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Willingness to Pay to Conserve Wetland Ecosystems : A Case Study of Vellayani Fresh Water Lake in South India

KEYWORDS: Fresh water ecosystem, Vellayani lake, Contingent Valuation Method, Willingness to Pay, double bounded dichotomous choice method, regression

Aswathy Vijayan	Elsamma Job	Allan Thomas
Ph.D Scholar, Department of Agricultural Economics, College of Agriculture, Vellayani, Trivandrum, Kerala, India	Professor, Department of Agricultural Economics, College of Agriculture, Vellayani, Trivandrum, Kerala, India	Assistant Professor, Department of Agricultural extension, College of Agriculture, Vellayani, Trivandrum, Kerala, India

ABSTRACT *Freshwater ecosystems are most important functional unit that sustains human life in earth. But the deterioration and degradation of these ecosystems is a universal phenomenon. The main reason for this is the lack of awareness among the people about the value of the ecosystem services provided by these ecosystems. Vellayani lake is an important fresh water lake in the humid tropics of South India. This pristine lake, is a source of drinking water, livelihood generation and other life supporting activities. The study attempts to estimate the economic value of the lake using a double bounded dichotomous choice contingent valuation method. A sample of two hundred and forty local residents residing around the lake, at a distance of 100m (Zone I), 200m (Zone II) and 300m (Zone III) were interviewed to elicit their Willingness to Pay (WTP) to conserve the lake. Maximum WTP was observed in Zone I (Rs 354.25) and minimum in zone III (Rs 174.37). Number of respondents willing to pay also had a similar trend. The econometric model for estimation of WTP revealed that the statistically important variables that affected the WTP were monthly income, marital status, education and dependence on lake. The economic value of the lake system estimated using CVM was Rs 2.91crore per year.*

Introduction

A well defined ecosystem has strong interactions among its components and weak interactions across its boundaries (MA, 2003). Ecosystems provide several benefits to people that can be called as ecosystem services. It includes provisioning services, regulating services, cultural services and supporting services. Agricultural land, home garden land, forest land, dry land, wetlands etc. are the important type of ecosystems. Among all these, wetlands are the earth's most important and productive resources and therefore been termed the "kidneys of the landscape and biological supermarkets" (Barbier *et al.*, 1997). Ramsar Convention on Wetlands defines wetlands as "areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres". They are very important ecosystems and provide many ecosystem services to people.

Kerala, the green state in India is well known for its wetlands with a total area of 1,60,590 ha (ISRO, 2011). In Thiruvananthapuram, the capital city of Kerala, the total wetland area is 5,942 ha (ISRO, 2010) with Vellayani lake, as the only fresh water source. There is no salt water intrusion into it. This pristine lake, is a source of potable water, considered as sacred for religious functions, supports the people through livelihood generation and other life supporting functions. An understanding of the value of wetland ecosystems and their proportionate contribution is crucial while deciding on conservation and development priorities related to land use and the allocation of scarce water resources. Therefore, the value of the goods and services that the Vellayani lake provide to the society is a critical consideration. The lack of understanding among the people about the services of the lake and failure to take this value into account by policy makers lead to its over-exploitation or excessive degradation. Contingent Valuation Method (CVM) is a valuation technique used to estimate the value of environmental resources. So the present study attempts to estimate the economic value of the Vellayani lake freshwater ecosystem using CVM.

Materials and Methods

Lying on the South East of the Thiruvananthapuram city, Vellayani lake is one of the three major fresh water lakes of Kerala (Plate 1). The lake is an elongated water body, allinged in a North South direction. It lies between $8^0$24'09" - $8^0$26'30" N; 76°59›08» - 76°59'47» E. The lake is situated 11km south of Thiruvananthapuram city and 7 km from Kovalam tourist centre. Lying hardly about 3kms away from sea, the lake is surrounded in all sides by gently sloping hillocks. The whole terrain lies 29 m above MSL, and the lake bed is 0.1 to 1.5 m below the MSL. The lake stretches from Venniyoor - Muttakadu region in the South to reservoir in the North and from Poonkulam in the West, to Kakkamoola in the East. The length of the lake is 3.7 km with a maximum breadth of 2.1 km and a maximum depth of 3 meters. From the satellite images of the lake prepared using Geographical Information System (GIS) and cross checking with field visits, it was revealed that, the entire water body of Vellayani lake lies in *Kalliyoor* and *Venganoor* panchayats of Nemom and Athiyanoor blocks respectively.

For conducting the CVM study the local residents of Kalliyoor and Venganoor panchayats residing around the lake were selected. Sample selection was done based on purposive multi stage stratified sampling. Based on Participatory Rural Appraisal eight different locations were identified around the lake considering the presence of sufficient number of households for data collection and almost equal distribution around the lake. GPS co ordinates were obtained to ensure that the locations are almost equally spaced (Plate 2).The selected location were

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1.Arattukadavu(L_1)
2.Vazhavila(L_2)
3.Kakkamoola(L_3)
4. Vavvamoola (L_4)
5.Venniyoor(L_5)
6.Kadavinmoola(L_6)
7. Agricultural College (AGC) (L_7)
8. Palapoor(L_8)

The GPS co ordinates of the selected study locations are presented in Table 1.

Table 1. GPS co- ordinates of study locations

Locations	Zone1		Zone2		Zone3	
L_1	8.442750°	76.989944°	8.443003°	76.991081°	8.443106°	76.992153°
L_2	8.442750°	76.989944°	8.439825°	76.997389°	8.440703°	76.997700°
L_3	8.426425°	76.995561°	8.426828°	76.996383°	8.427119°	76.997231°
L_4	8.413603°	76.995686°	8.414381°	76.997406°	8.414800°	76.998236°
L_5	8.408719°	76.996333°	8.408750°	76.997281°	8.408847°	76.998175°
L_6	8.411786°	76.991583°	8.411222°	76.990700°	8.411178°	76.989850°
L_7	8.424569°	76.990178°	8.424681°	76.989717°	8.425556°	76.989181°
L_8	8.438286°	76.981414°	8.437828°	76.980756°	8.437219°	76.980092°

Eight locations selected were further stratified into three zones based on the distance from the lake. Zone I was at a distance of 100m, Zone II at a distance 200m and Zone III was at a distance of 300m from the lake. So total twenty four locations were identified for the study. Ten respondents were selected from each locations thus making a total sample size of two hundred and forty.

In CVM study questions are asked that help to reveal the monetary trade offs, each person would make concerning the value of goods and services (Carson, 2012). In other words it involves eliciting the Willingness to Pay (WTP) of the respondents for a defined change in goods or service (Loomis *et al.*, 2000 and Spash, 2000). CVM estimates the Hicksian consumer surplus and the welfare measure in the CVM is Compensating Surplus and Equivalent surplus based on the scenario. The WTP in question is a dependent variable elicited from the respondents and is made a function of many socioeconomic and individual characteristics.

As given by Markandya *et al.* (2002) elicitation of the WTP using CVM employed in the study followed 3 steps

1. A scenario is described explaining the ecosystem services of the lake.
2. The respondents are invited to consider the proposed context where the lake is well managed under a trust
3. The respondents are invited to supply their statement concerning their WTP from which the value attached to a change in the provision of good and service in question is inferred.

As a first step a pilot study was conducted in all the twenty four locations in order to get an idea about the socio economic conditions of the people. Based on the pilot study the elicitation format was finalised following the steps proposed by Marakandya *et al.*, 2002 and Gunatilake, 2003. The data collection proceeded on the assumption that each individual has a maximum Willingness to Pay (WTP) and will respond "Yes" to a bid only if his or her WTP is greater than the bid amount. It was revealed from the pilot study that the information obtained about an individual's WTP from the dichotomous choice format was limited and an alternative format, in which a follow-up bid is asked was used. The follow-up bid is lower if the person answered "No" to the starting bid and higher if the person answered "Yes." Thus the format used for elicitation of WTP was double-bounded dichotomous choice (take it or leave it with follow up). An open ended question was posed at the end of the game to confirm the maximum WTP.

The intial bid fixed was Rs.100 per month based on the pilot study. At the higher end it extended to 25 per cent and at the lower end it extended to 1 per cent. The model specification and identification of the independent variables was done based on previous research (Anoop, 2007; Mamta, 2008; Hema, 2013) and the field conditions. The factors influencing the WTP of the respondents were estimated using multiple regressions with WTP as dependent variable with a set of other relevant explanatory variables. Various functional forms were tried to get the best goodness of fit.

Results and Discussions

The respondents in each zone were interviewed to elicit their WTP per year for the conservation of lake contingent upon the hypothetical scenario that, in order to conserve the lake, how much they are willing to pay. A double bounded dichotomous choice format was used for elicitation of the WTP. The effectiveness of the double bounded dichotomous choice format method in CVM studies were confirmed by Blomquist and Whitehead,1998; Mamat *et al.*, 2003; Venkatachalam, 2004; Ramlan *et al.*, 2011 and Ikeuchi *et al.*, 2012. The number of respondents willing to pay to conserve the lake and their mean stated value of WTP in each zone is furnished in the Table 2 and Fig 1.

Table 2. Mean stated WTP of respondents

Zone	No of respondents with the WTP	No of respondents not willing to pay	Total number of respondents	Mean stated WTP (Rs/Year)
Zone I	52 (65)	28 (35)	80 (100)	354.25
Zone II	36 (45)	44 (55)	80 (100)	237.12
Zone III	28 (35)	52 (65)	80 (100)	174.37
Total	116 (48.33)	124 (51.67)	240 (100)	225.22

(Figures in parenthesis give percentage to total)

The study revealed that only about 48 per cent of the sample respondents were willing to pay for the conservation of lake with a mean stated WTP of Rs 225.22 per year . It ranged from Rs. 354.25 per year in zone I and Rs. 174.37 per year for zone III. The amount was much lower than average annual willingness to pay of Rs. 500 to Rs. 1200 for aesthetic and recreational purpose of Powai lake in India (Gupta and Mythili, 2009).

When location wise analysis was done in zone I, the higher WTP can be attributed to the acceptance of higher bids by respondents of L_3 followed by L_6 and L_7. The frequency distribution of respondents with WTP and average WTP in each of the study location is furnished in Table 3 and Table 4 respectively.

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Table 3.Frequency distribution of WTP in different Study locations

Zone	Location	No of respondents willing to pay	Total no respondents willing to pay per zone	% to total
Zone1	L_1	4	52	65
	L_2	7		
	L_3	9		
	L_4	6		
	L_5	5		
	L_6	6		
	L_7	8		
	L_8	7		
Zone2	L_1	2	36	45
	L_2	4		
	L_3	4		
	L_4	5		
	L_5	4		
	L_6	8		
	L_7	5		
	L_8	4		
Zone3	L_1	1	28	35
	L_2	4		
	L_3	4		
	L_4	4		
	L_5	2		
	L_6	6		
	L_7	3		
	L_8	4		
Total No of respondents willing to pay			116	48.33

Table 4. Average Willingness to Pay in different zones (Rs/Year)

Zone	Location	Average WTP	Average WTP
Zone1	L_1	73	354.25
	L_2	300	
	L_3	675	
	L_4	415	
	L_5	340	
	L_6	446	
	L_7	415	
	L_8	170	
Zone2	L_1	36	237.12
	L_2	114	
	L_3	306	
	L_4	76	
	L_5	75	
	L_6	320	
	L_7	510	
	L_8	460	
Zone3	L_1	12	174.37
	L_2	210	
	L_3	265	
	L_4	57	
	L_5	240	
	L_6	159	
	L_7	222	
	L_8	230	
Average willingness to pay of the local residents			255.25

The location L_3 is more urbanized when compared to other locations and respondents. The number of respondents willing to pay was also high in L_3 followed by L_7. L_1 in Zone I had least number of respondents willing to pay and least mean stated WTP (Rs.73/year). General backwardness with low educational status, low transportation facilities and rural atmosphere existed in the area. Except for livelihood generation such as lotus collection and fishing they are dependent on Pallichal canal as water source. This may be the reason for low WTP of the region.

In zone II the mean stated WTP was Rs 237.12 per annum with 45 per cent of the respondents willing to pay. The mean stated WTP was maximum for L_7. The zone III had still lower mean stated WTP (Rs 174.37 per year) and the number of respondents willing to pay was least (35 %).

The income distribution of respondents given in Table 5 shows that the respondents in L_3 had the highest average monthly income when compared to other zones which might have translated into higher WTP.

Table 5. Average income of respondents in study locations

Zone	Location	Average income in thousand Rs per month	Average income in thousand Rs per month
Zone1	L_1	10.25	13.71
	L_2	11.8	
	L_3	28.42	
	L_4	10.77	
	L_5	8.1	
	L_6	20.67	
	L_7	10.51	
	L_8	9.19	

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Zone2	L_1	6.78	11.45
	L_2	10.3	
	L_3	8.35	
	L_4	11.32	
	L_5	7.39	
	L_6	24.6	
	L_7	14.2	
	L_8	8.69	
Zone3	L_1	9.92	11.89
	L_2	14.6	
	L_3	13.84	
	L_4	8.06	
	L_5	6.61	
	L_6	13.12	
	L_7	16.73	
	L_8	12.23	
Average income of all zones			12.35

The WTP also varies inversely with the distance from the lake. As the distance from the lake is increased naturally the direct dependence on the lake is decreased. Those who are living near the lake are using it for bathing, washing or to enjoy the scenic beauty of the lake. The hilly terrain of zone II and III of L_4, L_6, $L_5$and L_6 makes the people in zone I alone to reap the benefits of ground water recharge which may be the reason for higher WTP of zone I.

The econometric model of CVM encompasses all the variables, the economic theory indicates would have an influence on WTP. CVM studies aim to find out the significant causal relationship between the selected socio economic and other characteristics, with WTP. Starting with this analytical basis an initial estimation was done using all the available characteristics which might influence the WTP. Various functional forms like linear, semilog, quadratic etc. were tried using SAS package. The best model selected using forward selection method was linear with nine explanatory variables.

The model used for analysis is as follows.

$$Y = a+b_{1i}X_1i+b_{2i}X_{2i}+b_{3i}X_{3i}+b_{4i}X_{4i}+b_{5i}X_{5i}+b_{6i}X_{6i}-b_{7i}X_{7i}-b_{8i}X_{8i}+b_{9i}X_{9i}+E_i$$

. Where,

Y	Willingness to pay to conserve the lake(Rs/year)
A	Intercept
X_{1i}	Area owned in Cents
b_{1i}	Regression co efficient of X_1
X_{2i}	Distance from lake in meters
b_{2i}	Regression co efficient of X_2
X_{3i}	Monthly income in thousand Rs.
b_{3i}	Regression co efficient of X_3
X_{4i}	Gender (1-male,2-Female)
b4i	Regression co efficient of X_4
X_{5i}	Marital status(1-married, 2-unmarried)
b_{5i}	Regression co efficient of X_5
X_{6i}	Education(values ranging from 1 to 5)
b_{6i}	Regression co efficient of X_6
X_{7i}	Source of water(1-well, 2-tap water from Vellayani lake, 3-both)
b_{7i}	Regression co efficient of X_7
X_{8i}	Submerged property in lake in cents
b_{8i}	Regression co efficient of X_8
X_{9i}	Dependent on lake (1-no,2-yes)
b_{9i}	Regression co efficient of X_9
Ei	Error term

Table 6 illustrates the multiple linear regression results of the model. The R^2 value of 0.1971 indicated that nearly 20 per cent of the variation in WTP could be explained by the selected variables. Explanatory power was low, but it is more than similar studies by Imandoust and Gadam (2007), where R^2 was 0.161. Coefficients of regression model was statistically significant and consistent with economic theory.

Table 6.Model parameters of WTP

Variable	Parameter Estimate	Standard Error	F Value	Pr > F
R^2	0.1971			
Intercept(a)	-1269.79673**	437.34226	8.43	0.0041
Area owned(X1)	1.21852	1.00378	1.47	0.226
Distance from lake(x2)	-0.21317	0.3057	0.49	0.4863
Monthly income(X3)	6.38484**	2.24397	8.1	0.0048
Gender(X4)	105.65303	72.63438	2.12	0.1471
Marital status (x5)	847.23656*	391.8677	4.67	0.0316
Education(X6)	88.24074*	40.10837	4.84	0.0288
Source of water (x7)	-40.46607	29.29923	1.91	0.1686
Submerged property in lake (x8)	-1.41391	0.88116	2.57	0.11
Dependent on lake (x9)	249.2667**	75.51623	10.9	0.0011

* Significant at 5 % level of significance

** Significant at 1 % level of significance

The variables which significantly influenced the WTP by the respondents were the monthly income, marital status and education. The significance of income and education in determining the WTP of stakeholders is consistent with the study by Qureshi *et al.*, 2013. It was reported by Das-

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gupta and Dasgupta, 2004 and Yang *et al.*, 2008 also that higher the education and income of the people higher will be the WTP. Halkos and Matsiori (2013) also reported high association between individual WTP towards river protection and characteristics like education and income. It is noteworthy that even though the distance from the lake was not found to be statistically significant parameter the minus sign of the variable indicated that as distance from the lake increases the WTP decreases. The study is also consistent with the studies by Mamat *et al.*, 2013 where age, education and gross income are the important factors that affected the WTP. From the econometric model the estimated WTP was derived as Rs 1481.54 per year. The WTP of local residents residing around the lake was estimated by multiplying the total number of households in the two panchayats *ie*. 19694 (GOI,2014) with the estimated WTP. Thus, using CVM the economic value of Vellayani lake was Rs 2.91 crore per year.

This amount was meager when compared to the value of other services provided by Vellayani lake such as drinking water(Rs.370.05Crores /Year) and aesthetic value(Rs.275.92Crores /Year) derived from the present study. Thus it can be inferred from the CVM study that the WTP of local residents for conserving the lake was low. This shows the lack of awareness among the people on the economic and ecological significance of the lake and this can be viewed as the main reason for degradation of the lake system.

Conclusion

If not properly managed, the degradation and loss of Vellayani lake will continue in an accelerated manner leading to the death of the invaluable services provided by the lake which cannot be replaced by any means. People may be made aware of the significance of the ecosystem services provided by the lake. Developing sustainable management action plan for the lake along with creation of awareness among the local residents may help in conserving and prevention of further degradation of this unique lake system

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