Vietnam J. Agri. Sci. 2016, Vol. 14, No. 10: 1608 -1617 Tạp chí KH Nông nghiệp Việt Nam 2016, tập 14, số 10: 1608 - 1617
www.vnua.edu.vn

WILLINGNESS TO PAY FOR WATER QUALITY IMPROVEMENT IN HANDICRAFT VILLAGES OF BAC NINH PROVINCE, VIETNAM

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Received date:15.09.2016 Accepted date: 02.11.2016

ABSTRACT

The study was conducted to survey one thousand households (HH) from 5 out of 62 villages in Bac Ninh province to estimate people's willingness to pay (WTP) for water quality improvement, to identify the factors affecting people's willingness to pay. Respondents are the heads of household. The Turnbull technique was used to estimate expected willingness to pay for water quality improvement. Results of this research show that the average WTP is 485.273 VND per per HH per per year. The potential fundsobtainedwould beapproximately 6 billion VND per year (268,251 USD per year) and the real fundswould have a value of 3.45 billion VND per year (154,475 USD per year). For Bac Ninh province, the total funding that would really be achieved would be 100.2 billion VND per year (4.48 million USD). Potential funding has a value of 155.4 billion VND per year (6.9 million USD).

Several factors positively impact the WTP of HH with HH type, trade-off between economic growth and environmental quality, using tap water, and income of HH being significant statistic variables with positive coefficients. These coefficients indicate that the heads of handicraft households who have high incomes, agree to sacrifice environmental quality to get fast economic growth, and who use tap water are more likely to say "yes" to the given bid. The factors of village and bid had negative coefficients and high statistical significance.

Keywords*:* Contingent valuation, handicraf village, willingness to pay, water quality improvement.

Sẵn lòng chi trả để cải thiện chất lượng nước ở các làng nghề của Bắc Ninh, Việt Nam

TÓM TẮT

Nghiên cứu được tiến hành điều tra 1.000 hộ từ 5 làng nghề trong tổng số 62 làng nghề của tỉnh Bắc Ninh nhằm ước lượng sự sẵn lòng trả của các hộ để nâng cao chất lượng môi trường nước, xác định các yếu tố ảnh hưởng tới mức sẵn lòng trả. Đáp viên được xác định là chủ của hộ gia đình. Sử dụng công cụ ước tính của Turnbull để ước lượng mức sẵn lòng chi trả trung bình. Kết quả nghiên cứu và phân tích cho thấy rằng mức sẵn lòng trả trung bình của các hộ làm nghề truyền thống là 485,273 VND/ hộ/năm. Tổng quỹ tiềm năng có thể thu được từ các hộ này xấp xỉ 6 tỉ VNĐ/năm (268,251 USD/năm) và tổng quỹ thực tế là 3,45 tỉ VNĐ/năm (154,475 USD/năm). Đối với toàn tỉnh Bắc Ninh, tổng quỹ thực tế có thể thu được là 100,2 tỉ VNĐ/năm (4,48 million USD). Trong khi đó, tổng quỹ tiềm năng có thể đạt được lên tới 155,4 tỉ VNĐ/năm (6,9 million USD).

Các yếu tố loại hộ (làm nghề hay không làm nghề), quan điểm đánh đổi giữa sự phát triển kinh tế và môi trường, nguồn nước hộ sử dụng, thu nhập của hộ tương quan cùng chiều với sẵn lòng trả và có ý nghĩa thống kê. Điều này có nghĩa là những hộ sản xuất nghề, hộ đồng ý với việc đánh đổi giữa phát triển kinh tế và môi trường, hộ sử dụng nước máy và những hộ có thu nhập cao là những hộ có nhiều khả năng trả lời "đồng ý" với mức giá họ được nhận. Các biến làng nghề, mức giá thầu có tương quan ngược chiều với sẵn lòng trả. Những hộ sống gần với hai con sông đang bị ô nhiễm nặng của tỉnh Bắc Ninh có xu hướng trả lời "đồng ý" trong khi những đáp viên ít có khuynh hướng đồng ý nếu họ nhận được các mức giá thầu cao.

Từ khóa: Cải thiện chất lượng nước, đánh giá ngẫu nhiên, làng nghề, sẵn lòng chi trả.

1. INTRODUCTION

In Vietnam, handicraft villages have been developed based on culture and civilization which were formulated during thousands of years of the country's history. According to the Vietnam Craft Village Association, the country currently has 2,790 craft villages, of which, one-third are traditional craft villages and are distributed mainly in the Red River delta region (about 60 percent). These handicraft villages, which have a participation rate of at least 30 percent of all households and make up at least 50 percent of the village's total income, have greatly contributed to increased incomes and have reduced poverty in rural areas.

However, craft villages have also caused severe environmental pollution, especially in water sources (Government, 2011). Reports on the environmental status of the villages in 2008 by the Ministry of Natural Resources and Environment (MoNRE) show that 46% of villages had heavy environmental pollution. Most of the environment quality indicators exceeded the permissible standards. For example, the level of SO_2 in the air was exceeded 6.5 times, BOD5 and COD in waste water in some places reached 200 times the limit, and coliform exceeded from 20 to 50 times the limit, these are very negative impacts to production activities, and activities in and out of the village population (MoNRE, 2008). Among craft villages, environmental pollution is often quite high in the manufacturing sector, with a direct impact on health of workers. The environmental quality in most manufacturing areas in the villages is not up to standard. The percentages of workers at risk of exposure to dust, heat, and chemicals are 95%, 85.9% and 59.6%, respectively (Department of Environmental Pollution Control, 2008).

There are 62 handicraft villages in Bac Ninh province, of which, 31 are traditional handicraft villages. In 2014, about 14,360 households in Bac Ninh were employed, accounting for 4.54% of the total households in Bac Ninh province. The total production value of the village reached 7629.4 billion VND, accounting for 7.78% of the provincial GDP (Bac Ninh Provincial People's Committee, 2015). The analysis results of surface water showed that concentrations of pollutants exceeded the Vietnam Permissible Standards (VPS) several times. BOD_5 levels exceeded VPS 1.2 times to 6.3 times; COD exceeded VPS 1.2 times to 5.7 times; TSS levels exceeded VPS 1.2 times; ammonia levels exceeded VPS 1.18 times to 9.1 times; coliform levels exceeded VPS 1.6 times; chromium content exceeded VPS 1.8 times to 3 times; and nitrite content exceeded VPS 1.5 times to 7.4 times. Of note, wastewater in Dai Bai from casting copper exceeded VPS dozens of times to hundreds of times (Centre for Monitoring Environment Quality, 2014). The volume and characteristics of wastewater produced in the villages are not the same and depend on the type of technology and materials used in production. Food processing and textile dyeing are the industries that use lots of water and also discharge large volumes of wastewater with high organic pollution levels. The volume of wastewater of these villages is from 2,000 m^3 to 5,000 m^3 per day. Textile dyeing has a huge chemical demand. Approximately 85 - 90% of the chemicals are dissolved in wastewater. Metal recycling villages do not use much water but wastewater from these villages contains many toxic substances. Weaving, carpentry, and paper making villages have high chemical demands so waste water from these handicraft villages contain harmful chemicals. There are many studies on pollution issues in craft villages of Bac Ninh province. However, these studies have focused primarily on the pollution status and technical solutions. Therefore, a study related to financial issues in order to contribute to solving water pollution is necessary. Under such a circumstance, this research is designed to estimate people's willingness to pay for water quality improvement, to identify the factors affecting people's willingness to pay, and to propose effective policy recommendations. The results from this study might be the basis for Bac Ninh's officials to determine solutions to solve water pollution.

2. DATA AND RESEARCH METHODS

2.1. Literature review

There are two ways of estimating the economic values attached to non-marketed goods and services: using revealed preferences or using stated preferences (SP). Revealed preference approaches identify the ways in which a non-marketed good influences actual markets for some other good, i.e. the value is revealed through a complementary (surrogate or proxy) market. Stated preference approaches, on the other hand, are based on constructed markets, i.e. they ask people what economic value they attach to those goods and services. In other words, the economic value is revealed through a hypothetical or constructed market based on questionnaires (Bateman and Carson, 2002). Within the class of SP methods, there are two alternative groups of techniques: choice modeling (CM) and contingent valuation (CV). The contingent valuation method (CVM) (Mitchell and Carson, 1989) uses expressions like reflecting the direct approach to elicit the willingness (and ability) to pay. For example, respondents may be asked about hypothetical recreational trips with and without an improvement in water quality (Whitehead *et al.*, 2000). In choice modeling, respondents to a questionnaire are asked directly for their WTP ('What are you willing to pay?' or 'Are you willing to pay £X?'). The main method used in this research is the contingent valuation method. This is a way to examine directly to elicit preferences, abilities and ideas from consumers (Kahneman and Knetch, 1992).

Dale *et al.* (1990), estimated the level of willingness to pay for water services in developing countries. The authors found no evidence of deviation from the initial point of the suggested methods of generating between the 2 groups investigated. The study also shows that deviations from the strategy that best answer the CVsurvey method. The willingness to pay (WTP) is positively related to the variable of household income, occupation, education level and distance from all water users to water. This demonstrated that the willingness to pay completely followed the rules of economics and economic theory. Some methods try to 'price' non-market goods by examining the relationship of "price" with market rules. Brox *et al.* (2013) estimated the WTP for improved water quality in residential areas in the Grand River basin in the Province of Ontario, Canada, and Barton (2002) used an identical method to find the WTP. Additionally, Atkins *et al.* (2007) applied CVM, decision tree analysis and investigation of the willingness to pay for improved water quality. And there are many studies on improving water quality, for example, Barton (2002), Atkins *et al.* (2007), Gupta and Mythili (2008), and Brox *et al.* (2013). From these studies, the efficacy of using the CVM method has been strengthened.

Concerning the WTP elicitation methods, many studies used the single or double - bounded dichotomous choice method to elicit people's WTP, such as Huynh Viet Khai and Mitsuyasu Yabe (2013), Quy Van Khuc (2014), Nasreen Islam Khan *et al.* (2014), Hua Wang*et al.* (2014), and Jin Jianjun *et al.* (2016). These studies found a significant impact of socio-economic characteristics of respondents on their WTP. The authors also found that the bid was negative and significantly correlated with WTP.

2.2. Data collections

Bac Ninh province has 62 handicraft villages, of which 31 are traditional villages. There are 7 polluted handicraft villages. The five (5) villages with most seriously polluted water due to handicraft production were sellected to be surveyed (Table 1).

Most CV studies reported in the literature use sample sizes far below those typically used by survey researchers (an appropriate range is 600 to 1,500 respondents) who need to generalize to a population (Mitchell and Carson, 1989). For this study, one thousand (1,000) HHs were randomly selected for the survey.

Table 1. The total number of households, number of polluted handicraft households and sample sizes

Name of village	Total (HHs)	Handicraft production (HHs)	Non-handicraft production (HHs)	Sample size (HHs)
1) Yen Phu Agr. Processing village	2,674	930	1,744	200
2) Noodle Khac Niem village	997	200	797	200
3) Phong Khe paper village	2,798	796	2,002	200
4) Dai Bai recycling village	1,500	722	778	200
5) Da Hoi steel recycling village	1,200	900	300	200
Total	9,169	3,548	5,621	1,000

Source: Bac Ninh provincial people's committee, 2015

The bid ranges were based on results of focus group discussions, pre-tests and consultations of experts. Therefore,bid values ranged from 150,000 VND to 850,000VND and were divided into 5 bids (150,000 - 325,000 - 500,000 - 675,000 - 850,000). Each respondent received one randomly drawn bid price. The respondents were then asked to state whether they would be willing to pay for anwater quality improvement project to change the water's current contaminated status to a clean status (as shown in a picture) at the offered price ("yes" means willing to pay and "no" means not willing to pay). Accept/reject respondent probabilities were calculated for each VND amount offered.

It was explained to the respondents that this survey focused on HHs living in handicraft villages, including producers and agricultural HHs. Companies located in the locality were not interviewed because they have to pay an anual environmental protection charge.

2.3. Procedures and techniques for processing and analyzing data

2.3.1 Analysis of fundamental factors affecting the level of people's willingness to pay

The acceptance probability P is written as follows (Johannesson *et al.*, 1996)

$$P = F(B) = 1/(1+e^{-\Delta V}) \quad (1)$$

Where: F(B) is the "survivor" function yielding the probability of accepting to pay at least $B.

ΔV is the change in utility caused by the considered improvement in safety if the person pays $B for the improvement. $\Delta v = ß_0 + ß_1 bid + ß_2 Si$

Where: S is a vector of socio economic factors such as: age, sex, education, household size, and household income

$ß_i$ (I = 0,1,2) is parameters to be estimated

The logistic function in equation (1) can be written as:

$$Ln [P/(1-P)] = ß_0 + ß_1 bid + ß_2 Si \quad (2)$$

2.3.2. Non-parametric approach to estimate willingness to pay

A lower bound estimator, also known as the Turnbull estimate, is one of the non-parametric approaches. In this study, we used the Turnbull technique to estimate the expected willingness to pay E(WTP).

For bids indexed j = 1 , . . . , M, calculate $F_j = N_j /N_j + Y_j$

where Nj is the number of no responses to tj and Yj is the number of yes responses to the same bid, and $T_j = N_j + Y_j$.

Beginning with j = 1, compare Fj and Fj+ l ·

If $F_{j+1} > F_j$ then continue.

If $F_{j+1} < Fj$ then pool cells j and j + 1 into one cell with boundaries (t_j ; t_{j+2}), and calculate $F_j^* = (N_j + N_{j+1})/(T_j + T_{j+1})$. That is eliminate bid t_{j+1} and pool responses to bid t_{j+1} with responses to bid t_j

Continue until cells are pooled sufficiently to allow for a monotonically.

Increasing Cumulative Distribution Function (CDF).

Set $F_{M+1} = 1$

Calculate the Probability Density Function (PDF)as the step difference in the final CDF:

$f_j^* = F_j^* - F_{j-1}^*$

The lower bound of the WTP for a sample of referendum responses can be expressed formally as follows:

E_{LB} (WTP) = $\sum_j^{M^*} t_j f_{j+1}^*$ (Haab and Mc Connell, 2002)

2.3.3. Estimating the total funding for rehabilitation of water sources from people

Real funding = Average WTP × The percentage of HHs willing to pay × Total HHs

Potential funding = Average WTP × Total HHs

3. RESULTS AND DISCUSION

3.1.1. Socio-economic characteristics of respondents

The total number of surveyed households in BacNinhprovince was 1000 households. Of which, the average age of the respondents was 46 years old. Men accounted for 65.1% of the total respondents. There were more respondents who did not complete high school (57.2%) than those who completed high school (30.7%).This proportion was relatively similar between study sites. The education level of the respondents is not high because the demand for labor in a handicraft village is very high. After graduating high school, respondents often choose to live in the villages to help their family in production activities instead of continuing to get higher levels of education. The results of studying the relationship between education level of the heads of household and their age showed that the respondents who had the lowest education level (did not complete high school) had ages ranging from 46 to 60. Respondents who were 36 to 45 years of age had an education attainment of high school. Respondents who had the highest education levels were in the ages of 25 to 35 years old.The average number of people living in a household was 5 persons. The average household income was 15.5 million VND per month per HH. Of which, 46.8% households had anincome under 10 million VND per month. The results of analyzing the relationship between income and study areas indicated that the number of HHs having an income under 10 million VND per month were located primarily in agro product villages, such as KhacNiem noodle village and Yen Phu agro processing village.

3.1.2 The willingness to pay by type of household

Comparing the willingness to pay among groups that have different careers showed that the differences between these groups is very clear. It should be noted that although the willingness of households to pay increased proportionally to their income, the proportion of handicraft manufacturers refusing to pay is 42.41%, higher than agricultural households (32.68%). This suggests an important meaning: propaganda is very important. Families of the villages in these areas have not been properly educated on environmental issues and who is responsible for environment issues. Handicraft households also think that they have to pay a higher fee or take more legal responsibility if they are willing to pay. Based on the Turnbull estimator, the means of the WTP of craft HHs and agriculture HHs are respectively 417,321 VND per HH per year (18.68 USD per HH per year) and 545,295 VND per HH per year (24.41 USD per HH per year).

3.1.3. The level of willingness to pay according to education attainment

Results of the willingness to pay for environmental improvements by level of education are shown in Figure 1. Households that obtained higher education levels are willing to pay more. The percentage of people that have primary school and high school education levels who are not willing to pay to improve water quality is higher than the percentage of people who have higher education

levels. The reason for this is that people who have a high level of education often have awareness of environmental issues more than respondents who have a low level of education. They are able to access mass media, newspapers, and new information, therefore their willingness to pay is also higher than others. This implies an important conclusion that there is an influence of education on the quality of the environment in the long term and the improvement of the environment in the short term.

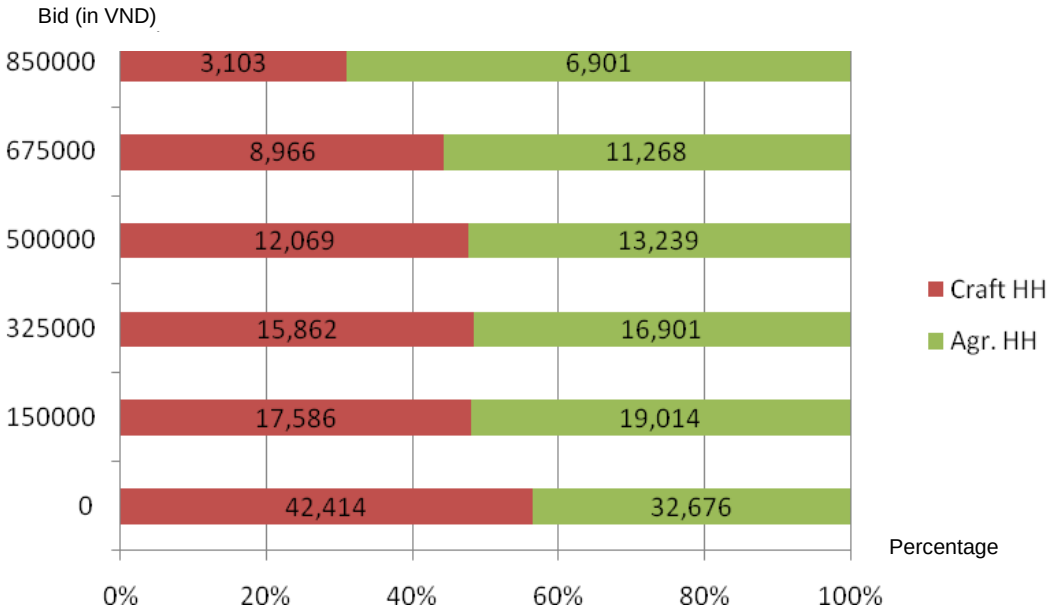

Figure 1. The level of willingness to pay classified by type of household

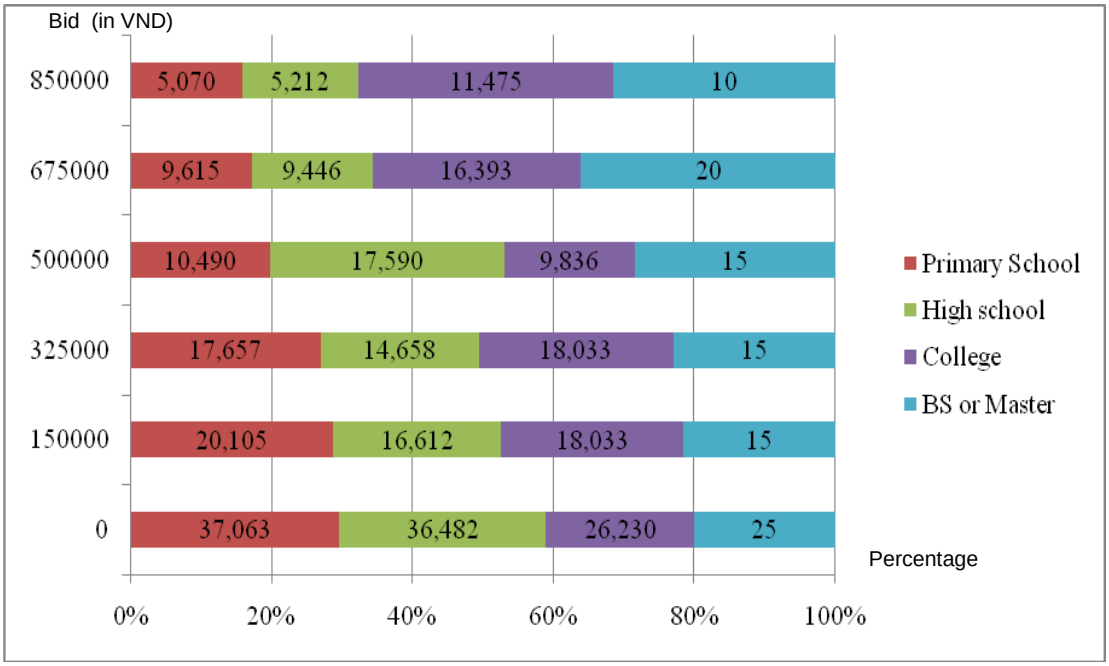

Figure 2. The level of willingness to pay classified by education attainment

Table 2. Estimation of total funding may be obtained to improve water quality

	Handicraft HH	Total HH
Mean WTP (VND)	417,322	485,273
Percentage of HH who voted "yes" (%)	57.59	64.50
Total household number (HH)	14,360	320,228
Real number of HH willing to pay (HH)	8,269	206,547
Potential funding (1,000 VND)	5,992,738	155,398,002
Real funding (1,000 VND)	3,450,990	100,231,711

Source: survey (2016)

3.1.4. Total funding that may be obtained from people in order to improve water quality

The funding that will be obtained from people to improve the environmental quality of water is estimated according to the types of household. These funds will be obtained through socialization programs for improved environmental issues. All the people in theregion will then see it as their responsibility to contribute to the improvement of the environment in general and the water in particular.

We assumed that the Bac Ninh province's authorities want to focus on handicraft households and require their responsibility to reduce the water pollution in the locality. The potential funds able to be obtained is approximately 6 billion VND per year (268,251 USD per year) and the real funds would have a value of 3.45 billion VND per year (154,475 USD per year). For Bac Ninh province, the total value of funds that they would really be able to achieve is 100.2 billion VND per year (4.48 million USD). Potential funding has a value of 155.4 billion VND per year (6.9 million USD). So, if governments, environmental organizations, and other social organizations have correct policies, and rational and effective propaganda aimed to educate people andgovernments at all levels, everyone can understand their responsibilities together to jointly protect the environment. This source of funding will collecta valuable amount to contribute to improve the water quality for Bac Ninh annually.

3.2. The causes affecting the willingness of people to pay in order to improve water quality

Binary logit regression is used in this study to estimate the effects of different explanatory variables on the decisions the HHs make to pay for improved water quality.

The chi-square result with a high significance (P = 0.000) shows that the model has strong explanatory power.

Trade-offs of HH between economic growth and environmental quality, using tap water, income of HH, and types of HH are significant statistic variables with positive coefficients. These coefficients indicate that high income and HHs using tap water are more likely to say "yes" to the given bid. Similar to research from Quy Van Khuc (2013), making use of water sources like natural sources would allow the HH to reduce the probability to pay for improved water quality. The positive coefficient of HH income confirms microeconomic theory (e.g. Dale *et al.*, 1990; Bateman *et al.*, 2002)that WTP depends on the ability to pay more.

The village and bid variables have negative coefficients and high statistical significance. The negative coefficient of village, as found in the results from the study of Nasreen *et al.* (2014), shows that HHs living in high risk zones tend to respond "yes". In these cases, HHs that are closer to two contaminated rivers would be more likely to support the project to improve the water quality of the rivers near their homes. As expected, the parameter of bid was negative and significant at the 1% significance level. This

result is similar to the conclusions of Jin *et al.* (2016) and Nasreen *et al.* (2014). This finding indicates that the respondents were less inclined to say "yes" to the WTP question if they were presented with a higher bid amount. This result also confirms the willingness to pay completely followed the rules of economic theory.

4. CONCLUSIONS

Currently the province of Bac Ninh has 62 handicraft villages, approximately 5 times as high as the national average number of handicraft villages. Bac Ninh is the smallest province in Vietnam, but it has the highest density of handicraft villages. The problem of water pollution in the handicraft villages in Bac Ninh province in recent years has been worrisome. The results of analyses of waste water samples, surface water and ground water in the villages showed that the levels of BOD5, COD, TSS, ammonia, and coliform exceeded permissible standards many times, even hundreds of times in some places. Many measures, like the construction of local biogas and periodical environmental cleaning, do not bring high efficiency.

Table 3. Description of the variables in the model

Variables	Description	Note
WTP	Willingness of HHto pay	Yes= 1 No = 0
Age	Age of HH head	Continuing variable
Edu	Education level	Primary School = 1 High School = 2 College = 3 Bs or Master = 4
HH size	Number of HH member	Continuing variable
Distance	Distance from HH to polluted watersource	Continuing variable
HH trade-off	Trade-off between income and water quality improvement	Agree = 1 Disagree =0
Income	Household Income	< 10 M VND/per month= 1 From 10 – 20 M VND/per month = 2 From 21 – 30 M VND/per month = 3 From 31 – 40 M VND/per month = 4 From 41 – 50 M VND/per month = 5 >51 M VND/per month = 6
Village	Location (Distance from villages from Cau river and NguHuyenKhe river)	KhacNiem (very far) = 1 Yen Phu (far) = 2 Dai Bai (nomal)= 3 Da Hoi (near) = 4 PhongKhe (very near) = 5
Water source	Water source for HH use	Using tap water =1 Not using tap water = 0
HH type	Types of HH	Handicraft HH = 1 Non-handicraft HH = 0
bid	bid that respondents picked up	Continuing variable

Table 4. Factors affecting respondent's WTP

Independent variables	Coefficient	Standard error of Coefficient
Age	0.00001	0.008
Edu (Education)	0.086	-0.11
HHsize (Household size)	-0.046	-0.058
HH trade- off (trade – off between economic development with environment quality)	0.335**	-0.191
Income	0.644 ***	-0.109
Water sources	2.615***	-0.369
HH type (Handicraft HH or Not)	0.613***	-0.19
bid	-0.005***	0
Village	-1.087***	-0.133
Constant	3.582***	-0.657
N	997	
-2 Log likehood	957.562	
P seudo R2	0.397	
LR Chi2	339.587	
Prob>chi2	0	

*Note: *significant at 10%; **significant at 5%; ***significant at 1%.*

Research on the willingness of people in the village of Bac Ninh to pay was performed in over 1,000 HHs. The results of the study have shown that people here are aware that environmental pollution has worsened. Ninety-six percent of interviewees said that environmental pollution has affected the health of their families' members. In addition, environmental pollution also adversely affects operational activities such as production, consumption, and economics. Nearly all, 96.8%, of the locals agree that environmental pollution in the country is the most serious problem. The vast majority of people did not, however, agree with a trade-off between economic growth and environmental quality. On average, about 64.5% of households are willing to pay to improve the quality of the water environment. The level of willingness to pay is 485,273 VND per household per year. The total potential funding to protect the water environment that could be obtained from the Bac Ninh people willing to make an annual contributionis estimated to be about 155.4 billion VND per year (6.9 million USD)

The level of willingness to pay depends on factors such as income, residence localities, HH size,water sourcethe HH is using, and the point of view of the respondents on trade-offs between economic growth and environmental quality. These households have higher income levels and higher awareness, and households closer to two contaminated rivers are willing to pay more for water environmental quality improvement and protection. Contrary to predictions, the rate of handicraft households willing to pay was less than in agricultural households. As expected, the coefficient of bid is negative and strongly significant.

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