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Estimating the Option Value of Ashtamudi Estuary in South India: a contingent valuation approach

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Abstract— **Ashtamudi estuary of south India provides many direct and indirect use values to the local community in terms of fishing, coconut husk retting, recreation and inland navigation. Nowadays the estuary is facing many threats like pollution, reclamation, injudicious fishing practices etc. At the same time it is having many potential future uses also. So it is imperative to assess the option value of the estuary to appraise the importance to conserve it. Here a contingent valuation method is applied for the assessment. The high option value of the estuary indicates the urgent need of conserving it for the potential future uses.**

Keywords— **Ashtamudi, Option value, CVM**

I. INTRODUCTION

Estuaries are defined as places where the rivers meet sea and the salinity is intermediary to that of marine and fresh water. This makes the estuarine ecosystems unique in their ecological and biological functions. The services as well as resources provided by an estuarine ecosystem to the people depending on it are innumerable and invaluable. Many times it is very intricate to value all these services and benefits because a plenty of them are non marketable in nature. Estuaries possess both use values and non use values. The use values can be again classified into direct and non-direct use values [1]. Option value is a kind of use value defined as the value that can be attributed to the potential future uses of a resource. Option value arises because an individual may be uncertain about his or her future demand for a resource and /or its availability in the wetland in the future [2].

Ashtamudi estuary in Kerala, covering an area of around 6400 hectares, is a RAMSAR site designated as the "wetland of international importance". It is located in the Kollam district of Kerala state in south india .The estuary possess many direct as well as indirect use values viz. fishery, coconut husk retting, inland navigation, recreation, carbon sequestration, shrimp larvae protection etc.. It also has many potential uses like creation of a marine reserve, promoting ecotourism, and export of indigenous fishes [3]. At present the estuary is facing many threats viz. pollution, over-fishing, sand mining, bank erosion and loss of mangroves. Hence an attempt was made to assess the option value of Ashtamudi estuary in terms of people's willingness to pay for conserving it using a contingent valuation approach.

II.METHODOLOGY

In contingent valuation method, the service demand is elicited by posing hypothetical scenarios that involve the description of alternatives in a social survey questionnaire. For example, asking the respondents to express their willingness to pay (i.e., their stated preference as opposed to the revealed preference) to increase the level of an attribute or service or the quality of a resource, etc. Later, the related method of contingent choice - asking the respondents whether or not they would pay a predetermined amount- has gained popularity, since it eliminates some of the weaknesses of the earlier method [4] .

The double bounded dichotomous choice contingent valuation: In this method, instead of single time bidding, two times bidding is practiced. Here the respondent will be provided with a first bid amount and then a follow-up question of another bid amount depending on the response to the first bid (question). This method was first suggested by [5]. If the response to the first bid amount was 'YES' then a higher bid amount was presented. If the first response was 'NO', a lower bid amount was presented. The double bounded procedure is statistically more efficient than single bounded process [6].

The bid structure was designed by pre-testing using the payment card format.

A double bounded logit was used to analyse the data. Two dichotomous variables will be observed for the double bounded model, i.e. the answers to the first question and its follow up. This method produces four possible outcomes i.e. 'YES - YES' (YY), 'YES - NO' (YN), 'NO - YES' (NY) and 'NO - NO' (NN).

Following [5], the following response probabilities were obtained for the Logit model.

$$P_i^{yy} = 1/ (1+ e^{-(\alpha + \beta \text{ HIGH BID})}) \quad (1)$$

$$P_i^{NN} = 1- 1/ (1+ e^{-(\alpha + \beta \text{ LOW BID})}) \quad (2)$$

$$P_i^{YN} = 1/ (1+ e^{-(\alpha + \beta \text{ HIGH BID})}) - 1/ (1+ e^{-(\alpha + \beta \text{ FIRST BID})}) \quad (3)$$

$$P_i^{NY} = 1/ (1+ e^{-(\alpha + \beta \text{ FIRST BID})}) - 1/ (1+ e^{-(\alpha + \beta \text{ LOW BID})}) \quad (4)$$

Where
FIRST BID – Starting bid value
LOW BID – Follow-up lower bid value
HIGH BID – Follow-up higher bid value

The double bounded log – likelihood function is

$$LDB = \Sigma I_i^{yy} \log P_i^{YY} + \Sigma I_i^{YN} \log P_i^{YN} + \Sigma I_i^{NY} \log P_i^{NY} + \Sigma I_i^{NN} \log P_i^{NN} \quad (5)$$

i = 1…….40

Where, Ii indicates the response category of each respondent i.

According to [5], the mean willingness to pay can be estimated using the formula,

$$WTP^* = \alpha / | \beta | \quad (6)$$

The truncated or restricted mean was given by

$$WTP^* = \ln (1+e^{\alpha}) / | \beta | \quad (7)$$

Where | β | is the absolute value of bid coefficient.

Referendum CVM programs (GAUSS) written by [7] was used to estimate the double bounded logit regression.

The parameter estimates used to calculate welfare measures (α and β) are themselves random variables. So it is essential to determine a confidence interval for the welfare estimates. Krinsky Robb confidence interval estimation suggested by [8]was employed here.

The confidence interval estimation can be done by using the information given by the estimated logit model i.e., the estimated parameter vector β^ and the estimated variance-covariance matrix, denoted by V^. Multiple random drawings to create a new parameter vector β^^ are made from multivariate normal distribution with variance covariance vector V^ and mean β^. By each drawing of β^^, WTP was calculated. An empirical distribution for WTP was then obtained for the Logit model using the complete set of replications. A (1- α) confidence interval was obtained by ranking the vector of calculated WTP values and dropping α / 2 values from each tail of the ranked vector. Krinsky Robb confidence interval was obtained using the Referendum CVM (GAUSS) written by [7].

Here the respondents (a total of 120 respondents with 40 each in three categories viz. fishermen, coir producers, and tourists) were asked about the amount of one time payment they are willing to contribute towards the conservation of the Ashtamudi estuary. The willingness to pay response was elicited form the three categories of respondents viz. fishermen, coir producers and tourists. The double bounded logit was fitted for each category separately due to the difference in income, education and other characteristics.

III. RESULTS

In case of coir producers the initial bid and age were found to have a significant negative influence on the WTP (willingness to pay) for conserving the estuary while the income was having a positive significant influence. It is obvious that as the initial bid increases the people will be willing to pay lesser amount. Even though income is having significant effect the additional amount they are WTP is only feeble which can be attributed to the very low household income of respondents (table 1).

Table 1 Coir producer's WTP for conservation of the estuary

Variable	Coefficient	SE	t stat
Constant	5.5074	6.537	0.8425
Bid	- 0.07196**	0.01773	- 4.06
Age	-0.06994	0.08886	-0.7871
Sex	- 3.0728*	1.471	-2.089
Education	-0.0662	0.3017	- 0.2194
Income	0.0034**	0.0009	3.881
Log likelihood function			-18.50540

Note: * and ** indicate significance at 10 % and 1 % levels respectively.

The mean WTP of coir producers to conserve the Ashtamudi estuary was estimated to be Rs.142.07 per household. The option value of estuary for this category amounted to Rs.29,252 only because of the few number of households engaged in coir production (table 2).

Table 2 Option value for coir producers - Krinsky and Robb confidence intervals using 1000 repetitions

99 % C.I	119.278 to 166.090
95 % C.I	125.890 to 159.925
90 % C.I	129.778 to 155.508
Average of the Krinsky and Robb CS values	142.43
Median of the Krinsky and Robb CS values	142.29
Restricted WTP point estimate	142.07
Option value of the Estuary(Rs)	29,252

Fishermen's WTP to conserve the estuary was influenced by only the initial bid amount. The other parameters like age and monthly income were not found to have any significant influence on their WTP (table 3).

Table 3 Fishermen's WTP for conservation of the estuary

Variable	Coefficient	SE	t - stat
Constant	1.3726	2.962	0.4635
Bid	-0.0198***	0.0054	-3.713
Age	-0.0011	0.0425	-0.0258
Education	0.1366	0.1665	0.8206
Income	0.0002	0.0004	0.4257
Log likelihood function			-41.17385

Note: *** indicates the significance at 1 % level

The mean WTP (Rs. 139.85 per household) was also less then that of coir producers but the option value (Rs. 357177 per household) was higher because of large number of fishermen in the area (table 4). Fishermen are willing to pay less than that of coir producers for conservation of Ashtamudi estuary.

Table 4 Option value for fishermen - Krinsky and Robb confidence intervals using 1000 repetitions

99 % C.I	93.376 to 313.770
95 % C.I	107.025 to 212.221
90 % C.I	110.612 to 189.698
Average of the Krinsky and Robb CS values	146.043
Median of the Krinsky and Robb CS values	141.254
Restricted WTP point estimate	139.850
Option value of the Estuary(Rs)	3,57,177

Age and education were found to have significant positive influence on WTP in case of tourists. Here also the bid was having a negative and significant influence (table 5).

Table 5 Tourists' WTP for conservation of the estuary

Variable	Coefficient	SE	t - stat
Constant	-6.575*	3.079	-2.136
Bid	-0.0165***	0.0044	-3.74
Age	0.1248**	0.0482	2.589
Sex	-0.3984	1.075	-0.3705
Education	0.463**	0.208	2.227
MS	-1.2646	1.236	-1.023
Log likelihood			-41.492

Note **: *, **** and *** are levels of significance at 10 %, 5 % and 1 % respectively

The mean WTP to conserve the estuary was as high as Rs. 192 per visitor which amounted to an option value of Rs. 34,98,324 (table 6)in case of tourists (visitors). This reveals that the option value of recreation is higher in case of Ashtamudi estuary. The higher WTP of tourists can be attributed to their high household income, education and social status. This is of particular relevance since in many cases the demographic characteristics other than income were not found to have any significant effect on the amount visitors are willing to pay [9].

Table 6 Option value for tourists – Krinsky and Robbconfidence intervals using 1000 repetitions

99 % C.I	138.039 to 336.600
95 % C.I	149.326 to 270.670
90 % C.I	191.689 to 252.939
Average of the Krinsky and Robb CS values	197.189
Median of the Krinsky and Robb CS values	192.752
Restricted WTP point estimate	191.689
Option value of estuary	34,98,324

The aggregate option value of Ashtamudi estuary was found to be Rs.38.84 lakhs (table 7) with a present value of Rs. 871 lakhs (at four per cent discount rate).

Table 7 Option value of Ashtamudi estuary (Rs. lakhs)

Sl.No.	Category	Option value	Present option value*
1	Coir producers	0.29	
2	Fishermen	3.57	
3	Tourists	34.98	871
	Total	38.84	

* indicates the discounted option value at four percent rate

IV. CONCLUSIONS

The value of Ashtamudi estuary, the second largest estuary in Kerala, for its potential future uses (option value) was assessed using a double bounded dichotomous contingent valuation method (DBDCVM).

The option value was assessed separately for the three categories of stakeholders viz. coir producers, fishermen and tourists. The WTP for conserving the estuary was comparatively appreciable in case of all the categories. Tourists are WTP highest amount for conserving the estuary for using it in future for recreation purpose. The WTP of other two categories were also very close and for them conservation of estuary is more important since they are directly depending on it for their livelihood.

Contingent valuation method is having many inherent biases and hence utmost care was taken at each stage of the study to avoid such problems to the least. The high option value of Ashtamudi estuary suggests people's willingness to pay for its conservation keeping in mind the recent threats faced by the estuary. Hence there is an urgent need to protect this fragile ecosystem and manage it in a sustainable manner with the participation of the stake holders as well as experts for securing the livelihood of people depending on it.

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