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Economic Value of an Ecosystem Conservation Project: A Case Study of U Minh National Forest in the Vietnamese Mekong Delta

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This study applies the contingent valuation method (CVM) to estimate urban residents' willingness to pay for an ecosystem conservation program in U Minh national forest, one of the most important protected areas in the Mekong Delta. The results showed that most households are willing to make a monthly contribution of about VND 85,515 (US$ 3.72) toward the program. Overall, the urban residents of the Mekong Delta have agreed to contribute about US$ 55 million annually to the U Minh forest ecosystem conservation project. This annual aggregate contribution is relatively large enough to elicit interest from the government, policymakers, and other stakeholders to financially invest in preserving the forest ecosystem.

Key words: CVM, Ecosystem Conservation, Forest, U Minh National Park, Vietnam, WTP

INTRODUCTION

Vietnam has been acknowledged as a country with high biodiversity and is also highly prioritized in global conservation efforts. The country's ecosystems and biological resources are an integral part of its economy and culture, as reflected in the value they impart in terms of environmental protection (ecological function value), direct use (economic value), and socio–cultural activities. Biodiversity, therefore, makes a significant contribution to the national economy by ensuring food security; maintaining gene resources of livestock and plants; and providing materials for fuel, medicine, and construction (MONRE, 2015).

Vietnam is sensitive to global climate change; it is one of the ten countries most seriously affected by climate change. Fragmented ecosystems might be too weak to respond to such changes and therefore, unable to prevent a rapid mass loss of various species (MONRE, 2008). Increases in average temperature could change the geographic distribution and population structure of many ecosystems. Scientists have found evidence of species migration resulting from global warming. Increasing temperatures trigger forest fires, especially in peat swamp, dipterocarp, and pine forests. Climate change, combined with decreasing watershed forests and irrational water use, may result in increased inundation, flash floods, and landslides, which would severely impact the environment and human livelihoods (MONRE, 2008).

The wetlands in the Mekong Delta have very high biodiversity. There are now 386 species of birds, over 400 species of fish, and 23 species of mammals in this region (WWF, 2010). However, the region also faces several biodiversity threats, including population growth, agricultural intensification, increasing use of fertilizers and pesticides, as well as changing flood levels during heavy rains. Water quality might be further compromised owing to human activity in Vietnam. The greatest long-term threat to the Mekong Delta is climate change. A rise in the sea level to 65 cm would cause a loss about 5,200 km^2 or 13% of the Mekong Delta's land area. This would lead to serious consequences not only for the Mekong Delta's biodiversity but also for the overall Vietnamese economy (Campbell, 2012).

To prevent biodiversity loss and degradation, local authorities have proposed the use of public finance (Khai and Yabe, 2014). Many studies have been carried out over the past 50 years to assess the biodiversity of wetland ecosystems in the Mekong Delta. Until now, limited information was available on the value of biodiversity and ecosystem conservation projects. According to Khai and Yabe (2014), the cost calculations of biodiversity conservation programs are relatively easy; however, estimation of the benefits is difficult. The benefits of biodiversity policies can be estimated by studying public preferences regarding conservation programs. This study uses the contingent valuation method (CVM) to estimate the total economic value of a proposed ecosystem conservation program in the U Minh forest, the largest peat swamp forest in Vietnam. The study might provide policymakers and other stakeholders with additional information on residents' attitudes toward the environment and natural resources as well as the benefits of ecosystem conservation.

The paper is structured as follows. The next section describes the methodology, project scenario, and data collection. This is followed by a presentation of the main results, a discussion on protest zero and valid zero bids, the reasons for residents' unwillingness to pay for the proposed project, and the results from the estimation of willingness to pay (WTP). The final section presents the

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conclusion.

METHODOLOGY

This study applies the CVM to estimate the willingness to pay (WTP) of a proposed U Minh forest ecosystem conservation project. Based on a hypothetical market, CVM is a survey–based approach, where an independent individual declares his/her WTP for the preservation of environmental services in a specific location (Mitchell and Carson, 1989). Over the past decades, CVM has been widely used to measure the WTP for social projects in developing countries (Thang and Bennett, 2005, 2009; Hoa and Ly, 2009). CVM is an appropriate tool to measure the value of natural resources (Tuan *et al*., 2014; Khai *et al*., 2019).

The use of the discrete choice contingent valuation question is widely accepted because other question types are problematic owing to incentive compatibility (Carson *et al*., 2001). Contingent valuation questions are analyzed using a random utility model (Haab and McConnell, 2002; Bateman *et al*., 2002). It is assumed that the respondent is asked to select a change from Q_0 (status quo) to Q_1, which refers to the environment's quality (U Minh forest conservation), and where Q_1 is preferred to Q_0. The utility function of the respondent is described as $V(P, Q, I, Z, \varepsilon)$, where P is the price vector of goods available in the market, I is the income vector of the respondent, Z is the vector of the respondent's characteristics, and ε is the error term of the utility function. If the respondent is asked whether he/she is willing to pay an amount M to obtain Q_1, his/her answer would be "yes" if the following condition holds (where Pr denotes the probability):

$$\begin{aligned} Pr\,(Yes) &= Pr\,\{\,V\,(P, Q1, I-M, Z) + \varepsilon 1 \\ &\quad \geq V\,(P, Q0, I-0, Z) + \varepsilon 0\,\} \\ &= Pr\,\{\,V\,(P, Q1, I-M, Z) \\ &\quad - V\,(P, Q0, I-0, Z) + \varepsilon 1 - \varepsilon 0 \geq 0\,\} \end{aligned} \quad (1)$$

where ε_0 and ε_1 are unobservable components of the utility and identically and independently distributed (IID) random variables with a zero mean. If we define $\Delta V = V\,(P, Q1, I-M, Z) - V\,(P, Q0, I-0, Z)$ and $\gamma = \varepsilon 1 - \varepsilon 0$, we derive:

$$Pr\,(Yes) = Pr\,(\gamma \geq -\Delta V) = 1 - F\gamma(-\Delta V) = F\gamma(\Delta V) \quad (2)$$

where $F\gamma(\Delta V)$ represents the cumulative density function of the respondent's true maximum WTP.

The discrete choice contingent valuation technique estimates the mean and median WTPs based on the coefficients related to the WTP responses against the regression constant and the *BID* coefficient. Additional coefficients (X) of other variables, such as the respondent's awareness, perception, or demographic information, may also be factored into the model. This study used the logistic function; the following form was used to estimate these coefficients:

$$\begin{aligned} Pr\,(Yes) = F\gamma(\Delta V) &= \frac{1}{1 + exp(-\Delta V)} \\ &= \frac{1}{1 + exp\,[-(\alpha + \beta_1 BID + \beta_2 X)]} \end{aligned} \quad (3)$$

where α and β are estimated coefficients and *BID* is the amount of money the respondents were asked to pay.

Logistic function was analyzed using the maximum likelihood estimation approach. Assume R_k as an indicator variable for observation k, with:

$$\begin{aligned} &Pr\,(Yes) = Pr\,(R_k = 1) = Pr\,(\gamma_k \leq \Delta V_k) = F\gamma\,(\Delta V_k) \\ &Pr\,(No) = Pr\,(R_k = 0) = Pr\,(\gamma_k \leq \Delta V_k) = 1 - F\gamma\,(\Delta V_k) \end{aligned} \quad (4)$$

So, the log–likelihood function is formed as:

$$\log L = \sum_{k=1}^{N} \{R_k \ln\,(F_\gamma\,(\Delta V_k) + (1-R_k)\,\ln\,(1-F_\gamma\,(\Delta V_k))\} \quad (5)$$

In this case, we assume a linear correlation between the dependent and *BID* variable; then the mean and median WTP are equal and calculated by the following formula:

$$Mean/Median\ WTP = -\frac{(\widehat{\alpha} + \widehat{\beta}_2 \overline{X})}{\widehat{\beta}_1} \quad (6)$$

PROJECT SCENARIO AND DATA COLLECTION

The ecosystem conservation program is proposed to be carried out in the U Minh national forest, one of the most important protected areas in the Mekong Delta, with the objective of conserving this area. The project's hypothetical scenario is as follows: "Suppose the People's Committee of Kien Giang province and the People's Committee of Ca Mau province establish a U Minh ecosystem conservation fund (UMECF) using contributions from urban residents. The fund then receives additional support from international organizations as well as the Government with amounts equal to or higher than the contribution of the urban residents. The contribution would have to be made for three years, as a component of the monthly water bill. Furthermore, the amount of contribution is fixed and does not vary with water usage in cubic meters, and will only be used by the UMECF to:

(1) Plan the increase of forest coverage, protect against soil erosion, landslides, and washout;

(2) Promote investment for upgrading roads leading up to the U Minh forest to create favorable conditions for tourists;

(3) Collaborate with domestic and foreign agencies and organizations to conserve biodiversity;

(4) Strengthen forest management and biodiversity conservation through programs to protect and restore forest ecosystems, improve law enforcement capacity, and encourage state regulations on forest protection and

development;

(5) Implement livelihood projects to gradually improve the lives of local residents around the U Minh forest."

The presentation of this above scenario is followed by the WTP question and some brief follow–up questions about the certainty of the respondents' answers and their reasons for willingness or unwillingness to pay. Five different bid values of VND 20,000, VND 50,000, VND 80,000, VND 110,000, and VND 130,000 were selected for the study. These are equivalent to US$[4] values of $0.87, $2.17, $3.48, $4.78, and $5.65 respectively. Each respondent was randomly interviewed on whether he/she was willing to contribute one of these bid values. If the answer was "yes," the list of "yes" reasons was then presented. If the response was "no," the list of "no" reasons was then introduced and an open–ended question was also asked—whether the respondent would like to contribute some additional amount of money, to identify the categories of protest zero, valid zero, and WTP less bids.

In 2018, face–to–face interviews with urban residents in the Vietnamese Mekong Delta were conducted and these interviews were divided into two phases. The first phase was a pilot survey, and was, therefore, essential for the contingent valuation study (Bateman *et al*. 1995). The purpose of these interviews was to refine the questionnaire, format the bid starting point more clearly and concisely, and help interviewers understand the suitability of the questionnaire given the research objective. Based on the results of the pilot survey, the questionnaire was revised, and this revised version was used as the final questionnaire. In the second phase, a survey with 450 urban respondents was conducted in three provinces of the Vietnamese Mekong Delta in 2018 (150 in Can Tho, 150 in Kien Giang, and 150 in An Giang) using a random sampling method.

The final questionnaire consisted of four major parts. The first part presents the respondents' opinions and information on forests and forest conservation. Respondents express their attitudes and perceptions using a five–point Likert scale. In the second part, five questions related to biodiversity and threats to the U Minh forest are introduced. Respondents are asked to choose one of three answers: "*I don't know*," "*I know*," and "*I know well*." The third part describes the hypothetical scenario and the CVM question. In the final part of the questionnaire, the socio–economic information of the respondent, including age, education, income, and the number of family members, was collected.

RESULTS AND DISCUSSION

The socio–demographic characteristics of the respondents are shown in Table 1. We tried to send invitations to both women and men equally (i.e., to take gender issues into consideration); we found that the distribution was quite equal for both sexes (56.4% male and 43.6% female). In terms of the respondents' education levels, it is hypothesized that the education variable and the probability of agreeing to pay for ecosystem conservation could be positively correlated. The survey shows that most of the respondents have high education levels; more than half of the respondents had an education level of high school and above.

Table 1. Socio–demographic characteristics of respondents

Characteristics	Percent (%)
Gender	
Male	56.4
Female	43.6
Education	
Primary	6.0
Secondary	15.3
High school	38.7
College and above	40.0
Employment	
Government staff	17.3
Private-sector staff	14.9
Housewife	15.8
Businessperson	32.0
Retiree	4.2
Others	15.8
Monthly household income (VND 1,000,000)	
Up to 5	5.1
Between 5 and 11	32.2
Between 11 and 17	36.9
Between 17 and 23	16.0
Between 23 and 29	6.2
Over 29	3.6

Table 1 also shows that about 18.0% of the respondents work for government offices and agencies at a town, district, ward, and community level or for state–sponsored social organizations. Most of the respondents (36.9%) have a monthly household income of VND 11–17 million, while only 5.1% of the respondents have a total income of less than VND 5 million per month.

Table 2 shows the results of the respondents who are willing or unwilling to pay for the proposed project. About 53.6% of the respondents are willing to pay. The probability of answering "no" increases as the amount of money requested increases. Specifically, a request for VND 20,000 has the highest acceptance rate (90.0%), the amount of VND 80,000 has half the acceptance rate (50.0%), and the highest ask of VND 130,000, has the lowest acceptance rate (31.1%).

Table 3 illustrates the reasons for the respondents' refusal to pay a given amount. Approximately 74.3% of the respondents cannot afford to contribute to the ecosystem conservation fund (reason #1). Such a high rate of unwillingness to pay owing to income constraints is consistent with the study by Khai and Yabe (2014), who

[4] 1 USD = 23,000 VND

Table 2. Willingness and unwillingness to pay for the given discrete choice

Bid level (VND)	Observations	The answer to WTP question			
		Willingness to pay		Unwillingness to pay	
		Number	Percent (%)	Number	Percent (%)
20,000	90	81	90.0	9	10.0
50,000	90	57	63.3	33	36.7
80,000	90	45	50.0	45	50.0
110,000	90	30	33.3	60	66.7
130,000	90	28	31.1	62	68.9
Total	**450**	**241**	**53.6**	**209**	**46.4**

Table 3. The reasons for refusing to pay for the given discrete choice

Reasons	Number	Percent (%)
1 = I cannot afford to pay for the project	179	74.3
2 = I do not think it is important to preserve the ecosystem of U Minh forest	150	62.2
3 = I do not believe my contribution can solve the problem	99	41.1
4 = I think that conservation will be carried out even without my contribution	97	40.3
5 = I do not believe that my contribution will be used for U Minh forest ecosystem conservation	91	37.8
6 = I do not receive any personal benefits from this contribution	125	51.9
7 = Others	5	2.1

Table 4. The division of protest zero bid, valid zero, and less bid respondents

	Number	Percent (%)
Protest zero bids	133	63.64
Valid zero bids	19	9.09
Willing to pay lower than the bid values given in the questionnaire	57	27.27
– Under VND 20,000	25	11.96
– Between VND 20,000–50,000	23	11.00
– Over VND 50,000	9	4.31

stated that about 51.0% of the respondents refused to contribute to the conservation program owing to low income. The second biggest reason, stated by 62.2% of the respondents, was that preserving the ecosystem in the U Minh swamp forest took a backseat compared to other pressing challenges they were facing on the personal front. Besides, about 40.3% of the respondents said that without their contributions, conservation activities could still be carried out because it is a part of the Government's and NGOs' responsibility.

This study follows other previous contingent valuation studies (e.g., Halsteal *et al*., 1992; Khai and Yabe, 2014) to discriminate between protest zero and valid zero bids. "Protest zero bids" are those in which a respondent positively values the environment but does not believe in or like a particular conservation project. The respondents are not willing to pay for the proposed project citing reason #3 (I do not believe my contribution can solve the problem) and reason #5 (I do not believe my contribution will be used for U Minh forest ecosystem conservation) listed under the category of "protest zero bids," while those with any other reasons are categorized as "valid zero bids." Table 4 shows that about 63.6% of the respondents belong to the group of protest zero bids, 9.1% belong to the group of valid zero bids, and 27.3% belong to the group paying less than the bid values given in the questionnaire.

One of the most important elements when using the CVM method is to identify how important factors such as income, age, gender, and so on, affect the WTP. The study applies the Logit model, in which the dependent variable is the probability of a "yes" answer in relation to the WTP for the ecosystem conservation program; the explanatory variables include bid levels, socioeconomic characteristics, the respondents' knowledge of the U Minh forest, and the impact of the decision of surrounding households. A detailed description of the variables used in the model is presented in Table 5. There are some hypotheses related to the model. The bid level and age are expected to be negatively correlated with the probability of agreeing to the project while knowledge and education of the respondents is expected to positively affect the probability. The government staff respondents are more likely to accept the conservation project. A "participation effect" is detected, which includes those who support the given scenario if they are

Table 5. Descriptive statistics of variables in the Logit function

Variables	Description	Mean	Standard Deviation
Choice	Willingness to pay for the conservation project (1 = Yes, 0 = No)	0.536	0.499
Bid	Bid value (Thousand VND)	78.000	39.743
Knowledge [€]	Total points of respondent's knowledge	2.250	1.163
Govstaff	The occupation of respondents (1 = Government Staff, 0 = Otherwise)	0.173	0.379
Age	Age of respondents (Years)	36.893	10.186
Education	The education of respondents (Years)	12.244	3.661
Gender	Gender of respondents (1 = Male, 0 = Female)	0.564	0.496
Status	Civil status of respondents (1 = Married, 0 = Otherwise)	0.760	0.428
Income	Monthly household income of respondents (Million VND)	13.822	6.311
Depend	Number of dependent members (Children under 15 years old and elderly people over 60 years old)	1.527	1.247
Effect	Respondents are willing to pay for the project if neighboring households also want to pay (1 = Yes, 0 = No)	0.767	0.423

Note: [€] Each respondent was asked 5 questions related to biodiversity and threats to the U Minh forest. The knowledge score is equal to 1 if the respondent chooses "I know well," equal to 0.5 for choosing "I know," and equal to 0 for choosing "I don't know."

Table 6. Logit analysis of willingness to pay for the ecosystem conservation project

Variables	Model 1 (All respondents)		Model 2 (Excluding "protest zero bids")	
	Coefficient	Standard Error	Coefficient	Standard Error
Bid	– 0.0315***	0.0035	–0.0305***	0.0049
Knowledge	0.1862*	0.1068	0.0741	0.1489
Govstaff	0.4878	0.3415	0.1379	0.4955
Age	– 0.0722*	0.0139	–.0264*	0.0174
Education	0.0721*	0.0395	0.1247**	0.0543
Gender	0.0876	0.2367	0.5295	0.3437
Status	0.3792	0.3111	0.5294	0.4338
Income	0.0732***	0.0207	0.1243***	0.0322
Depend	– 0.1832*	0.0954	-0.1840	0.1423
Effect	1.3187***	0.2866	1.1964***	0.4197
Constant	0.1295	0.8014	-0.0143	1.0778
Log–Likelihood value	– 227.6426		–122.2487	
Pseudo R^2	0.2675		0.2998	
Correct prediction (%)	75.56		83.91	
Observation (N)	450		317	

Note: ***, ** and * denote significant levels at 1%, 5% and 10% respectively.

told that other families said "yes" to making a contribution to the project.

Table 6 shows the results of a logistic analysis of the dichotomous choice responses to the contingent valuation question. Model 1 is an estimate for all respondents and Model 2 shows the results after excluding the "protest zero bids" respondents. The predictive power of the models is relatively high, with nearly 75.6% in Model 1 and over 83.91% in Model 2. The correlation matrix among the explanatory variables supports the absence of multicollinearity, as there are no correlation indices in excess of 70.0% (Khai and Yabe, 2014).

Table 6 shows that five factors (*Bid, Age, Education, Income, and Effect*) have a significant impact on the respondent's WTP for conserving the U Minh forest's ecosystem in two models. The coefficients of *Bid* in both the models are negative and statistically significant at a 1% level, implying that an increase in the bid levels leads to a decreasing probability of saying "yes". This is consistent with the demand theory. Consistent with the same studies by Khai and Yabe (2014) in U Minh Thuong National Park, the coefficients of *Age* in the two models are statistically significant and have negative signs, implying that the older respondents have a higher tendency to say "no" to the WTP question.

The coefficients of *Income* are significantly positive at a 1% level, suggesting that higher–income could increase the probability of "yes" answer to the CVM question, consistent with previous studies using the same CVM method (e.g., Khai, 2015; Thalany, 2013; Tao *et al.*, 2012). Similar to other studies (e.g., Stone *et al.*, 2008; Kamri, 2013; Tao *et al.*, 2012), the coefficients of

Table 7. Willingness to pay for the proposed ecosystem conservation project

Unit: thousand VND

Model	Mean WTP	95% Confident interval		
		Upper bound	Lower bound	ASL
All respondents	85.515	78.172	93.021	0.0000
Protest bids excluded	130.000	113.646	147.699	0.0000

Note: ASL: Achieved Significance Level for testing H_0: WTP < = 0 vs H_1: WTP > 0; Confidence intervals are estimated by the Krinsky and Robb (1986) method.

Education are statistically significant at a 10% level in Model 1 and 5% level in Model 2, implying that the respondents with higher education levels are more likely to pay for the project. The coefficients of the *Effect* are positive at the significant level of 1% in the two models; this implies that the respondents who are affected by decisions made by the neighbors and those around them would be more likely to say "yes" to the project.

The mean WTP for the proposed ecosystem conservation project is calculated using the direct estimates of the coefficients shown in Table 6 and applied to formula (6) (please refer to the section: Methodology). The results are reported in Table 7. The mean WTP of all the respondents is estimated at VND 85,515 per household on a monthly basis with a 95% confident interval between VND 78,172 and VND 93,021. The mean WTP after excluding protest vote respondents increases to VND 130,000 per household on a monthly basis with a 95% confident interval from VND 113,646 to VND 147,699.

According to the General Statistics Office of Vietnam (GSO, 2017), the Vietnamese Mekong Delta has a population of about 4,527.2 thousand urban people with a household size of about 3.7 people per household. Therefore, there are 1,223,568 urban households in the Mekong Delta. Based on the outcome of Model 1, the WTP for ecosystems conservation in the U Minh forest is estimated at approximately VND 1,026,180 per household annually. Furthermore, the total economic value of the U Minh forest could be estimated at about VND 1,255 billion a year, equivalent to about US$ 55 million per annum.

CONCLUSION

This study applied the CVM to estimate urban residents' WTP for the proposed ecosystem conservation program in the U Minh swamp forest within the Mekong Delta. The results show that a majority of the households involved in this study are willing to pay for the project and their mean WTP is approximately VND 85,515 per household per month, which is nearly 0.6% of the monthly household income. Moreover, the study also estimated a mean WTP of VND 130,000 per household on a monthly basis after excluding the protest zero and scenario rejecting respondents. An aggregate welfare measure could be derived by multiplying the mean WTP with the total number of urban households in the Mekong Delta, which was calculated to be approximately VND 1,255 billion, equivalent to nearly US$ 55 million per year. This annual aggregate contribution is relatively large enough to elicit interest from the government, policymakers, and other stakeholders to financially invest in conserving the ecosystem in U Minh National Park.

The total economic value of the proposed conservation project estimated by the CVM may also be valuable for environmental evaluation; these estimated values can be used for the cost–benefit analysis of this project as well as other future projects in Vietnam.

This study also showed that certain households were willing to support the proposed project if they were informed that neighboring households had also agreed to contribute or if they were provided more knowledge about biodiversity and climate change threats in the U Minh forest. If improvements in communication raise awareness of the impact of climate change on forests, urban residents are more likely to pay for the forest conservation project. This study makes an important contribution toward the evaluation of the U Minh forest ecosystem in the context of climate change. The findings also suggest that as bid prices increased, the probability of the respondents agreeing to pay decreased. Respondents with higher household income and education are more likely to pay for the ecosystem conservation project.

AUTHOR CONTRIBUTIONS

Huynh Viet Khai and Nguyen Phi Van designed the study questionnaire, collected and analyzed the data, and drafted the manuscript; Mitsuyasu Yabe supervised the research and made critical revisions to the manuscript under the Can Tho University Improvement Project VN14–P6, supported by a Japanese ODA loan. All authors read and approved the final manuscript.

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