Economic Valuation of Mangrove Ecosystems of Kerala, India

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ABSTRACT

Mangroves are invaluable treasure of our biodiversity with immense ecological and economic significance.The study was conducted in the mangrove areas of Ernakulam and Kannur districts of Kerala. These two districts accounted for nearly 65 per cent of the mangroves of the state. The study was based on primary and secondary data. The primary data was gathered from 480 respondents belonging to four identified stakeholder groups (residents, fishermen, paddy farmers and general public), selected through simple random sampling method. Data was collected through personal interview using structured pretested interview schedule along with direct observation. Four stakeholder groups of the mangrove ecosystem in the study area were residents living close to mangroves, fishermen, paddy farmers and general public. The economic valuation of ecological benefits of mangroves was attempted employing the Contingent Valuation Method. The respondents expressed their willingness to contribute towards conservation both in cash and kind (cash payment and manual participation as labor and as volunteer in awareness programs) and in combination. The average WTP expressed by the respondents was `2308/annum the range being `50–28,870. The TEV of the mangrove ecosystem of the state was thus `117,947 million, which was 0.14 per cent of the GSDP (2011-12).

KEYWORDS: *Contingent valuation, Economic valuation, Mangroves, Willingness-to-Pay*

Introduction

Coastal resources such as coral reefs, mangroves and other wetlands are one among the richest store houses of biological diversity and primary productivity. The complex interaction between water, soil, topography, micro-organisms, plants and animals makes wetlands one of the most productive ecosystems. The significance and value of wetlands was first brought to the notice of the world by Ramsar Convention on Wetlands (1971).

The direct and indirect anthropogenic activities have considerably altered the nature of wetlands especially mangroves of tropical countries in the world. The importance of mangroves has been underestimated despite being a critical and fragile ecosystem. The categorization as 'waste lands' has led to the conversion of mangroves to agricultural, industrial or residential uses. This erroneous description made it easier to exploit mangrove forests as cheap and unprotected sources of land for urbanization and other economic activities. However, the havoc created by the Tsunami of 2004, has created the occasion for realizing the ecological significance of mangroves. The reports from across the globe confirmed the storm protection function of this coastal bio-shield (Das, 2009; Kathiresan, 2010). Moreover, the life of mangrove inhabited coastal areas depends on various goods and services provided by mangroves.

With this understanding there have been legal, institutional and policy interventions on the conservation of this fragile ecosystem. Naturally, the understanding of the Total Economic Value (TEV) of these resources was required for economically justifiable policy decision making. There had been attempts on the economic valuation of wetland ecosystem in general (Costanza *et al.*, 1997; Barbier, 2007; Binilkumar, 2010) and mangroves in particular (Lal, 2003; Sathirathai, 2003; Gunawardena and Rowan, 2005), in different parts of the globe. But such attempts are rather limited in India (Hirway and Goswami, 2007; Hussain and Badola, 2010) and scanty in Kerala. Swarupanandan and Muraleedharan (2010) in their report on assessing the feasibility of alternate developmental options along the coastal tracts in Kochi destroying the rich mangrove ecosystem, have highlighted the importance of such studies in Kerala. This paper analyses the total economic value of the mangrove ecosystems of Kerala, India.

Materials and Methods

Kerala with a coastal line of about 590 km (370 miles) and 41 rivers emptying into the Arabian Sea, was once very rich in mangrove formations, perhaps next only to the Sunderbans, in the eastern part of the country. Due to natural catastrophe, climatic changes and anthropogenic factors, there was a gradual decline in mangrove wealth. Kerala coast, covering 10 per cent of the country's coastal line has only less than 1 per cent of India's total mangrove ecosystem currently. As per the latest reported information by Madhusoodhanan and Vidyasagar (2012), Kannur (44%) and Ernakulam (24%) districts are the major areas where mangroves are seen. This study was undertaken in these two districts. The study was conducted in the mangrove areas of Ernakulam and Kannur districts of Kerala.

The study was primarily based on primary data. The study was initiated by holding informal discussions with local residents, officials of the forest/agriculture/fisheries department, members of local self-governments and elderly people in the locality and also by direct observations. Through this process, three groups of stakeholders who depended on the ecosystem directly were identified. They were categorized as residents living close to the mangroves and population depending on mangrove

related livelihood options. They were mainly fishermen and paddy farmers (*Kaippad* in Kannur and *Pokkali* in Ernakulam). Further one more stakeholder group to represent the indirect beneficiaries was identified as the general public. They were people who resided away from these ecosystems and did not directly depend on them for livelihood. Thus, there were four stakeholder groups.

The data was gathered from 480 respondents belonging to above four identified stakeholder groups selected through simple random sampling method. Data was collected through personal interview using structured pretested interview schedule along with direct observation. The supporting secondary data was gathered from various government departments of Kerala such as Department of Agriculture, Forest & Wildlife, Fisheries and Irrigation and also from Cochin University of Science and Technology (CUSAT), Cochin, Kerala Agricultural University, Thrissur, University of Calicut, Malappuram, Kerala Forest Research Institute (KFRI), Peechi and published articles and reports including electronic sources. The survey was conducted during the period from June 2012 to January 2013.

The valuation of an ecosystem is a complex process that depends on the availability of relevant and accurate biophysical data on ecosystem processes and functions and the appropriate applications of economic valuation (Morse-Jones *et al*., 2011). The Total Economic Value (TEV) conceptual framework views ecosystem goods and services as the flow of benefits to mankind by nature. TEV is broadly classified into use values and non-use values, based on the benefits derived from the present and future generation (Barbier, 1994). Under this framework, the TEV of mangrove ecosystem can be depicted as in Appendix 1.

The non-market based methods in valuation were employed in the case of ecosystem services which were not traded in the market. Contingent Valuation Method (CVM) is one of the most widely employed techniques in the valuation of ecosystem services (Mitchell and Carson, 1989; Bann, 1999; Lal, 2003; Gunawadena and Rowan, 2005; Yacob *et al*., 2009; Binilkumar, 2010; Ekka and Pandit, 2012). In this method, the individuals are asked directly about their Willingness to Pay (WTP) or Willingness to Accept (WTA) for maintaining or compensating for the loss of environmental goods and services. This method is called 'contingent' valuation method, since people are asked to express their willingness to pay or accept, dependent on a particular hypothetical situation for environmental goods and services (Brookshire and Eubanks, 1978). The present study adopted the method employed by Bann (1999); Lal (2003); Gunawadena and Rowan (2005); Yacob *et al*. (2009); Sathya and Sekar (2012) with appropriate modifications to suit local socioeconomic settings. WTP is the maximum amount of money an individual is willing to pay for obtaining/enjoying certain ecosystem goods and services. His /her preference is based on the utility he/she derives from the good. It represents an individual's perceived values on a particular good or service.

The factors influencing the WTP of the respondents were estimated using multiple regressions with WTP as dependent variable with a set of explanatory variables. Wherever necessary the functional transformations were done to improve the goodness of fit. The explanatory variables include socioeconomic variables and respondent's perceptions.

The model used for the present study was in the following form and the description of the variables is furnished in Table 1.

WTP = f {AGE, EDN, MI, OI, LHS, DIS, AI}

Table 1: Description of variables

Variable Name	Description
Dependent Variable	
WTP	Willingness-to-Pay for the conservation of the mangrove ecosystem (household/year)
Explanatory Variables	
AGE	Age of the respondents (Number of years)
EDN	Years of schooling (Number of years)
MI	Annual income derived from mangrove related activities (household/year) (Fisheries, Rice farming)
OI	Annual income derived from other sources (household/year)
LHS	Land holding size (ha)
DIS	Distance between respondent household and the nearest mangrove area (km)
AI	Awareness Index

In the case of multi period payments, the WTP was discounted as suggested by Nelson *et al*. (1973). The discount rate was taken at rate of 6 per cent based on the current inflation rate of the country.

$$V = \frac{I(1+i)^n - 1}{i(1+i)^n}$$

Where; V = Present value; I = Future value; *i* = Discount rate (6%), and *n* = number of years.

In the case of the responses in favor of kind payment, the corresponding value was calculated based on the proportionate earnings of the respective respondent. The analysis is done using software package of SPSS 17.

Each respondent was asked to assign a value (1-5) reflecting the relative importance assigned to good/service received from mangroves for calculating awareness index (Question 1 from Part 3 of the schedule). There were 17 statements depicting the details of goods and services from the mangrove ecosystem. Each statement was assigned value according to Likert scale with a value ranging from 5- for strongly agree, 4- for agree, 3- for neutral, 2- for disagree and 1- for strongly disagree (Edward, 1963). The respondent's awareness index was calculated by adding up the response to all the seventeen statements. Thus, the highest value for an index can be 85 and lowest value can be 17. The higher the value, the better informed is the respondent of the various goods/ service of mangroves.

Results and Discussion

The valuation techniques are based, either directly or indirectly on the estimation of 'Willingness to Pay' (WTP) of individuals for ecosystem services (Costanza *et al*., 1997). Willingness to pay is the amount of money a person is willing to part for any commodity/service. It is associated with the utility of that particular commodity/service.

Adopting the method as explained in the methodology section, the WTP for conservation of the mangroves was gathered from the respondents. The respondents expressed their willingness to contribute towards conservation both in cash and kind (cash payment and manual participation as labor and as volunteer in awareness programs) and in combination. On an average 50 per cent of the stakeholders expressed their willingness to contribute towards conservation efforts. About 15 per cent of residents, fishermen and general public and one fourth of the paddy farmers were not willing to contribute, either cash or kind. This may be due to the situation of competition between paddy cultivation and prevailing mangroves in certain areas like Ezhome and Chengal (Kannur). Some of these respondents opined that it was the responsibility of the government to conserve the natural ecosystems. Few among the general public observed that those deriving direct benefits from the mangroves were to be taxed rather than the population at large. The poor economic status may also be a reason that restricts their willingness to pay.

On an average less than one fifth of the stakeholders were willing to contribute in cash. Among them, the proportion was lowest with residents, mainly because of the poor financial status. About one fourth of the resident, fishermen and general public were willing to contribute manually through offering labor for the planting/replanting measures and participating in awareness campaigns to increase the level of consciousness among the society towards mangrove conservation. The residents and fishermen were willing to offer labor for the replanting efforts and conservation of the existing mangrove stand. They were ready to offer one day labor/month for the same. The respondents among the general public were more interested in participating in awareness drives. The group expressed their willingness to offer 4- 6 hours/month for the awareness campaigns for mangrove

conservation. This disparity may be attributed to the level of educational attainment and the nature of occupation. Among the stakeholder groups, paddy farmers showed minimum interest to contribute manually. This may be primarily attributed to the age factor (majority of them were above 55 years of age) and the involvement in paddy cultivation which by itself is highly labor intensive. Nearly half of the respondents expressed their interest in combining cash and kind payments towards conservation.

The willingness to cash payment differed with respect to mode and pattern. Most of the residents, fishermen and paddy farmers opted for a onetime payment while the general public preferred payment in installments. The respondents in the general public group were assured income earners, which perhaps explained the behavior. The willingness to pay is also influenced by the mode of payment. The respondents were given two options; one was the eco-tax, which is to be collected for the conservation and sustainable management of natural resource. Second option was the system of direct payment to a government organization set up for the conservation of mangroves. Majority preferred direct cash payment. Large section of residents, fishermen and paddy farmers preferred direct cash payment. There was some difference in the case of general public category.

The trust and confidence of people in parting their hard earned money for the conservation of natural resources is an important element in determining the WTP. The notion of improper management in the government machinery hampers the people's willingness to pay. The respondents emphasized that there should be stringent norms to ensure the proper utilization of the funds for mangrove conservation programs.

The WTP for conservation efforts are influenced by various social, economic and personal factors. Going by various studies in this aspect (Hadker *et al.*, 1997; Ekka and Pandit, 2012; Sathya and Sekar, 2012; Venkatachalam and Narayanamoorthy, 2012), and researcher's observation, the WTP was estimated, by regressing the same with a set of variables. Various functional forms were tried and the one which was statistically best among the alternatives was chosen for discussion. The WTP expressed by each section of the respondent group for the conservation was calculated by converting the kind component to value terms in proportion to their monthly income. Further, in the case of payments in installments the present value was estimated through discounting. Thus, the estimated value in monetary terms was furnished.The results were furnished in Appendix 2.a to 2.d.

Semi-log multiple regression form was found to be the best fit in the case of residents. The education level (years of schooling) was positively related to WTP of the residents and was found to be statistically significant at 10 per cent level. Higher education provides better awareness about the necessity of the mangrove conservation for their well-being. Better education may also facilitate better jobs and higher income. The awareness index, that reflected the level of awareness on importance of mangroves, was also found to be having a positive influence at 1 per

cent level. This stakeholder group often possesses mangrove ownership and experiences the direct ecological benefits (storm protection, reduction in soil and embankment erosion). The benefits received through direct and indirect goods and services provided by the mangroves thus influenced the WTP positively. The result highlights the importance of organizing awareness programs in mangrove rich areas.

The model fitted for the fishermen group was better in the explanatory power. Education, income from fisheries and total holding size of the respondents were the major determinants of WTP. It was found that education and income from mangroves were significant and positively related to WTP. The fishermen with higher years of schooling were willing to pay more than their counterparts. The average years of schooling for the fishermen were 8 years. Hence it can be concluded that higher educational levels enhance the understanding in conservation and can positively influence the WTP. Among the respondent fishermen nearly 90 per cent had only single source of income i.e. income derived from mangrove dependent activities, and they were resource poor. Hence, the importance of mangrove conservation and the economic value attached to mangroves by fishermen were highly influenced by their income from the major livelihood activity. The studies by Hadker *et al*. (1997), Binilkumar (2010) and Ekka and Pandit (2012) also had reported similar results.

The holding size of the respondents exhibited significant negative influence. The average holding size of fishermen was less than 0.05 ha. The fishermen with larger holding size would be economically well off and hence their dependence on mangroves might be rather low. It was implicit that fishermen with lesser area are more concerned about the mangrove conservation. They were more prone to the natural vagaries and were directly benefitted by the ecological services of mangroves. So the value they attach to the mangroves might be higher.

In the case of paddy farmers, apart from the three factors for fishermen, other household income was also found to be significantly influencing the value they attach on mangroves. Contrary to the general behavior, educated farmers had shown lower willingness to pay for the conservation of the mangroves. The problem of succession of mangroves to the paddy fields has aggravated the constraints in paddy cultivation especially in Kaippad area. This might be one of the reasons for this behavior. However, the respondents' total income was found to be positively influencing the WTP.

The explanatory power of regression equation fitted for the general public category was 70 per cent. It was observed that age, educational level and awareness index had significant positive influence on WTP. Education, generally has expressed positive influence on valuation of mangroves except in the case of paddy farmers. Awareness index was an important attribute in the case of general public and the residents. Income from mangrove dependent activities exerted significant positive influence on WTP by fishermen and farmers. The results highlight the importance

of awareness creation efforts in natural resource conservation. Further the importance of mangrove conservation ensuring the livelihood security of the marginalized section of the society like resource poor fishermen and paddy farmers is also understood.

The WTP of each stakeholder groups were finally calculated based on the above regression equation. The results were furnished in Table 2. The average WTP among the residents was found to be `998. Majority of residents (58%) expressed their willingness to provide `1,000–2,000/annum for the conservation. A section of the respondents in both Ernakulam and Kannur, especially residing at the embankment of canals and rivers are currently involved in mangrove conservation initiatives by planting mangroves along the boundary line of the household or along the coastal mud flats. The mangrove species *Bruguieragymnorrhiza* (Ernakulam) and *Rhizophoramucronata* (Kannur) are commonly planted.

Similar to resident population, most of the fishermen were also willing to pay less than `1,000/annum. About 90 per cent of the WTP was expressed to be provided by the manual component. Fishermen were also willing to offer their labor for the restoration and conservation initiatives. A section of the respondents in Kannur, most of them, the shrimp farmers denied to contribute even though they occupy the highest income strata among the respondents.

The average WTP of this stakeholder group was`932/annum. The dependence on mangrove ecosystem, either direct or indirect is higher for both residents and fishermen compared to other stakeholder groups. However, the fishermen expressed their apprehension over their ability to participate during the day time owing to the peculiar nature and working hours of their livelihood activity i.e. fishing.

Among the four stakeholder groups, paddy farmers expressed their apprehensions towards the payment. The negative attitude among a section of the respondents in the group might be attributed to competitive relation prevailing in the paddy-mangrove ecosystem and relatively poor economic returns from paddy cultivation. The average WTP of the group was `1159/annum. Even though mangroves are indirectly providing the nourishment to paddy, a few respondents were not convinced. They opined that conservation efforts are not required since natural rate of regeneration of mangroves is very high.

The maximum WTP was offered by the general public. About one third of the respondents were willing to pay above `6,000/annum, maximum being `12190/annum with minimum of `50/annum. The higher value of WTP of the group was primarily on account of the higher income/salaried class in the public and private sector. Contrary to the other stakeholders, majority of the respondents who were ready to pay, were willing to contribute their time and energy for the awareness campaigns and similar conservation efforts. Very small percentage in this group was willing to contribute physical labor for the restoration activities.

Table 2: Details of WTP of the respondents

Sl No.	Payment (household/year)	No. of Respondents			
		Residents	**Fishermen**	**Paddy Farmers**	**General Public**
1	< 1000	78 (58)	69 (58)	72 (60)	8 (7)
2	1000 – 2000	27 (31)	37 (31)	28 (22)	8 (7)
3	2000 – 3000	7 (6)	13 (10)	12 (10)	20 (16)
4	3000 – 4000	3 (2)	1 (1)	2 (2)	13 (11)
5	4000 – 5000	3 (2)	-	2 (2)	31 (25)
6	5000 – 6000	-	-	3 (3)	7 (6)
7	> 6000	2 (1)	-	1 (1)	33 (28)
	Total	120 (100)	120 (100)	120 (100)	120 (100)

Figures in parentheses represent percentage to total

The aggregate value of mangrove ecosystem in the state was extrapolated from the WTP estimates and is presented in Table 3. The mean annual WTP of each stakeholder group was estimated and found that WTP varies between `12,190 and `10. Being the salaried class, general public expressed maximum WTP while minimum was expressed by economically weak fishermen. One fourth of paddy farmers were not willing to pay, and the proportion was the highest among the four groups. The lowest average WTP was also expressed by the farmers.

The TEV (Total Economic Value) of the stakeholder groups were estimated based on the average annual WTP of the sample stakeholders and their respective population. The population of each category was obtained by assessing the proportion of population WTP in the respective category. The population of residents, fishermen and general public were calculated based on Census (GoI, 2011) and Ramesh *et al*. (2013). Farmer population was calculated based on per capita land availability of Pokkali/ Kaippad area and the total area under cultivation.

TEV of each stakeholder group is the multiplicative value of average WTP and their respective population. Being the largest group, general public had highest TEV of `102,793 million and lowest being paddy farmers (`15 million), the smallest group. Hence the TEV of the mangrove ecosystem of the state was `110,769 million and was 0.14 per cent of the GSDP. This highlights the economic importance of the ecosystem in our economy. The forests in the state currently account for only less than 1 per cent of GDP while taking into consideration the direct benefits. Even with very high pressure on land resources, the people of Kerala is attaching very high value to the ecosystem presumably owing to the high environmental awareness.

Table 3: Estimated TEV of the mangrove ecosystem

Sl No.	Stakeholder Group	WTP (`/household/year)			Proportion of Population Having WTP	Estimated Value of TEV (` million)
		Maximum	Minimum	Average		
1	Residents	6965	23	998	7770721 (85%)	7755
2	Fishermen	3838	10	932	219816 (86%)	204
3	Paddy farmers	11161	21	1159	13304 (76%)	15
4	General public	12190	50	4986	20616390 (86%)	102793
			TEV			110769

Figures in parentheses represent percentage of willingness for payment (cash/manual) expressed by each stakeholder group.

Policy Suggestions

1. Scientific attempts on realistic area estimation and mapping of the mangrove resources in the state are to be initiated.

2. The stakeholders who live closest to the mangrove ecosystem attribute more importance to the ecological benefits. Hence, their role in conservation efforts should be appropriately utilized.

3. The Pokkali and Kaippad rice farming systems are also supported by the mangrove system. However, there seems to be differing perceptions regarding the extent of association. There should be region specific studies to establish and quantify the extent of association between mangrove ecosystem and the livelihood activities.

4. The monetary value attached to the mangrove ecosystem signifies the economic importance and can justify the resource allocation for the conservation efforts.

Conclusions

Mangroves are invaluable treasure of our biodiversity with immense ecological and economical significance. But, the ecosystem was often considered as economically unproductive. This situation has resulted in taking most of the policy decisions in favor of other sectors, leading to the destruction and depletion of the natural mangrove ecosystems. Realistic estimation of the economic value of the system supports the scientific decision making when confronted with problem of

conservation versus development. The economic valuation of ecological benefits of mangroves was attempted employing the Contingent Valuation Method.

The respondents expressed their willingness to contribute towards conservation both in cash and kind (cash payment and manual participation as labor and as volunteer in awareness programs) and in combination. Three fourth of the respondents were willing to contribute and the rest included those who expressed negative attitude towards mangroves and the group which believed that it was the state's responsibility to conserve the natural ecosystems. Onetime payment was the preferred option for the payment and was mostly in the form of direct cash payment.

The average WTP expressed by the respondents was `2,308 the range being `50 – 28,870. The Total Economic Value (TEV) was estimated from this, based on the proportion of stakeholder group who were willing to pay and their total population in the state. The estimated TEV was `12,744 million (residents), `335 million (fishermen), `13 million (paddy farmers) and `104,855 million (general public). The TEV of the mangrove ecosystem of the state was thus `117,947 million, which was 0.14 per cent of the GSDP (2011-12). Educated people generally expressed their WTP, as evidenced by the positive value of the coefficient in the case of three stakeholder groups (e.g.: Chen *et al*., 2005; Badola *et al*., 2012). Awareness index was an important factor in the case of general public and the residents which influenced the WTP. Income from mangrove dependent activities exerted significant positive influence on WTP by fishermen and farmers. The results highlight the importance of awareness creation efforts in natural resource conservation as well as the importance attached by the direct dependent population.

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Appendix

Appendix 1: Total Economic Value of mangrove ecosystem

Use Values		Non-use Values
Direct Use Value	**Indirect Use Value**	**Existence Value**
Fish	Nutrient sink	Biodiversity
Fuel wood	Flood control	conservation
Fodder	Breeding and nursery ground	
Medicine	for fishes, crustaceans	
Timber	Shoreline protection	
Honey	Storm protection	
Tannins	Micro climate stabilization	
Recreation and aesthetic	Water purification	
	Roost for the birds	

Appendix 2.a: Estimation of willingness to pay for mangroves by residents

$$\ln Y = a - b_1X_1 + b_2X_2 - b_3X_3 + b_4X_4 - b_5X_5 + b_6X_6 + b_7X_7$$

Variables	Co-efficient	Standard Error	t-ratio
Constant (a)	0.879	0.740	1.188
Age (X_1)	-0.006	0.009	-0.670
Education (X_2)	0.052*	0.032	1.608
Holding size (X_3)	-0.292	0.218	-1.340
Income from mangrove dependent activity (X_4)	2.524E-6	0.001	0.870
Other income (X_5)	-5.516E-7	0.001	-0.368
Distance (X_6)	0.273	0.476	0.573
Awareness index (X_7)	0.049***	0.014	3.491
R^2	0.622		

**** 1 percent level of significance, ** 5 percent level of significance,* 10 percent level of significance respectively.*

Appendix 2.b: Estimation of willingness to pay for mangroves by fishermen

$$\ln Y = -a + b_1 \ln X_1 + b_2 \ln X_2 - b_3 \ln X3 + b_4 \ln X_4 - b_5 \ln X_5 - b_6 \ln X_6 + b_7 \ln X_7$$

Variables	Co-efficient	Standard Error	t-ratio
Constant	-5.773	3.441	-1.678
Age (X_1)	0.072	1.050	0.069
Education (X_2)	1.312**	0.449	2.920
Holding size (X_3)	-2.358***	0.530	-4.448
Income from mangrove dependent activity (X_4)	1.440*	0.538	2.678
Other income (X_5)	-0.044	0.064	-0.696
Distance (X_6)	-1.039	0.794	-1.309
Awareness index (X_7)	0.466	0.634	0.735
R^2	0.731		

**** 1 percent level of significance, ** 5 percent level of significance,* 10 percent level of significance, respectively.*

Appendix 2.c: Estimation of willingness to pay for mangroves by paddy farmers

$$\ln Y = -a - b_1 \ln X_1 - b_2 \ln X_2 - b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 - b_6 \ln X_6 + b_7 \ln X_7$$

Variables	Co-efficient	Standard Error	t-ratio
Constant	-6.304	5.997	-1.051
Age (X_1)	-2.060	1.592	-1.294
Education (X_2)	-0.700*	0.421	-1.664
Holding size (X_3)	-2.696***	0.799	-3.375
Income from mangrove dependent activity (X_4)	02.247**	0.971	2.211
Other income (X_5)	0.938*	0.547	1.716
Distance (X_6)	-1.888	1.215	-1.554
Awareness index (X_7)	0.126	0.922	0.137
R^2	0.617		

**** 1 percent level of significance, ** 5 percent level of significance,* 10 percent level of significance, respectively.*

Appendix 2.d: Estimation of willingness to pay for mangroves by general public

$Y = -a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 - b_6X_6 + b_7X_7$

Variables	Co-efficient	Standard Error	t-ratio
Constant	-9717.180	3100.912	-3.134
Age (X_1)	172.760***	39.431	4.381
Education (X_2)	266.372**	133.550	1.995
Holding size (X_3)	231.282	471.695	0.490
Income from mangrove dependent activity (X_4)	0.027	0.047	0.574
Other income (X_5)	0.001	0.002	0.141
Distance (X_6)	-642.001	434.695	-1.477
Awareness index (X_7)	115.727**	39.180	2.954
R^2	0.704		

**** 1 percent level of significance, ** 5 percent level of significance,* 10 percent level of significance, respectively.*