Willingness to Pay for Water Quality: A Contingent Valuation Approach for Bolgoda Lake

S.A.G.C. Jayasekara[1] and U.A.D.P. Gunawardena[2]*

[1]*Department of Management Audit, Ministry of Finance, The Secretariat, Colombo 01, Sri Lanka*
[2]*Department of Forestry and Environmental Science, University of Sri Jayewardenepura, Nugegoda, Sri Lanka*

Date Received: 30-05-2020 Date Accepted: 05-06-2020

Abstract

Bolgoda lake is known as the largest fresh water body in Colombo Urban Area (CUA) and situated in the Southern boundary of CUA. The lake provides a variety of environmental services including recreation, fisheries production and ground water recharge. Environment of the Bolgoda lake is currently threatened by the disposal of waste by industries. However, there will be an increasing demand for the environmental services produced by the Bolgoda lake in the future.

Objectives of the present study are to identify the environmental benefits of the lake and estimate economic values of different user groups for the improvement of water quality. A pilot survey was carried out and five major user groups were identified; fishermen, hotel owners, boat owners, recreational users and indirect users. Selected study area for the present study belongs to five GN divisions from Moratuwa and Panadura DS divisions. Contingent valuation method was applied and users' willingness to pay (WTP) was elicited on a pre-tested hypothetical market focusing on a pollution control programme.

Depending on the WTP values, the 5 user groups were regrouped into two categories, WTP values per household per month for the heavy dependency group was LKR 1,550 while for the less dependency group it was LKR 514.30. Regression analysis was carried out to identify the socio economic characteristics of the users that affect the WTP value of the users. The results were consistent with the theory. Aggregated value for all user types for the study area is LKR 1.365 billion per year and per hectare value is LKR 4.389 million per year (2020 prices).

Natural assets such as Bolgoda lake are becoming very scarce in the Colombo Urban Area. The above estimated value could be taken as a guide to manage it as an environmental amenity and to highlight the need to prevent pollution and to improve the uses obtained from the lake.

Keywords: Bolgoda lake, contingent valuation, water quality

1. Introduction

Bolgoda lake is known as an aesthetic coastal water body among 45 basins and riverine estuaries located along the coast of Sri Lanka. It is situated in the southern boundary of Colombo Urban Area (CUA) and considered as the largest fresh water body in CUA. Bolgoda lake currently provides a variety of environmental services, such as provision of natural habitat for fisheries production and estuary functions; ground water recharge, potable water supply; recreation/tourism; and natural biotic habitat. The lake lies along the townships such as Mount Lavinia, Moratuwa and Ratmalana etc. It is a semi-urbanised area, having industries as well as households and little vegetation.

**Correspondence: prasanth@sjp.ac.lk*
Tel: +94 773618606

The lake's environment is currently subjected to a wide array of threats including disposal of industrial and domestic liquid and solid wastes, agricultural run-off, and sedimentation. Industrial waste disposal to the Bolgoda lake is the predominant cause of pollution. On the other hand, there is an increasing demand for the environmental services produced by the Bolgoda lake due to the increase of the urban areas and the scarcity of natural habitats in the CUA.

It is important therefore to study economic benefits of the lake which could provide valuable information towards better management of the lake. There are number of studies carried out on pollution aspects of Bolgoda lake focusing on disposal of liquid and solid waste from hotels, industries and households along with factors affecting the pollution and threats to biodiversity (Silva, 1996; Gunathilaka, 2000; Kularatne et al., 2003). Bhuvendralingam et al. (1994) carried out an economic valuation of Bolgoda lake and arrived at a controversial conclusion that it is more economical to use Bolgoda lake as a sink for disposal of liquid or solid waste than using it as an aesthetic asset.

There has been some valuation of environmental benefits of water resources in the country. Perera et al. (2005) reports annual total economic return per hectare of water spread of a tank as LKR 294,230. The annual value of the ecosystem services of the Kala Oya Basin is estimated to be LKR 23,500 million (Gunawardena, 2009). The value of Muthurajawela Marsh for direct and indirect economic benefits is estimated to be LKR 726.49 million (Emerton and Kekulandala, 2003). However, there has been no studies carried out on the lake ecosystems and valuation of water quality aspects have been largely neglected. Objectives of the present study are to identify the environmental benefits of the lake and estimate economic values of users for the improvement of water quality. The estimated values will help policy makers to take their decisions on maintenance and management of Bolgoda lake in its best use.

The paper is organised as follows: the next provides a review of literature related to the economic valuation of lakes followed by the methodology of the study. Results and discussion is presented next followed by conclusions.

2. Economic Valuation of Benefits of Lakes

2.1 The need for benefit estimation

Ecosystem goods and services are very diverse and generates ecological, socio-cultural and economic values for many people in the world. The concept of ecosystem services have gained much attention in recent years, emphasising their importance for human societies, (e.g. Costanza, et al., 1997 and 2014; de Groot, et al., 2002; Millennium Ecosystem Assessment, 2003). However, in decision-making, these benefits are often not fully taken into account and multi-functional ecosystems are continuously being converted into more simple, uni-functional and direct use oriented types (e.g. agriculture) or left for degradation without adequate investment on conservation. The total value of multi -functional use of natural landscapes is often economically more beneficial than the value of the converted systems. However, this is not reflected in the prices both due to failures of the existing market and the non-existence of markets.

There are various ecosystem service benefits associated with lakes. Cities of the developing countries are often faced with various lake related developments targeting economic development and public welfare. In such situations, valuation is necessary to arrive at rational investment decisions and in evaluating policy options. In addition, ecological life supporting systems provided by lake ecosystems are essential as inputs to the economic system and for the wellbeing of the human. However, only few direct and very obvious benefits from the lake ecosystems are usually assessed and are highlighted in the policy discussions and decision making. The negligence of values that have no obvious markets may lead to loss of natural lake habitats and their degradation. The protection of water habitats however, reflects the

protection of numerous goods and services that have an economic value not only to the local population living in their periphery but also to communities outside these areas. The economic value of these goods and services can be made more explicit through economic valuation studies. The results of these studies can be weighed against other land and water uses.

2.2 Contingent valuation method

Contingent valuation method (CVM) which is a stated preference method is commonly used in valuing non-market costs and benefits. The method creates a hypothetical market to elicit people's willingness to pay (WTP) for changes of non-market goods and the method is capable of measuring types of costs that other methods can measure only with difficulty (Mitchel and Carson, 1989). The derived estimates are capable of aiding decisions concerning non-market goods, including decisions on environmental policy.

a) Theoretical background

The concept underlying the valuation is the willingness to pay (WTP) of individuals for an environmental service or resource which represents the area under a demand curve for the consumption of the particular environmental resource. Also, the change in value could be explained in terms of the difference between the values of two expenditure functions which gives a value for the minimum amount necessary to achieve a desired level of utility for a household before and after varying the quality of the environmental resource in question, all other aspects being constant. Conceptually, using an indirect utility framework, the economic valuation construct of a value of environmental quality can be represented in equation 1.

$$U_0 (Y_0, E_0, P_0) = U_0 (Y_0 - WTP, E_1, P_0) \quad (1)$$

where: for a given individual, U_0 is a base level of utility, P_0 represents existing prices, Y_0 is current income, E_0 represent the present environmental quality and E_1 represent the improved level of environmental quality. Annual household WTP is the amount of income a household would give up in order to gain the higher level of environmental quality, E_1, while maintaining a constant level of utility.

2.2 Economic value estimates of lakes

There are wide variety of benefit estimates available in the literature on water based natural habitats. Birol et al. (2006) provides a summary different types valuation methods applicable. Brouwer (2006) provides an estimate on average WTP values related to ecological rehabilitation of Frisian lake district for biological diversity and water recreation including both use and non-use value as € 75 (58-93) per household per year. Various water quality related values are reported ranging from € 35-105 per household per year. Cooper et al. (2004) examined the use and non-use benefits associated with three nested schemes for improving water quality in a lake in Norwich, UK, and find that these range from € 18-36.8 depending on the scheme. Oglethorp and Miliadou (2000) find that mean per capita WTP per year for use and non-use values of lake Kerkini in Greece is € 22.5. Nishizawa et al. (2006) estimates willingness to pay (WTP) of residents in Shiga for conserving the lake Biwa ecosystem by decreasing alien fish Using the contingent valuation estimated median WTP per household was 1,850 yen per year. Bueno et al. (2016) on measuring household willingness to pay for water quality restoration of Sampaloc lake in Philippines has used CVM and computed that WTP per household is PHP 177.09 per month.

There are not many valuation studies on water ecosystems in Sri Lanka. The mean WTP value for preventing the loss of river flow due to a run off river has been estimated as LKR 425 from a sample of foreign visitors and value of white water rafting in Kelani river in Kitulgala area is LKR 5.49 million (Gunawardena, 2010). Many of the above studies carried out in Sri Lanka have focused on the estimating existing uses of the water resources. There has been a lack of valuation studies on the water quality aspects

of the water resources. Given the increasing threats due to increased industrialisation and urbanisation in the country, it is important to establish people's preferences for better environmental quality.

3. Materials and Methods

3.1 Description of the study site

Bolgoda lake (6/40// N, 79/54//-58// E) is situated at the southern boundary of Colombo Urban Area (CUA) and it is known as the largest fresh water body in the CUA. It covers 1,245 ha and located between the northern boundary of the Kalu Ganga basin and southern boundary of the Kelani Ganga basin in the West Zone of the country. The lake has two major basins: North lake and South lake connected by narrow stream known as the Bolgoda Ganga (Silva, 1996). Encircling Panadura together with North lake, Panadura Ganga and Bolgoda lake represents an important water resource for Colombo. It is fed by minor inflows, which are exclusively confined to the first peneplane in the wet-zone in addition to the monsoonal rain.

North Western side of Bolgoda lake is an airport. Natural vegetation has been substituted mainly by paddy, rubber and by village gardens. Entire watershed of Bolgoda lake is about 6,000 ha. Densely popularised townships along the coastal boundary of the watershed are Mount Lavinia, Ratmalana, Moratuwa, Panadura and Wadduwa. In the Upstream water shed of Bolgoda lake, two major townships, Horana and Bandaragama are located. The entire watershed is subjected to infrastructure development such as transportation, telecommunication, transmission of electricity and other amenities like schools, hospitals etc. (Silva, 1996).

There are 14 Divisional Secretariat Divisions under the Bolgoda basin which includes Horana, Bandaragama, Millaniya, Moratuwa, Kalutara, Panadura, Ratmalana, Dehiwala-Mount Lavinia, Nugegoda, Kotte, Kesbawa, Dodangoda, and Homagama. Total number of Grama Niladhari Divisions within the basin is 105.

The selected area for the present study belongs to Moratuwa and Panadura DSDs. Borupana and Molpe GN Divisions from Moratuwa DSD and Keselwatta and Bolgoda GN Divisions from Panadura DSD were selected as the study sites. Most of the study area around the Bolgoda lake comprises of mixed residential and industrial concentrations. Main industrial activities include garment manufacturing and textile processing. Recreational sites and play grounds are intermixed with residential and industrial areas. Marshlands are located in the North Eastern areas of Ratmalana.

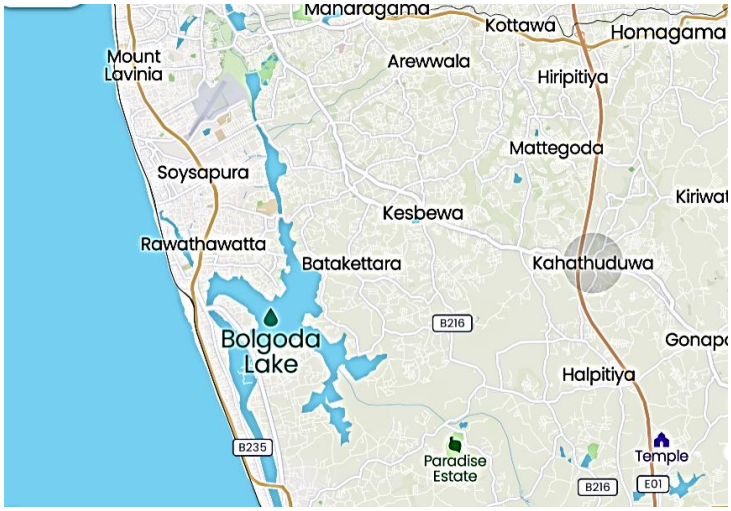

Figure 1. Map of the study area.

3.2 Contingent valuation survey

Contingent Valuation method (CVM) was used to evaluate the economic benefits in the present study. CVM represent the most promising approach yet developed for determining the public's willingness to pay for public goods (Mitchel and Carson, 1989).

a) Questionnaire

The questionnaire was developed based on the standard practice (Arrow et al., 1993). Main focus of the questionnaire was the hypothetical payment vehicle which elicits values. In addition, it intended to obtain socioeconomic information of the respondents and their perceptions on the lake environment.

Prior to the main survey, a pilot survey was conducted to identify different types of users of Bolgoda lake. This was a necessary prerequisite for the study since the differences in user associations with the lake is going to be a major determinant factor on the value they place on the good being valued. The pilot study revealed presence of a variety of user groups who have a very close relationship with the lake. Most of them depend on the lake as their main source of money income. This fact was taken into consideration in designing the payment vehicle, a pollution control programme of Bolgoda lake. Within the hypothetical scenario, it was emphasised to the respondents that, if there were a pollution control programme, the lake could have been prevented from the pollution and maintained well and the flow of benefits from the lake would be increased both quality and quantity wise. Contingent valuation survey had open-ended question format which elicited WTP as a monthly contribution. Respondents were allowed to express their willingness to pay in labour terms as well in order to avoid they get constrained by their cash income.

b) Pilot test and the survey

In order to check whether the questionnaire was understandable, the questionnaire was pre-tested among 10 respondents. Survey was carried out by randomly selecting individuals and carrying out in-person interviews at the site. Interviews were conducted both in weekdays and week-ends, normally around 9.00 a.m. to 6.00 p.m. The survey was carried out for a period of about four months in 2004. It was attempted to include as many user groups as possible in the sample and different locations around the lake where the users are found including hotels were used to intercept respondents. The total sample size was 100. The good being valued, water quality aspect of the Bolgoda lake was carefully explained to the respondents and the payment vehicle was presented fully and clearly.

3.3 Analysis of data

Data were cleaned identifying incomplete and protest responses. Different types of user groups was the main focus of the analysis. Willingness to pay values were categorised according to the user groups and statistical tests were carried out to identify significant differences among the groups. Similar groups were aggregated in the regression analysis which was carried out to identify contributory factors for the willingness to pay values (WTP). Validity was tested considering theoretical, convergent and content validity aspects based on the standard practice. Finally, WTP values were aggregated for the population of the selected study area.

4. Results and Discussion

4.1 General observations on the sample

The survey resulted in 78 usable responses after cleaning the data for incomplete responses. There were five identifiable major user groups in the sample as indicated below:

1. Fishermen-Their main income source was catching fish in the Bolgoda lake.

2. Hotel owners-Hotels located in each side of the Bolgoda lake were included in this group. Aesthetic values of those hotels were influenced by the lake, which attracts the visitors.

3. Boat owners-They provide their services either for recreational boat users or for transporting passengers from one side to the other side of the lake. There were two main places in the study area where the boats are used as the main transportation mode by people for their daily traveling.

4. Recreational users-There were two types of recreational users: the first group uses the lake for swimming and bathing. The second group was visitors to the hotel who come there weekly to spend their leisure time which was solely due to the high aesthetic value around the lake. The hotel visitors interviewed in the survey elaborated that their preferences towards this particular hotel was due to aesthetic value gained from the Bolgoda lake.

5. Other Users (Indirect Users)-Residents around the lake (villagers) and who are not directly dependent on the lake are included in this group. This group derive various indirect benefits from the lake.

Table 1 presents socioeconomic characteristics related to the different user groups. Household income generation activities of the respondents of user groups 1, 2 and 3 were mainly depended on the Bolgoda lake. Other two groups did not mainly depend on the lake. Respondents of group 4 and 5 were engaged in different employments outside the lake such as in government, private sector or self-employment. User groups 1, 2 and 3 were obviously male dominated.

Table 1. Socioeconomic characteristics of the sample.

Variable	User 1 Fishermen	User 2 Hotel owners	User 3 Boat owners	User 4 Recreation	User 5 Other users (Indirect user)
Occupation	Catching Fish	Hoteling	Boating	Various occupations	Various occupations
Mean income (LKR per month)	25,043	23,636	10,000	11,458	5,000
Mean level of Education	Below GCE OL	Up to or above GCE OL	Below GCE OL	Up to or above GCE OL	Up to GCE AL
Age range (yrs)	34-56	25-55	33-57	25-50	24-60
Mean monthly WTP (LKR)	1,565.0	1,545.0	1,500.0	500.0	545.5
Number of individuals in the sample	23	12	6	25	12

4.2 Analysis of willingness to pay values

Outliers and protest zero responses were identified before the analysis according to the Standard practice (Mitchell and Carson, 1989). There were no identifiable outliers in the sample. If a respondent has given a zero value for WTP for an environmental good though he has some value for that good, it was considered as a protest zero. Validation was done by asking reasons for zero bidding. The sample had three protest zero response (4% of the sample) that refused to contribute the pollution control programme indicating that it is not their responsibility. Refusal rate was very low. Only one respondent from the village (use group 5) refused to respond. Almost all the respondents except two respondents were familiar with the good being valued. Table 2 provides summary statistics of the WTP values of the sample.

Table 2: Summary statistics of willingness to pay values of the sample.

User Group	Mode	Median	Mean	Minimum	Maximum	St. Dev.
Fishermen	2,000	1,500	1,565	1,000	2,000	459.9
Hotel owners	1,500	1,500	1,545	1,000	2,000	350.0
Boat owners	1,000	1,500	1,500	1,000	2,000	447.2
Recreation	500	500	500	200	600	88.5
Others	500	500	545.5	200	1,000	186.4

Majority of Fishermen were willing to contribute towards the water quality improvement of the Bolgoda lake. However, they were not able to pay cash but were willing to contribute in terms of labour. Such contributions (for example, one day per week or three days per month) were converted to monetary terms considering the daily payment for a labourer as LKR 500. Responses of Boat owners were similar to fishermen. Recreation group and other user group were willing to pay by cash.

According to Table 2, User groups 1, 2 and 3 showed least differences among WTP values. User 4 and 5 showed similarities in WTP values. User groups 1, 2 and 3 showed clear differences in WTP values compared to User 4 and User 5. Since WTP values showed non-normality, Mann - Whitney test, a nonnparametric test was carried out for all possible combinations of the user groups to test significance of the differences in WTP values. The results are shown in Table 3.

Table 3: Comparison of WTP values among user groups (Mann-Whitney test).

Hypothesis	Significance level	Reject or not	Conclusion
Ho; $Ul_{WTP}=U2_{WTP}$	0.5312	Cannot reject Ho	Ho; $Ul_{WTP}=U2_{WTP}$
Ho; $Ul_{WTP}=U3_{WTP}$	0.7496	Cannot reject Ho	Ho; $Ul_{WTP}=U3_{WTP}$
Ho; $U2_{WTP}=U3_{WTP}$	0.9602	Cannot reject Ho	Ho; $U_{WTP}=U3_{WTP}$
Ho; $Ul_{WTP}=U4_{WTP}$ Ha; $U1_{WTP}\neq U4_{WTP}$	0.0000	Reject Ho Accept Ha	Ha; $U1_{WTP}\neq U4_{WTP}$
Ho; $Ul_{WTP}=U5_{WTP}$ Ha; $U1_{WTP}\neq U5_{WTP}$	0.0000	Reject Ho Accept Ha	Ha; $U1_{WTP}\neq U5_{WTP}$
Ho; $U2_{WTP}=U4_{WTP}$ Ha; $U2_{WTP}\neq U4_{WTP}$	0.0000	Reject Ho Accept Ha	Ha; $U2_{WTP}\neq U4_{WTP}$
Ho; $U2_{WTP}=U5_{WTP}$ Ha; $U2_{WTP}\neq U5_{WTP}$	0.0005	Reject Ho Accept Ha	Ha;$U2_{WTP}\neq U5_{WTP}$
Ho; $U3_{WTP}=U4_{WTP}$ Ha; $U3_{WTP}\neq U4_{WTP}$	0.0000	Reject Ho Accept Ha	Ha; $U3_{WTP}\neq U4_{WTP}$
Ho; $U3_{WTP}=U5_{WTP}$ Ha; $U3_{WTP}\neq U5_{WTP}$	0.0009	Reject Ho Accept Ha	Ha; $U3_{WTP}\neq U5_{WTP}$
Ho; $U4_{WTP}=U5_{WTP}$ Ha; $U4_{WTP}\neq U5_{WTP}$	0.6262	Cannot reject Ho	Ho; $U4_{WTP}=U5_{WTP}$

According to Table 3, user groups 1, 2 and 3 showed no significant differences in the WTP values among each other but showed significant differences with groups 4 and 5. User groups 4 and 5 showed similarities to each other. For further analysis therefore, similar groups were combined.

4.3 Variation of WTP Values with Socio-economic variables

A multiple regression analysis was carried out to relate the respondent's WTP values to their socio-economic characteristics using previous empirical research as a guide in selection of the factors that would influence the amount of WTP. User groups 1, 2 and 3 were combined to derive the following regression equation (equation 2).

$$WTP = 1823-15.03\ Age+0.0041\ Income+107\ Dependents \quad (2)$$

Table 4 indicates the parameter estimates for the regression equation. Age significantly and negatively contribute to the WTP values. A unit increment (an year) of age would reduce WTP by LKR 15. A unit increment of a dependent would increase the WTP by LKR 107. However, the low R squared values indicates the uncertainty in predicting human behavior.

Table 4: Results of the multiple regression analysis for user groups 1, 2 and 3.

Predictor	Coef	SECoef	T	P
Constant	1823.8200	454.920000	4.0091	0.0003
Age	-15.0328	7.472821	-2.0117	0.0518
Income	0.0041	0.013544	0.3054	0.7618
Dependents	107.8870	55.253230	1.9526	0.0587

R-Sq=16.5%, R-Sq (adj)=9.6%

The regression analysis for the combined sample of user groups 4 and 5 did not result in significant predictors indicating that there could be some other variables that determine the WTP value of the respondents. The regression analysis carried out for individual user groups also did not result in significant predictors.

4.4 Deriving aggregated values for the population

Aggregation is the process of deriving total value for the population from the sample mean. Table 5 provides details related to the aggregation for all user groups. Mean monthly WTP value of User groups 1, 2 and 3 is LKR 1,550 per household (average for the 3 user groups) and for user groups 4 and 5, it is LKR 514.30.

Table 5: Aggregation for population of the study area.

User group	Total population operating in a year[1]	Aggregated value[2,3] (LKR per year)
Group 1-Fishermen	51	948,600
Group 2-Hotel owners	42	781,200
Group 3-Boat owners	21	390,600
Sub Total for groups 1, 2 and 3	114	2,120,400
Group 4-Recreation visitors during week end	26,520	163,670,832
Group 4-Recreation visitors during week days	19,200	118,494,720
Group 5-Residents/ villagers	315	1,944,054
Sub total for groups 4 and 5	46,035	284,109,606
Grand total	46,149	286,230,006

[1]Based on the information gathered from the survey
[2]mean WTP for user groups 1, 2 and 3 is LKR 1,550 per household per month
[3]mean WTP for user groups 4 and 5 is LKR 514.30 per household per month

Table 6: Value of the Bolgoda lake for the population of all user groups.

Parameter	Total value (LKR per year)	Per ha value[1] (LKR per year)
Value for the study year (2004)	286,230,006	919,614
Value for 2020 (without considering the population change)[2]	994,999,552	3,196,786
Value for 2020 with adjustment for the increase of the population level in the area[3]	1,365,921,162	4,388,502

[1]extent of the Bolgoda lake in the study area is 311.25 ha
[2]calculated using GDP deflator
[3]assumed to be increasing 2% annually

According to Table 5, total value of the Bolgoda lake for the population of all 5 user groups is LKR 286 million per year for the considered study area. The extent of the Bolgoda lake in the study area is 311.25 ha. Table 6 provides details on the estimation of per hectare economic value for the population of the study area due to improvement of the Bolgoda lake water quality. The study was carried out in 2004 and update of the values for the year 2020 are presented with adjustment for the increase of the population level in the area.

4.5 Validity testing

Validity testing was done following the criteria set by Mitchell and Carson (1989). Content validity was checked with main emphasis on the design of the questionnaire, associated information and survey sample strategy. In this study respondents were give full information and hypothetical scenario was adjusted according to the user group to highlight the importance of the quality of the lake for their lives. The theoretical validity was examined by estimating the bid function; income had a positive co-efficient in the estimated bid function confirming theoretical validity.

Convergent validity was carried out by comparing mean WTP with other studies. Bhuvendralingam et al. (1994) provided an estimate for environmental services (fisheries, recreation and sink services for industry) of the Bolgoda lake under low pollution (LKR mn 1,629.46) and high pollution scenario (LKR mn 3,996.68). The values of the present study are comparable with the low pollution scenario values of the above study when per ha values are considered. Higher values under high pollution scenario implies that values are maximised when the lake is used as a waste sink for industries. However, this study seem not to has paid attention to the possible future costs associated with allowing for such high pollution levels illustrated by the huge rehabilitation budgets required for cleaning polluted water bodies such as Beira lake.

The values estimated by the present study are comparable to WTP for a wetlands improvement program in California, USA, which is about € 183.3 per household (Pate and Loomis, 1997). The estimated values are also comparable with estimates of Costanza et al. (1997) on annual values of lakes and rivers for recreation ($ 230 per ha), for food production ($ 41 per ha) and the total value of 8,498 per ha.

4.6 Analysis of biases

Contingent valuation method present challenges due to the hypothetical nature of the market. The researcher can take steps to avoid them and so the policy maker can evaluate and use CV finding with confidence. Strategic bias was minimal in this study. Many respondents (almost all the fishermen) mentioned that they would like to contribute to the pollution control programme not in cash but in terms of labour as they had no money to spend beyond their needs. This implies that people were well aware of their income constraints and may not have acted strategically.

4.7 Limitations of the study

The study has identified only five different user groups. There are other user groups who use the lake as a sink for disposal of liquid and solid waste. This aspect has not been included in the current study as this use is in conflict with other user groups. The present study has been carried out for a period of four months. Further studies may be needed to capture year round variation of the users especially visitors and fishermen.

This survey was conducted among four Grama Niladhari divisions only, which come under 2 Divisional Secretariat divisions. There are 14 Divisional Secretariat divisions and about 105 Grama Niladhari divisions under the Bolgoda Basin. Availability of users from one site to the other site along the Bolgoda lake vary. Further studies may be required to capture the values of the entire basin.

4.8 Policy implications

At present the use of Bolgoda lake is unrestricted and free. As many other natural resources in the country, the lake has been threatened and degraded over the past decades. The lake provides a number of benefits to the people. Any resource, if un priced or under priced, degradation could take place rapidly due to over exploitation of the resource.

The value placed by the direct users on the quality improvement of the lake is about three times higher than the recreational and indirect users. A large proportion of the total value is however shared by recreational users due to their higher numbers. The stresses created on the urban population due to increasing congestion and urbanisation could be eased by the recreational experience associated with natural environment. Bolgoda lake is a convenient option being located in close proximity to Colombo city. Further economic opportunities from the lake could be derived (identified and expanded) from the options that would not create threats to the quality of the lake environment.

Results of this study will help policy makers to prioritise their decisions on proper management of the Bolgoda lake. Formulating policy regarding the proper management and conservation of the Bolgoda lake especially towards the maintenance of the water quality may be supported by the findings of present study.

5. Conclusion

The main focus of the present study was valuation of the Bolgoda lake applying contingent valuation method. There were five different identifiable uses of the lake. If the household income or employment of the user group is totally depended on the lake, their WTP values towards the improvement of the water quality were higher compared to the user groups who are not directly dependent on the lake for their income. From all users point of view, improvement of the water quality of the lake has a value of LKR 1.37 billion per year and per ha value of LKR 4.4 million for the study area in 2020 prices.

Natural assets such as Bolgoda lake are becoming very scarce in the Colombo Urban Area. The above estimated value could be taken as a guide to manage it as an environmental amenity and to highlight the need to prevent pollution and to improve the uses obtained from the lake.

References

Arrow, K., Solow, R., Portney, P.R., Leamer, E.E., Radner, R. and Schuman, H., 1993. Report of the NOAA panel on contingent valuation. *Federal Register*, 58:4601-4614.

Bhuvendralingam, S., Chanmungam, S., Gunaruwan, T.L., Jayawardena, K., Rotaga, H.B., Sivaganansothy, V. and Wadugodapitiya, W.O., 1994. Economic valuation of environmental services provided by the Bolgoda lake; Sri Lanka. Colombo, Natural Resources and Environmental Policy Project.

Birol, E., Karousakis, K. and Koundouri, P., 2006. Using economic valuation techniques to inform water resources management: A survey and critical appraisal of available techniques and an application. *Science of the Total Environment*, 365:105-122.

Brouwer, R., 2006. Valuing water quality changes in the Netherlands using stated preference techniques. In: *Environmental Valuation in Developed Countries*. Edward Elgar, Cheltenham, UK, pp.132-147.

Bueno, E.A., Ancog, R., Obalan, E., Cero, A.D., Simon, A.N., Malvecino-Macalintal, M.R., Bactong, M., Lunar, J., Buena, G.R. and Sugui, L., 2016. Measuring households' willingness to pay for water quality restoration of a natural urban lake in the Philippines. *Environmental Processes*, 3:875-894.

Cooper, P., Poe, G.L. and Bateman, I.J., 2004. The structure of motivation for contingent values: A case study of lake water quality improvement. *Ecological Economics*, 50:69-82.

Costanza, R., d'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'neill, R.V., Paruelo, J. and Raskin, R.G., 1997. The value of the world's ecosystem services and natural capital. *Nature*, 387:253-260.

Costanza, R., De Groot, R., Sutton, P., Van der Ploeg, S., Anderson, S.J., Kubiszewski, I., Farber, S. and Turner, R.K., 2014. Changes in the global value of ecosystem services. *Global Environmental Change*, 26:152-158.

De Groot, R.S., Wilson, M.A. and Bournans, R.M., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics*, 41:393-408.

Emerton, L. and Kekulandala, L.D.C.B., 2003. Assessment of the Economic Value of Muthurajawela Wetland. Occ. Pap. IUCN, Sri Lanka., 4:iv + 28pp.

Gunathilake, W.M.P., 2000. Preliminary Studies on use of Bacterial population as a Biological Indicator in Aquatic Ecosystems with special Reference to Bolgoda North Lake, pp 12-15.

Gunawardena, U.A.D.P., 2009. Valuation of Ecosystem Services of Kala Oya River Basin: Implications for river basin Management, *Special volume of Vidyodaya Journal.*

Kularatne, K.I.A., Dissanayake, D.P. and Mahanama, K.R.R., 2003. Contribution of dissolved sulfates and sulfites in hydrogen sulfide emission from stagnant water bodies in Sri Lanka. *Chemosphere*, 52:901-907.

Gunawardena, U.A.D.P., 2010. Inequalities and externalities of power sector: A case of Broadlands hydropower project in Sri Lanka. *Energy Policy*, 38:726-734.

Millennium Ecosystem Assessment, 2005. Ecosystems & Human Wellbeing: Synthesis Report, Island Press.

Mitchell, R.C., Carson, R.T. and Carson, R.T., 1989. Using surveys to value public goods: the contingent valuation method. Resources for the Future.

Nishizawa, E., Kurokawa, T. and Yabe, M., 2006. Policies and resident's willingness to pay for restoring the ecosystem damaged by alien fish in Lake Biwa, Japan. *Environmental Science and Policy*, 9:448-456.

Oglethorpe, D.R. and Miliadou, D., 2000. Economic valuation of the non-use attributes of a wetland: A case-study for Lake Kerkini. *Journal of Environmental Planning and Management*, 43:755-767.

Perera, H.D.B.S., Vidanage, S.P. and Kallesoe, M.F., 2005. Multiple Benefits of Small Irrigation Tanks and Their Economic Value: A Case Study in the Kala Oya Basin, Sri Lanka. IUCN-The World Conservation Union, Sri Lanka Country Office.

Silva, E.I.L., 1996. Water Quality of Sri Lanka: A review on twelve water bodies, Institute of Fundamental Studies, pp 64-74.