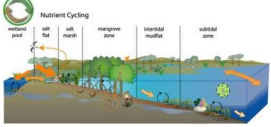
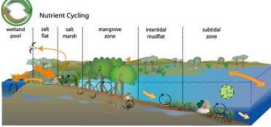




Attributes	Level I	Level II	Level III
Provisioning	Fish	Crabs	Prawns
Recreation	Full view	Partial view	No view
Regulating	Prevention soil erosion	Water purification	Flood reduction
Supporting	Sediment stabilization	Nutrient recycling	Biodiversity
Annual Payment	Rs. 243.75	Rs. 325.00	Rs. 162.50

The pilot survey participants also identified the minimum (Rs.162.50 per year) and maximum (Rs. 325 per year) they could contribute for the lagoon ecosystem conservation activities.

Since each of the four ecosystem services and “Annual Payment” has three levels, these were combined in to a limited number of choice sets made up of optimal combinations of attributes and their levels. For this purpose, Statistical Package for the Social Sciences (SPSS 16.0) was used. Orthogonalization procedure was adopted to identify the main effects.

A complete factorial design including all possible combinations of attributes and levels would use 243 ( $3 \times 3 \times 3 \times 3 \times 3 = 243$ ) choice tasks. From the 243 possible combinations, 18 lagoon profiles were randomly blocked into six different versions, each with three different lagoon alternatives (Table 2).

**Table 2. An Example of a Choice Card**

Choice A	Choice B	Choice C
Full view	No view	Partial view
		
Prawns	Fish	Fish
		
Reduction of flood damage by mangrove	Reduction of flood damage by mangrove	Cleaning of polluted lagoon water by mangrove
		
Nutrient recycling by mangrove	Nutrient recycling by mangrove	Biodiversity around mangrove
		
Rs.325/year	Rs.243.75/year	Rs.162.50/year
		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

During the second phase, respondents were asked to select their best choice out of three alternatives present in one choice card. The data collection was conducted by using 300 respondents, representing 15 ‘Thotupola’ areas adjacent to the lagoon during February to April 2016.

### Data Analysis

For assessing the value of the ESS, Conditional Logistic (CL) Regression was employed when all the assumptions were met.

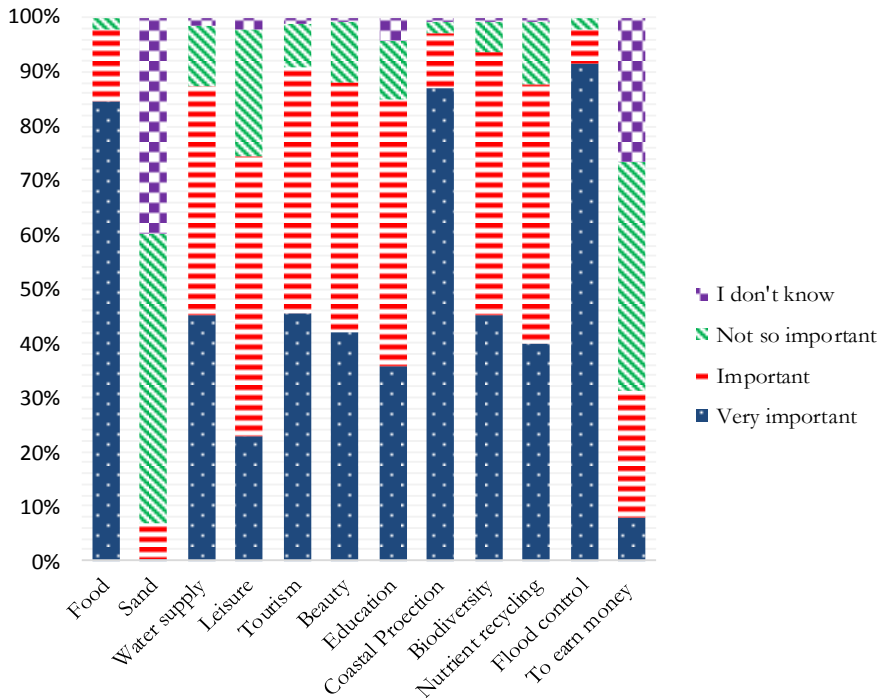
### Results and Discussion

Out of 300 participants, 55% of the respondents were males and 22% of the respondents were in the age category of less than 35 years. Fifty seven percent of the sample was educated above the 11<sup>th</sup> grade (Table 3).

**Table 3. Descriptive Statistics of the Sample**

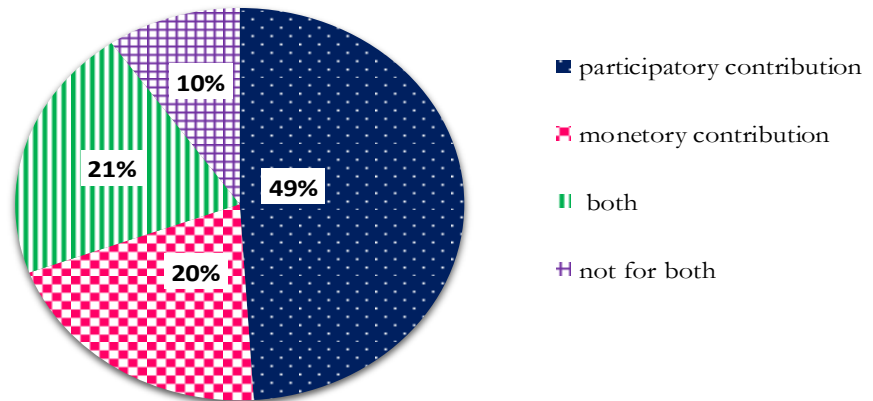
Parameter	Percentage (%)
Age (Years)	
< 35	22.00
36 – 50	37.67
50 <	40.33
Education (Grade)	
< 5	2.33
5 – 10	40.67
11 <	57.00
Monthly Wage (Rs.)	
< 10,000	9.00
10,000 - 20,000	40.67
20,000 <	50.33
Gender	
Male	55.00
Female	45.00

According to the survey, Flood control (92%), coastal protection (87%) and lagoon fisheries (85%) ranked as the major services provided by the lagoon. Scenic beauty of the lagoon was categorized as very important (42%) and important (46%) by the adjacent community (Figure 1). Therefore, 88% of the respondents around the Negombo lagoon have clearly identified the scenic beauty of the lagoon as a major services provided by the lagoon ecosystem and the benefits that they would receive through the well maintained lagoon ecosystem (Figure 1).



**Figure 1. Importance Given by Residents to Main Functions of the Lagoon**

The residents of Negombo lagoon are more willing to provide participatory contribution (49%) than monetary contribution (20%) to conserve the lagoon for the future generation (Figure 2).



**Figure 2. Contribution for Conservation**

Twenty one percent of them were willing to give contribution in both ways while 10% of them were not willing to take part in any conservation activities. Ninety

percent of the fishing households willingly contribute for the proper functioning conservation programs.

Because adjacent fishing community becomes the major stakeholder who directly deals with the ecosystem services provided by the lagoon and they have clearly recognized the direct benefits that they would receive through a conservation program.

### Outcomes of CE

According to the results (Table 3), seven out of eight levels of ecosystem services considered in the analysis (i.e. crabs, prawns, partial view, full view, cleaning polluted water, reduce flood damage and biodiversity) were significant at 95% of significant level. Positive coefficients for the attribute imply that respondents' willingness to pay for conservation of those ecosystem services. According to the results of CE, respondents' are willing to pay for all ecosystem services except regulating services such as cleaning of polluted lagoon water and flood control (Table 3).

**Table 3. Outcomes of CE Model**

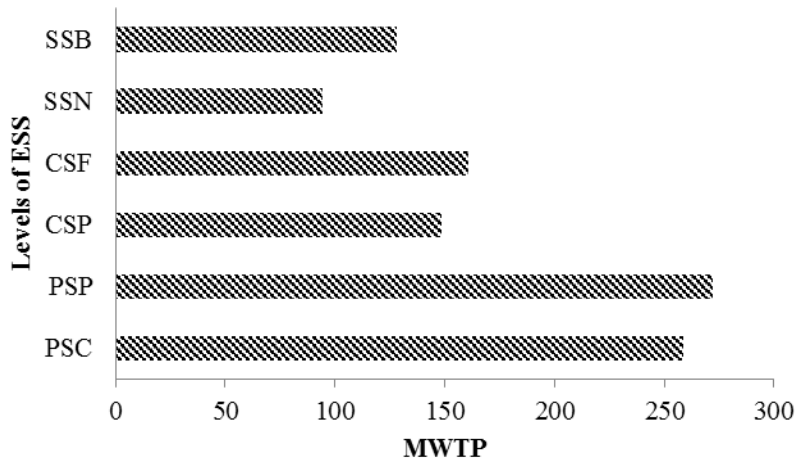
Attributes	Levels	Coefficients	Standard Error	P value	MWTP	MWTP for Whole Attribute
Provisioning (PS)	Fish (PSF) <sup>a</sup>	-	-	-	-	530.75
	Crabs (PSC)	1.034	0.272	0.000	258.50	
	Prawns (PSP)	1.089	0.307	0.000	272.25	
Cultural (Recreation) (CS)	No view (CSN) <sup>a</sup>	-	-	-	-	309.50
	Partial view (CSP)	0.594	0.193	0.002	148.50	
	Full view (CSF)	0.644	0.193	0.001	161.00	
Regulating (RS)	Prevention erosion (RSP) <sup>a</sup>	-	-	-	-	-
	Cleaning polluted water (RSC)	-0.653	0.277	0.019	-	
	Reduce flood damage (RSR)	-0.674	0.285	0.018	-	
Supporting (SS)	Sediment stabilization (SSS) <sup>a</sup>	-	-	-	-	222.50
	Nutrient recycling (SSN)	0.377	0.461	0.413	94.25	
	Biodiversity (SSB)	0.513	0.211	0.015	128.25	
Contribution to conservation		-0.004	0.001	0.005		

Note: MWTP in Rs. per perch per year, a-reference category, Log likelihood -516.07645, Pseudo R<sup>2</sup> 0.0732, N. Observations 900

According to the MWTP values, the fishing households around Negombo lagoon ranked the highest value (530.75) for provisioning services. Because their main



livelihoods attached with provisioning services and nowadays majority of the aquaculture farms are either non-functioning or abandoned due to low yields. Marginal willingness to pay for prawns was (272.25) higher than the value of (258.50) crabs. Second highest MWTP was (309.50) acquired by recreation attribute, scenic beauty of the lagoon (Figure 3).



**Figure 3. Marginal Willingness to Pay Values for Levels of Ecosystem Services**

*Note: PSC- crabs, PSP- prawns, CSP- partial view, CSF- full view, SSN- nutrient recycling, SSB- biodiversity*

Although the flood control was appeared as very important service in community ranking order, people were not willing to pay for that service due to the following reasons. Majority of the local fisher community stated that development activities and illegal constructions took place in this area are the major reasons behind these flood damages. Further they stated that flood damage can be reduced only by implementing proper functioning policies, rules and regulations.

The overall implicit price for the ecosystem services was derived as Rs. 1062.75. Scenic beauty of the lagoon acquired solely 30 percent from whole ecosystem value that cannot readily provide a substitute to the indigenous people in community. Therefore in formulating conservation policies and exploiting land development activities the policy makers must account the fact and importance of scenic beauty of lagoon ecosystem to the indigenous people in community.

## Conclusions

Economic valuation of ecosystem services and natural resources has become popular over the last two decades. But the focus towards urban ecosystems and their cultural services are lack in literature. Further the conservation of urban ecosystems means that the land cannot be put into alternative uses. Therefore in formulating conservation policies one must account for the fact that the benefits to the local communities who

are being asked to conserve must outweigh the costs to them. Otherwise it is unlikely that the policy will be accepted.

## **Acknowledgements**

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