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Willingness to Pay for Restoration of Natural Ecosystem: A Study of Sundarban Mangroves by Contingent Valuation Approach

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I

INTRODUCTION

The Sundarbans in India is the largest river delta and also the largest estuarine mangrove forest in the world. The Indian Sundarbans has a forest area of 4263 sq. km (Zoological Survey of India, *Annual Report 2009-10*). It became a UNESCO world heritage site in 1997 (UNESCO, WHC 2012). Being situated in the intertidal zone**,** inundated by tides twice a day, the mangroves possess a range of features which make them uniquely adaptable to their stressful environment. The mangrove swamp provides an ambience of food and shelter to a wide range of both land and aquatic organisms. It acts as nutrient stock for both esturine and marine ecosystems supporting local and commercial yields (Camilee, 1998). The mangroves forest acts as a nursery for many fish species all along the Eastern coast of India (Zoological Survey of India, *Annual Report 2009-10*). Apart from that, mangroves act as a natural buffer against cyclones and storms. Mangroves protect the vulnerable embankment from tidal surges and act as bio shield against storms (Sathirathi and Barbier, 2001).

Most of the people depend on Sundarban ecosystem for their livelihood and sustenance through fishing, collection of honey and fuelwood/timber (Zoological Survey of India, *Annual Report 2009-10*). It is an example of a community living in a balance with surrounding mangrove forest, upon which it depends for subsistence and livelihoods. These people are poor and have fewer years of education, employment and income, therefore their dependence on mangrove is greater (Hussain and Badola, 2010*).* Irrespective of many benefits, mangroves are under intense pressure from competing resource uses, increased commercial activities and urban development demands. Every year mangroves are being destroyed during prawn seed collection by the villagers or eaten up by their domesticated animals. Such activities can, therefore, have a drastic negative effect on the well-being of mangrove

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dependent community including the whole ecosystem. The balance will become fragile, because excessive exploitation can undermine the resource availability (Chowdhury, 2010*)*. Therefore, investment in the conservation and management of mangroves is increasingly seen as a key element of sustainable livelihood, risk reduction and disaster management.[1]

Such investments would make people better-off and more secure over time. However, there is less comprehension of the importance of these goods and raw materials in terms of their multiplier effects at local and national levels in terms of their contribution to the national economy, or their role in local livelihoods and poverty alleviation. The present study tries to analyse the people's perception about the importance of mangroves and their willingness to pay for its conservation. The study was conducted in fringe villages of Sundarban Tiger Reserve (STR) in the year 2010-11.

II

METHODOLOGY

Study Area

The study was conducted in Gosaba islands of Sundarban delta, India. It is located adjacent to the core area or critical tiger habitat under Sundarban Tiger Reserve. It is bounded by Matla and Zilla rivers/creeks. It is the last inhabitated area before the deep forests starts. It has 14 Gram Panchayats.[2] The people in these areas largely depend upon the Sundarbans ecosystem and the ecosystem traditionally formed the backbone of rural living. There are multiple sources of livelihoods in the Sundarbans, however, agriculture, fishing and aquaculture, forestry and tourism are predominant. Agriculture is an important source of livelihood in the Sundarbans economy (Rajshekar, 2011). Nearly 60 per cent of the total working population depends on agriculture as a primary occupation either as cultivators (23.6 per cent) or as agricultural labourers (36.1 per cent). Apart from agriculture, fisheries and aquaculture has significant potential for development. Many residents of the Sundarbans are dependent on collection of natural tiger shrimp (P. monodon*)* post larvae brood stock and seed for aquaculture. Honey collection, firewood and timber collection are some of the other means of livelihood to the Sundarban residents. However, the livelihoods in the Sundarbans are threatened by high levels of risks in the form of cyclonic storms, tidal creek erosion, embankment failures, salinity intrusion and other natural extreme events.

Survey Schedules

The survey was conducted in two stages. The first stage covered background information about the respondent's socio-economic characteristics like age, gender, education, occupation, income etc. to get complete information about the standard of

living of the respondents of the survey area. In the second stage, the respondents were first asked about the degradation of the mangroves and its impact on the surrounding areas. Whether they think that the mangroves were actually degrading. Response options were 1 for positive answer and 0 for no or don't know answers. Furthermore, they were asked whether they would like to pay a particular amount in the form of tax and again the positive answers were accompanied by the following questions:

- How much are you willing to pay for the maintenance and restoration of the mangroves and surrounding islands? Yes/No
- What will be your mode of payment? 1. Annual, 2. Lump sum, 3. Monthly, 4. No payment
- Whom you wanted to pay?

It was again divided into five responses, i.e., To autonomous body, State government, co-operative society, locally managed NGOs and nationalised NGO. It is important to know the resident's perception and belief towards different organisations for further implementation of development programmes. The problems faced by the respondents were also documented during the survey to support the study.

Survey Procedure

Stratified random sampling method was used which involves dividing the whole population into homogeneous sub-groups and then taking a simple random sample in each sub-group. The sub-groups were made on the basis of their occupational status. The sample residents of Gosaba islands aged 18 and above were interviewed. The data collection of the sub-group fisherman and agriculturist were covered by visiting individual households and group discussion. For traders and other sub-groups the data was collected from markets and haats. During group discussion the respondents were made familiar with the subject. Ten villages were covered during the whole period of survey and 432 households were interviewed from different stakeholders.

Analytical Techniques

This study employs the contingent valuation (CV) method, which involves finding an individual's Willingness To Pay (WTP) for the goods by constructing a hypothetical market (Kostald, 2000). CV is a method of recovering information about preferences or willingness to pay from direct questions. The purpose of contingent valuation is to estimate the individual's willingness to pay for changes in the quality or quantity of goods and services as well as effect of covariates on willingness to pay (Haab and McConnell, 2002). Typically the survey questioned how much money

people would be willing to pay to maintain the existence of (or be compensated for the loss of) an environmental feature, such as biodiversity, ecosystem health etc. (Nijkamp *et al.,* 2008). WTP indicates the strength of one's preference for environmental quality, and it is influenced typically by several factors, including an individual's income, gender, cultural preferences, education, or age (Nguyen and Vietnam, 2007).The estimation of value of the natural system as consideration of option and existence value, is usually defined in terms of the preservation of species, groups of species or ecosystems (Randall, 1991, Bishop, 1978). Randall (1991) concluded that we should approach the potential loss of any species, habitats with the presumption that its expected value to humans is positive.

The description of the variables under study is given in Table 1. The willingness to pay (WTP) was the dependent variable and the explanatory variables includes those variable which directly or indirectly affect the willingness to pay of the stakeholders. The explanatory variables are divided into three types, viz., quantitative variables, binary variables and categorical variables. The quantitative variables include age, household income, distance to the waterbody, and time spent on collection of resources. Since the residents of Sundarbans have direct interaction with the nature in their day-to-day life and are dependent on these resources for livelihood, therefore, it is important to note how much time they spent on various activities like firewood collection, prawn seed and crab collection, fishing, honey collection etc.

TABLE 1. DESCRIPTION OF VARIABLES UNDER STUDY DEPENDENT VARIABLE: WTP FOR CONSERVATION AND RESTORATION OF MANGROVES

Variables name (1)	Description (2)
Dependent Variables (Binary)	
WTP	Stated willingness to pay (Rs.) 1 for positive response and non-response recorded to zero
Quantitative variables	
AGE	Age of the respondent (in yrs)
HH INC	Household income in Rs. per year
DIST	Time taken to reach water body (km)
TM SPENT	Time spend in collection of resources (in hours)
BID	Bid value. The value in Rs. the respondent's willingness to pay
Binary and categorical variables	
GDR	Gender , Binary variable: 1= female; 0= male
EDU	Education, Binary variable: 1= literate; 0= illiterate
MGR DEG	Respondent's perception regarding mangrove resource degradation: 1 for positive response; 0 otherwise
MODE	1 for response option 1 and 2; 0 otherwise [b]
WPAY	Whom you want to pay 1 for response option 2 and 3; 0 otherwise [b]
OCUP	Occupation Categorical variable: Agriculturist-1, Fisherman -2, Traders - 3, others - 4 [a]

Note: a, b See text (Section analytical techniques).

The variable bid value represents the amount in rupees the respondents are willing to pay. The binary variables included gender, education, respondent's perception regarding resource degradation, mode of payment etc. One categorical

variable namely occupation were also included as explanatory variable having 4 levels (See Table 1) to see the response of the stated WTP across various occupational strata. The dominant livelihood option for Sundarbans dwellers are agriculture followed by fisheries. Some traders who were having permanent shops in the survey area are also included in the list of respondents. The last composite group of workers were denoted by word "others" which includes diverse occupational strata, who were mainly daily labour, rickshaw puller, vendors, etc. Due to frequent crop failure and low income from fishing, most of the people have diverted towards other occupations.

The analysis centred around the probability of person's willingness to pay (WTP) for the future. The proportion of cases where the respondents are willing to pay (WTP) was given value of 1 and those who do not want to pay was assigned 0 values. Step-wise logistic regression was used to determine which independent variable were predictor of people's willingness pay for the subsistence of this estuarine region. Mathematically speaking logistic regression is based on probabilities, odds and the logarithms of the odds (SJSU, 2001). By applying the concept of odds to work out logistic regression of classification as willingness to pay is defined as:

$$\text{Odds}_{wtp} = \frac{P(WTP)}{1 - P(WTP)}$$

where

$$WTP = f\,(AGE, HH\ INC, DIST, TM\ SPENT, BID, GDR, EDU, MGR\ DEG, MODE, WPAY, OCUP) \quad \ldots.(1)$$

In the present analysis the probability of having one outcome or another based on non-linear model resulting from the best linear combination of explanatory variables can be written as

$$Y_i = \frac{e^u}{1 + e^u} \quad \ldots.(2)$$

Where y_i is the estimated probability of the i-th case of the dependent variable and e is a constant equal to 2.718, raised to the power u, where u is the usual regression equation

$$u = B_o + B_1X_1 + B_2X_2 + B_3X_3 + B_kX_k \quad \ldots.(3)$$

The linear regression equation (u) is then the natural log of the probability of being in one group divided by the probability of being in the other group (Tabachnick and Fidell, 1996). The linear regression equation creates the logit or log of the odds:

$$\ln \frac{y}{1-y} = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_kX_k \quad \ldots.(4)$$

III

RESULTS AND DISCUSSION

Socio-Demographic Profile of the Sample

The socio-demographic profile of the respondents is given in Table 2. The table shows that with respect to age, most of the people interviewed belong to the age group of 36-55 years (41.18 per cent). Around 38.34 per cent of respondents belonged to the age group of less than 35 years. Regarding gender almost 85 per cent of the respondents were male and only 15 per cent interviewed were female.

TABLE 2. SOCIO-DEMOGRAPHIC PROFILE OF RESPONDENTS

Sl. No. (1)	Socio- economic characteristics (2)	Frequency (3)	Per cent (4)
1.	Age		
	less than 35	176	38.34
	36-55	189	41.18
	more than 56	94	20.48
2.	Gender		
	Male	394	85.84
	Female	65	14.16
3.	Education		
	Literate	290	63.18
	Illiterate	169	36.82
4.	Occupation		
	Agriculture	159	34.64
	Fisherman	181	39.43
	Traders	42	9.15
	Others	77	16.78
5.	Income		
	less than 10,000	171	37.25
	10000-20000	230	50.11
	more than 20000	58	12.64

In terms of education 63.18 per cent of respondents were literate and 36.82 per cent of respondents were found to be illiterate. The yearly income of respondents varies from Rs. 10,000 to 20,000 for 50 per cent of the respondents and 37.25 per cent of respondents have yearly income less than Rs. 10,000. Therefore, around 85 per cent of the households earn only an income of Rs. 20,000 or less per year which is far lower than the national average of Rs. 50,000 at current prices (Times of India, February 1, 2012).

Perceptions Regarding Utility of Mangroves

Table 3 represents the perception of the population regarding the importance of mangroves. Farmers were asked to put each statement in any of the five degrees of agreement followed by the percentage analysis. The table revealed that most of the respondents (92.59 per cent) strongly agreed that mangroves provide several benefits. Nobody was in disagreement with the statement. However, the respondents probably did not have a proper understanding of the ecological balance. Therefore, when they were asked to opine regarding the importance of mangroves in ecological balance about 50 per cent of them were non-responsive. A little above one-third of the sample agreed that mangroves have an important role to play in ecological balance. The analysis further reveals that the 78 per cent of the respondents strongly agreed that mangrove area has decreased. Another 18 per cent agreed on the same proposition. Some handful of them were of the opinion that in some area new mangroves are coming up, therefore, in total the area under mangroves is constant.

TABLE 3. FARMERS' PERCEPTION

Statement (1)	SA (2)	A (3)	NR (4)	DA (5)	SD (6)
Mangroves provide several benefits	92.59	5.56	1.85		-
Mangroves are important for ecological balance	14.81	29.63	46.99	8.56	-
Mangroves area decreasing	78.01	18.06	-	3.94	-

Note: SA: Strongly agree, A: Agree, NR: No response, DA: Disagree, SD: Strongly Disagree.

TABLE 4. PERCEPTION OF THREAT

Threat level (1)	Per cent of respondents quoted (2)
Serious	24.54
Threat but not serious	49.31
Not a threat	26.16

Risk perception by general public is critical because it strongly influences the decisions of the policy makers attempting to address the problem. Awareness of the problem is a necessary, but not a sufficient condition to motivate an individual or collective response. Hence, their threat perception level was further studied. Table 4 indicated that only a handful (25 per cent) of respondents thought that the threat of decreasing mangrove on ecosystem is very serious whereas almost equal (26 per cent) of them thought that is not a threat at all. Almost half of the respondents reported that decreasing of mangroves is a threat but not serious. Hence there is a need to organise awareness camp regarding the threat level of decreasing mangroves. People will be motivated easily for community level conservation measures once they are fully aware and convinced.

Individual's Willingness to Pay

The individual's willingness to pay is given in Table 5. It depicts that around 64.71 per cent of the respondents agreed to pay for conservation and restoration of mangroves at different bid levels. And 35.29 per cent of the respondents did not agree to pay at specified bid level. The maximum bid value which the respondents were willing to pay was Rs.10 (40.07 per cent) followed by Rs. 20 (20.27 per cent) and Rs.30 (18.86 per cent). As the bid value increased the willingness to pay decreased. The respondents valued the conservation of the mangroves at the same time their low income and poor standard of living forbids them from paying more for the conservation and restoration of mangroves. It becomes impossible for them to pay higher amount for its restoration in spite of being aware of the importance of mangroves. In this study mean and median were estimated as central tendency measured of WTP which is Rs. 25.90 and Rs. 20 respectively.

TABLE 5. INDIVIDUAL'S WILLINGNESS TO PAY FOR HYPOTHETICAL MARKET SCENARIO

WTP Bid value (in Rs.) (1)	Accepted (WTP=1) (2)	Rejected (WTP=0) (3)	Total (4)
10	119(40.07)	27(16.67)	146
20	81(27.27)	29(17.90)	110
30	56(18.86)	27(16.67)	83
50	16(5.39)	19(11.73)	35
70	6(2.02)	9(5.56)	15
100	5(1.68)	11(8.02)	16
120	6(2.02)	7(3.09)	12
150	4(1.35)	10(6.17)	15
200	2(0.67)	7(4.32)	9
250	1(0.34)	6(3.70)	7
300	1(0.34)	5(3.09)	6
500	0 (0.00)	5(3.09)	5
>500	0 (0.00)	0(0.00)	0
Total	297 (64.71)	162 (35.29)	459 (100.00)
	Mean WTP-25.90 ± 1.697		
	Median WTP- 20		

Figures in parentheses indicate percentage to their respective total.

Test of Theoretical Validity: The Bid Value Curves for Mangroves Conservation

Following Cameron and Huppert (1989), maximum likelihood estimation using logistic regression approach was used. The model was fitted using the SAS software package in Enterprise guide 4.2 (2006-2008 by SAS Institute Inc., Cary, NC, USA.) The model clearly classify 92.4 per cent among all cases (Table 6) at 0.5 per cent of probability level.

A test of the full model against a constant only model was statistically significant indicating that the predictors as a set reliability distinguished between WTP and non-WTP (Chi-square 246.07; <.000 df-13). Also the R^2 value of 0.67 indicates a moderately strong relation of 67 per cent between the predictors and prediction of

TABLE 6. THE VARIABLES INFLUENCING THE WTP RESPONSES FOR CONSERVATION OF MANGROVES

Dependent variable: WTP for conservation & restoration of mangroves
Model: binary logit — $X^2 = 246.07$
Probability modelled ; WTP= '1' — $R^2 = 0.67$
Optimization Technique: Fisher's scoring — P=0.05
No. of observations : 459 — D.F.= 13
Log. Likelihood of the model: 190.825
Log. Likelihood (only intercept): 436.89

Analysis of Maximum Likelihood Estimates

Parameter	Estimate	Standard Error	Wald Chi-Square	P	Sig.[c]
(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-1.6470	0.9273	3.1550	0.0757	*
AGE	-0.00025	0.0136	0.0003	0.9855	n.s.
HH INC	-0.00002	0.000027	0.6122	0.4339	n.s.
DIST	0.4632	0.3134	2.1846	0.1394	n.s.
TIME SPENT	0.1369	0.0892	2.3551	0.1249	n.s.
BID	-0.0443	0.0199	4.9910	0.0255	*
GENDER(0)	-0.3627	0.2581	1.9747	0.1600	n.s.
EDU	0.2490	0.2139	1.3551	0.2444	n.s.
MGR DEG	-0.7215	0.2113	11.6566	0.0006	***
MODE	-1.6953	0.3644	21.6397	<.0001	***
W PAY	-0.4500	0.3423	1.7288	0.1886	n.s.
OCUP (Agriculturist)	-0.6847	0.5702	1.4420	0.2298	n.s.
OCUP (Fisherman)	0.5839	0.3713	2.4733	0.1158	n.s.
OCUP (Traders)	-0.5695	0.6107	0.8696	0.3511	n.s.

[c] p< 0.01(***); p < .05(**); p < 0.1 (*); n.s : non- significant

WTP. The Wald criteria of maximum likelihood estimates that only 3 variables, viz., bid value, mode of payment and perception of mangrove degradation made significant contribution to the predictors. Other variables like age, education, income, distance, occupation status were not significant predictor of willingness to pay for restoration of mangroves. The odds ratio estimates (see Table 7) value indicates that when there is increase in 1 person for negative response perception towards degradation, the probability of WTP will decrease by 76.4 per cent. Likewise for

TABLE 7. THE PROBABILITY TO WTP FOR RESTORATION OF MANGROVES

Odds Ratio Estimates

Effect	Odds	Log-odds
(1)	(2)	(3)
Age	1.0	0
Total Income	1.0	0
Distance	1.589	0.589
Time spent	1.147	0.147
Bid value	1.045	0.045
Sex 1- male; 0 - female 0 vs 1	0.484	-0.516
Education 1- literate 0 vs 1	1.645	0.645
MGR degrading; 1 - yes 0 vs 1	0.236	-0.764
Mode of payment 0 vs 1	0.034	-0.966
to whom you want to pay 0 vs 1	0.407	-0.593
Occupation Agri vs others	0.258	-0.742
Occupation Fisheries vs others	0.917	-0.083

Occupation	Traders vs others	0.289	-0.711

payment to NGOs or autonomous body, will also decrease the WTP by 3.4 per cent. For the predictor bid value of 1 rupee increase in tax will increase the WTP by 4.5 per cent. Also, the occupational strata do not significantly contribute in willingness to pay.

IV

CONCLUSIONS

The concept of economic value has its foundations in welfare economics. Therefore, valuation in an economic sense is always the result of an interaction between the subject and an object. Moreover, an economist does not pursue total value assessment of an environment system but rather change (Nijkamp *et. al.*, 2008). The mangroves of Sundarban are of great importance. The residents were directly dependent on these mangroves as a last alternative for their livelihood. But its utility has been ignored by the inhabitants due to lack of awareness, lower household income and poor livelihood condition. The study may be an eye opener which shows that for conservation of natural resources the involvement of local people is necessary and they will pay more for it if more income generation options are made available to them. Also, awareness regarding conservation of mangroves will also increase their value. This study would be useful to the policy makers and decision-making would become easier with more information concerning the economic values of different ecosystem services (both marketed and non-marketed) which in turn leads to optimal allocation of funding towards sustainable development.

NOTES

1. Mangroves for the future, http://www.mangroves forthefuture.org/Programmes/4K-Economic-Valuation.html accessed on 27.01.2012.

2. Local self-government at village level in India.

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