Willingness to pay for improved drinking water in southwest coastal Bangladesh

Maliva Islam, Md. Ali Akber and Md. Atikul Islam

ABSTRACT

Households in the rural areas of southwest coastal Bangladesh mainly depend on unreliable sources of drinking water. This study assessed the willingness to pay (WTP) for improved drinking water in a rural area of the southwest coastal Bangladesh, using contingent valuation survey data of 215 households. The samples for the face-to-face interview were selected by purposive random sampling from Chila union of Mongla sub-district under Bagerhat district. The mean WTP for improved drinking water was estimated to be BDT 193 (US$ 2.47) per month (3% of the monthly income of the households). Results also indicate that educated respondents and households with higher income are willing to pay more for improved water supply. Moreover, the expenditure of the households for buying water and for medicine for waterborne diseases has a significant positive impact on the WTP. The results of this study can be useful for decision-makers to promote improved drinking water supply in southwest coastal Bangladesh.

Key words | coastal Bangladesh, contingent valuation method, improved drinking water, willingness to pay

Maliva Islam
Md. Ali Akber (corresponding author)
Md. Atikul Islam
Environmental Science Discipline,
Khulna University,
Khulna 9208,
Bangladesh
E-mail: *shamim.05es@gmail.com*; *makber@es.ku.ac.bd*

INTRODUCTION

The developing regions of the world often experience a low rate of access to improved drinking water (Van Houtven *et al.* 2017). In 2015, about 663 million people worldwide had lack of access to improved drinking water sources (WHO/UNICEF 2015). Lack of access to safe drinking water is designated as the heart of the poverty trap, because of the associated disease burden (Kaliba *et al.* 2003). Ensuring universal and equitable access to safe and affordable drinking water is therefore one of the commitments of the Sustainable Development Goals (United Nations 2014). It is of immense importance to understand and measure household demand for access to safe drinking water in the developing world (Van Houtven *et al.* 2017).

Southwest coastal Bangladesh is an area with an acute scarcity of safe drinking water (Islam *et al.* 2015; Kabir *et al.* 2016). This scarcity could be attributable to various reasons including unavailability of fresh water aquifers at suitable depths, increasing salinization of freshwater ponds, arsenic contamination in ground water (Hossain 2006), and microbial contamination of natural sources of drinking water (Karim 2010; Islam *et al.* 2011). Given the magnitude of the problem, a variety of water supply options have emerged so far, such as the rainwater harvesting system, piped water supply, aquifer storage and recovery (ASR) and the desalination plant (Kabir *et al.* 2016; Islam *et al.* 2017). However, only a few areas make use of these improved water supply options because of limitations of resources of the Government.

In the southwest coastal area of Bangladesh, people mainly use rain-fed pond water and rainwater harvesting system as the sources of drinking water (Karim 2010; Islam *et al.* 2015). Rainwater harvesting systems often contain small size storage tanks, which is not enough to supply drinking water throughout the year. Households in these

doi: 10.2166/ws.2018.047

areas can drink harvested rainwater for only about 4 months (the monsoon season – July to October) of the year (Islam et al. 2013). The scarcity of drinking water reaches its peak in the dry season. As a result, for the remaining 8 months of the year, the majority of the households need to depend on rain-fed pond water for drinking purposes, which is often microbially unsafe (Frisbie et al. 2002; Islam et al. 2011). Moreover, collection of rain-fed pond water from distant sources requires considerable time and effort (Islam et al. 2013). Therefore, households also buy drinking water from local vendors who supply drinking water. Several studies conducted in rural Bangladesh demonstrated the implicit need for determining the economic value of an improved drinking water supply (Ahmad et al. 2005; Akter 2008; Khan et al. 2014; Aziz et al. 2015); however, those have mainly focused on the willingness to pay (WTP) for arsenic contaminated water. Therefore, there is little information on understanding the economic value of an improved drinking water supply in the southwest coastal area of Bangladesh. Determining the economic value of improved drinking water is fundamental to ensure reliable drinking water sources in rural coastal areas of the country.

An economic valuation of a drinking water supply requires assessment of users' WTP for the service. The contingent valuation method (CVM) is widely used in this kind of valuation, where WTP is measured through a questionnaire survey (Whittington et al. 1990; Ahmad et al. 2005; Akter 2008; Khan et al. 2014). WTP of water users depends on diverse socio-economic factors and personal choice (Van Houtven et al. 2017). Households in Fuzhou, China, were found to be willing to pay an additional 10% from the current water tariff they were paying (Jiang et al. 2011). A similar finding was obtained in a district in Southern Ethiopia, where the amount of WTP was 1.5 times higher than the current water charges (Behailu et al. 2012). Cho et al. (2005) found that rural residents in Minnesota were willing to pay to improve their drinking water quality by reducing the iron and sulfate concentration in the water. Household income could be one of the most significant determinants of WTP (Wang et al. 2010; Sarker & Alam 2013). Age, educational status, household size, water taste and color, and uninterrupted water supply also influence WTP (Haq et al. 2007; Ifabiyi 2011; Beaumais et al. 2014). Jalan et al. (2009) conducted a study in urban India to address whether increasing awareness about the adverse health effects of environmental pollution would increase demand for improved water, and found that awareness such as schooling and exposure to mass media had statistically significant effects on the WTP. Venkatachalam (2015) found in Chennai city in India that poor people incur a sizeable expenditure on purchasing water from informal markets, and some of the households were also willing to pay additional amounts for an improved water supply from public sources. A meta-analysis conducted by Van Houtven et al. (2017) estimated WTP of households may vary between approximately US$3 and $30 per month for improvements in water access.

Previous studies conducted in Bangladesh in assessing WTP for improved drinking water services (Chowdhury 1999; Ahmad et al. 2005; Akter 2008; Sarker & Alam 2013; Khan et al. 2014; Aziz et al. 2015) also used CVM. The study of Ahmad et al. (2005) revealed that rural households in an arsenic affected area could spend about BDT (Bangladeshi taka) 9 per month, which is about 0.2% of their income. A study conducted by Akter (2008) in rural areas of Bangladesh estimated WTP of US$ 9 per year for arsenic free drinking water, which was less than one percent of the average annual household income. Another study conducted by Sarker & Alam (2013) found the WTP for improved water supply in Rajshahi city (a divisional headquarters in Bangladesh) depends upon household income, education and type of housing. A study conducted by Gunatilake & Tachiri (2014) found that the high cost for connection of a piped water supply in Khulna city is the main obstacle in expanding water supply coverage for the poor.

This paper is intended to address the WTP of the rural households in southwest coastal Bangladesh for improved drinking water. The value of improved drinking water service in the rural area is expected to be influenced by their risk perceptions and the severity of health risks associated with consuming contaminated water. Therefore, the objectives of the study were: (i) to estimate the household's WTP towards an improved drinking water supply; and (ii) to determine the socio-economic factors influencing it. The research results can help decision-makers understand the local population's demand for improved drinking water and undertake an environmental cost–benefit analysis.

METHODS

The theoretical model of this study is based on CVM, which determines the individual WTP with hypothetical scenarios, as presented in previous studies (Ahmad *et al.* 2005; Akter 2008; Khan *et al.* 2014). In this approach, a hypothetical market for improved drinking water is proposed to the respondents and their response to a suggested price for the service is determined through bidding. A household will accept to pay for an improved drinking water supply if, and only if:

$$v^1(q^1,\ I-M,\ A,\ S,\ e_1) > v^0(q^0,\ I,\ A,\ S,\ e_0) \quad (1)$$

where, q^0 is the existing water sources, q^1 is the proposed improved drinking water source, I is the average monthly income of the household, A is the awareness of the respondent regarding the health risks of drinking contaminated water, S is the other socio-economic characteristics of the respondent/household, M is the monthly charge agreed by that household for the improved drinking water, and e_0 and e_1 are the error terms (normally distributed with mean zero and variance 1).

WTP for an improved water service is the amount of payment that compensates the utility loss of the customer due to reduction in income by the improvement in water service (Akter 2008). Consequently, WTP for water from an improved drinking water source implies to M amount of payment by the customer, which satisfies the following equation:

$$v^0(q^0,\ I,\ A,\ S,\ e_0)\ = v^1(q^1,\ I-M,\ A,\ S,\ e_1) \quad (2)$$

WTP of a respondent for the source of improved drinking water may depend upon a number of factors that affect the decision on how much a respondent would be willing to pay. These can be expressed in a multiple-regression equation. Regression can demonstrate strong evidence for the validity of a contingent valuation survey if the coefficients of the explanatory variables have theoretically expected signs and statistically significant values (Mitchell & Carson 1989). For this study, the independent variables and their expected influences on WTP were decided based on judgment, and verified with local experts during the reconnaissance survey. In a contingent valuation study, the bid function is basically a regression equation that relates WTP with the explanatory independent variables. Therefore, WTP calculated from the survey was regressed on the influencing independent variables by the Ordinary Least Square (OLS) model to reveal the mean WTP and identify factors that significantly explain the WTP. Mathematically, the OLS model can be written as:

$$WTP = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \ \ldots\ + \varepsilon_i \quad (3)$$

where, the β's refer to the corresponding vectors of the estimated coefficient; X's represent the independent variables; ε_i is a random error term, assumed to be normally distributed with zero mean and variance σ^2.

Table 1 presents the definitions of the independent variables used in the regression model. The household heads, who are relatively older and are used to the unimproved free sources of water (e.g. pond water), may be less willing to switch to a new source, especially when the switch entails user fees. A similar finding is obtained in relevant literatures (Polyzou *et al.* 2011; Vásquez & Espaillat 2016). In contrast, the younger generations are more willing to contribute money for a new improved drinking water supply. However, WTP may also have a positive relation with the age of the

Table 1 | Variable definition of the selected independent variables

Variable name	Variable definition	Expected sign	Unit of measurement
AGE	Age of the respondent	±	Year
HHSIZE	Household size	+	Number of
EDUCATION	Level of education of the respondent	+	Years of schooling
INCOME	Monthly income of a household	+	BDT[a]
DWEXP	Monthly expenditure for purchasing drinking water	+	BDT
MEDEXP	Monthly expenditure for medicine related to waterborne disease	+	BDT

Note: Expected sign of coefficient shows the relationship with willingness to pay.
[a]BDT, Bangladeshi taka.

household head (Marques *et al.* 2016). Therefore, the age of the household head could be an important factor. A household with many members could be likely to pay more for the improved water source, since the demand for water increases with family members (Vásquez & Espaillat 2016). A study conducted by Khan *et al.* (2014) regarding WTP for arsenic-free water in Bangladesh revealed that WTP could increase with the amount of water use. Education may have a positive impact on the WTP, as educated household heads are generally more conscious of the health effects of drinking unsafe water (Polyzou *et al.* 2011; Khan *et al.* 2014; Vásquez & Espaillat 2016; Jianjun *et al.* 2016). Besides, the income of household is expected to be positively related with WTP, as higher income would give the capacity to spend more money for improved drinking water (Polyzou *et al.* 2011; Khan *et al.* 2014; Jianjun *et al.* 2016; Marques *et al.* 2016; Vásquez & Espaillat 2016). Drinking water purchasing cost would also have a positive impact on WTP, because WTP for improved drinking water would be higher for a respondent who spent a higher amount on buying drinking water from other sources (Marques *et al.* 2016). It is assumed that households that experience frequent occurrence of waterborne diseases will incur more costs for medicine, which could motivate the respondent to spend more for an improved drinking water supply. A few other variables such as the distance from the pond from which the households bring water, the distance from any other source of drinking water, and the transportation cost for bringing water from distant sources, were included in the questionnaire. Typically, households have availability of pond water within a short distance, and alternative bigger ponds in distant areas are less commonly used. As a result these variables were not significant in household WTP, and were not included in the regression model.

The contingent valuation survey was conducted in Bagerhat district of southwest Bangladesh (Figure 1). It is one of the coastal districts of Bangladesh, and is severely

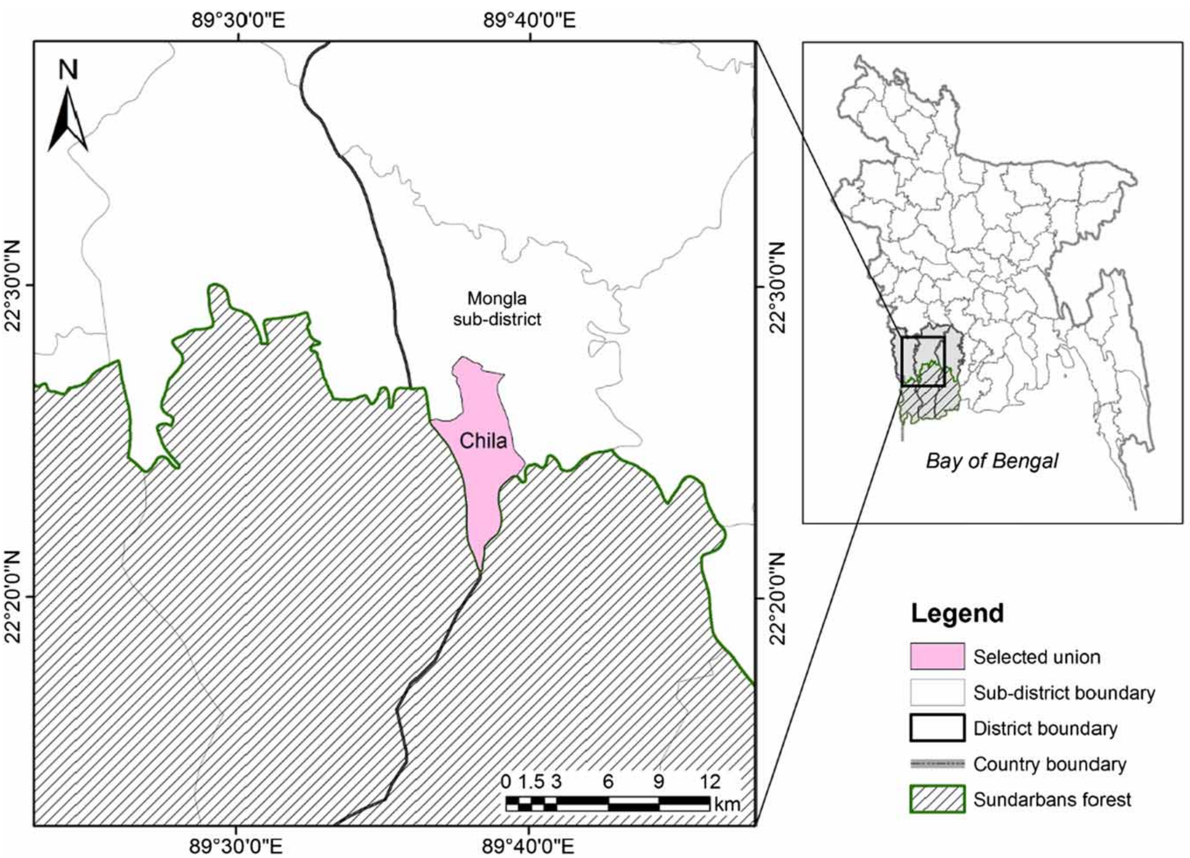

Figure 1 | Map of the study area.

affected by water salinity. The Chila union of Mongla subdistrict (upazila) under Bagerhat district was selected as the study site. The union has a population of about 19,000 residents and covers an area of 30.15 km^2. It was selected based on two characteristics: (i) the residents do not have improved drinking water sources within short distances (500 m) of their households year round; and (ii) households mainly depend on rain-fed pond water for about 8 months of the year, which is typical for the southwest coastal region of Bangladesh.

The most critical aspect of a CVM based study is the design of the survey instrument (questionnaire) to collect detailed information on the water consumption behavior and WTP of the sample households (Ahmad *et al.* 2005). To ensure a reasonable construction of the questionnaire, an expert survey was conducted in the study area and a draft questionnaire was prepared. Then a reconnaissance survey was conducted, and the draft questionnaire was pre-tested in three selected villages in the study area. During the reconnaissance survey, 12 households (four from each of the three villages) were interviewed to collect information regarding their drinking water sources, associated costs and their WTP toward an improved drinking water supply. The questionnaire was finalized after the reconnaissance survey.

Seven out of 14 villages of Chila union were randomly selected for the questionnaire survey. Before the final survey, 215 households were selected from the seven villages in the study area using a purposive random sampling method. The sample size is 10% of the total population of the seven selected villages. We only considered the households that did not have an improved drinking water supply within 500 m distance of their household.

Although female members of a household are mainly responsible for collection of drinking water for their family in the context of this study area, males are the earning members of a family and act as household head in most of the cases. Consequently, the decision on expenditure on water also depends upon the male members. Therefore, only the household heads were considered for face-to-face interview during the questionnaire survey, presuming that the household heads could appropriately answer the questions related to WTP. However, in a few cases we also found female household heads. For the household heads who fulfilled the selection criteria and were willing to be interviewed, their name, mobile number and address were noted down. The questionnaire survey was conducted in October 2015. The face-to-face interview with a structured questionnaire was administered by trained enumerators who were fluent in the local language. Interviews were done preferably at the household to allow the household head to verify any required information from other family members if necessary.

A contingent valuation study is highly susceptible to two types of bias: (i) strategic bias (when respondents have an incentive to understate or overstate the actual WTP) and (ii) starting point bias (when the initial price affects the individual's final WTP). Therefore, designing a questionnaire for contingent valuation requires special care about minimizing these possible biases (Briscoe *et al.* 1990). Hence, a scenario formulation was made with close-ended and bidding game format elicitation questions to minimize both strategic bias and starting point bias. The interviewee had been informed regarding the detail of the hypothetical establishment of an improved drinking water source and its benefits prior to the interview. Therefore, in the valuation section of the questionnaire, at first the characteristics of the existing water systems were described, then an improved water supply was presented, which would be improved in terms of quality and would provide an adequate quantity of water. The improved water supply system was proposed as a community based water supply to keep the similarity with the existing water supply technologies (e.g. piped water supply, ASR, community based rainwater harvesting system and desalination plant) promoted in this region. The households were asked to pay a certain fee per month for the improved drinking water supply. The referendum voting question used in the survey is the following:

> '*The current drinking water quality of Chila union is not good and the available pond water is not safe to drink. Suppose that an improved drinking water source will be established within 500 m of your house. The new source will be within your feasible distance so that it will save time, energy, transportation cost, expenditure on purchasing water, as well as you will be free from the expenditure for medicine as it will save you from danger of waterborne diseases. To get the improved drinking water service, you have to contribute a monthly fee. Be sure that the water*

supply would not be established in such an empty place of one's house yard that there will be a possibility of conflict between the owner of the house and other people. The type of water supply technology (e.g. piped water supply considering community points for water collection, desalination plant, ASR or community based rainwater harvesting system, etc.) will be decided later based on the suitability for the place. Remember that there will be no option to get the water without paying the monthly fee which is essential to operate and maintain the water source.'

[Are you willing to pay monthly for the improved water source?] __ Yes; __No

The close-ended question was expected to be effective in avoiding strategic bias, as it indicates the respondent's intention. A negative answer could be progressed to clarification for the negative stand of the respondent, whereas a positive answer gives scope to start the bidding game format questions. For this study, the starting amount of BDT 250 was decided for the bidding game on the value of improved drinking water.

For example: *[(a) if the committee decides the monthly payment as BDT 250, would you be willing to pay this amount to get an improved drinking water supply?]*

Yes__ Go to (b); No__ Go to (c); I do not know__ Go to (f)

The threshold amount of BDT 250 was decided from the findings of the reconnaissance survey. With the same referendum question, the household heads of the randomly selected 12 households during the reconnaissance survey were asked about their WTP a monthly subscription fee for the improved water. Their WTP ranged between BDT 150 to 350. Therefore, we chose the middle point (BDT 250) as the starting amount for the bidding.

If the respondent agreed the offer, then the amount was to be increased, e.g. BDT 300 for option (b), and if they disagreed, then the amount was to be decreased, e.g. BDT 200 for option (c). The bidding game continued until the respondent fixed a certain amount. Finally, the game ended with an open-ended question on maximum WTP (option (f)). The question was worded as follows:

[What is your maximum WTP per month to implement the project in your community?] Amount of money: BDT__; I do not know__

In case a respondent was still not willing to pay for the water supply, the WTP was recorded as zero, and they were asked about the causes of their unwillingness with an open-ended question.

The independent variables (Table 1) were estimated with the questionnaire survey. Respondents were asked about their main sources of income and other informal sources of income, and the respective amount earned per month for each of the categories was recorded. Besides, the monthly contribution of any other earning member of the family was also recorded. Finally, those were combined to determine the total monthly income of a household. Monthly expenditure of a household for purchasing drinking water was estimated by averaging the total expenditure for drinking water from various sources used for months of a year. Monthly expenditure of a household for medicine related to waterborne diseases was estimated by multiplying the frequency of the disease among the family members in a year and average cost of treatment per occurrence, and then calculating the per month cost from that.

RESULTS AND DISCUSSION

Sample characteristics

The socio-demographic characteristics of the respondents are presented in Table 2. The respondents were predominantly male (95%), as household heads are generally male in the study area. The age group of respondents ranged from 20–70 years, although the majority of the respondents (68%) were aged within 35–55 years. Only 2% of the respondents belong to a joint family, and most of the households (70%) contained five or fewer members in their family. About half of the respondents (51%) completed their primary education whereas 20% of the respondents were illiterate. Among all the occupations, about half of the

Table 2 | Respondent's socio-demographic characteristics ($n = 215$)

Socio-demographic factors	Percentage (%)
Gender	
Male	95
Female	5
Age distribution	
<35 years	21
35–55 years	68
>55 years	11
Type of family	
Single family	98
Joint family	2
Number of family members	
5 or <5 persons	70
>5 persons	30
Educational status	
Illiterate (<5 years of schooling)	20
Primary education (5 years of schooling)	51
Secondary education (10 years of schooling)	23
Higher secondary education (12 years of schooling)	5
University degree	1
Occupation	
Fisherman	27
Businessman	24
Owner of fish farm	11
Day labor	14
Shopkeeper	12
Others	12
Household income per month (BDT[a])	
<3,500	12
3,501–5,500	38
5,501–7,500	24
7,501–10,000	18
10,001–15,000	8

[a]BDT, Bangladeshi taka; US$ 1 = BDT 78 (as of October 16, 2015).

population (51%) was involved in fishing and fishery related businesses. Nearly 38% of the people had a monthly income within BDT 3500–5500, whereas only 8% respondents had monthly income >BDT10000–15000. The socio-economic features of the samples indicate that the study area holds a typical rural community of coastal Bangladesh.

Estimation of WTP

Out of the 215 samples, three of the respondents were not willing to pay for the establishment of improved drinking water source, and other three respondents were willing to pay more than BDT 500. These six cases were excluded from the data to estimate the mean WTP. Nearly half of the respondents were willing to pay BDT 100–200 and a quarter of the respondents had WTP less than BDT 100 per month, because this group had a lower income (Table 3). Only 3% of the respondents were willing to pay more than BDT 300. Mean WTP was BDT 193 (US$ 2.47) per month, which was about 3% of their average monthly household income. Although the coastal people face acute scarcity of safe drinking water, their low income level limits the WTP for improved drinking water. The bidding-game question format also worked better than the direct, open-ended questions, and was easily applicable.

Pond water is the major source of drinking water in the study area. Shortage of pond water in the pre-monsoon season (March–June) is also common, when the scarcity of drinking water reach the peak level. Pond water is not safe and often gets polluted with runoff water, especially during monsoon season (July–October). Harvested rainwater could be an important source of drinking water in the monsoon season. However, the majority of the households do not have the capacity to store harvested rainwater to use it throughout the year. The respondents who were not willing to pay for an improved drinking water service expressed their interest in improving storage of rainwater harvesting system instead of paying for the proposed improved drinking water supply. On the other hand, the respondents who were willing to pay more than BDT 300 had a higher income level than others.

Table 3 | Estimation of WTP for improved drinking water ($n = 209$)

WTP (in BDT[a])	Frequency	Percentage (%)
<100	50	24
101–200	94	45
201–300	59	28
301–<500	6	3

[a]BDT, Bangladeshi taka; US$ 1 = BDT 78 (as of 16 October, 2015).

The WTP of the households was low, considering their monthly expenditure on buying drinking water. Average monthly expenditure of the households for purchasing drinking water was BDT 689, which was about 11% of their average income. Typically, local people buy water during the time of shortage of water, especially in pre-monsoon season, which implies that they are bound to spend a higher amount because of excessive shortage. However, this also does not mean that the WTP would be higher than the estimate. Previous studies (Ahmad *et al.* 2005; Akter 2008; Khan *et al.* 2014) conducted in Bangladesh also found that WTP towards improved drinking water supply was much less compared to household income. This could be anecdotally related to the lack of awareness of the respondents regarding the health risks of drinking contaminated water. Besides, people living in this area mainly depend on buying water during the pre-monsoon season, when there is an excessive shortage of pond water and less opportunity for using harvested rainwater. Consequently, there is a higher possibility that this situation demotivates respondents about paying for the water service every month throughout the year.

Determinants of WTP

This section presents the relationship between a household's WTP for an improved drinking water service and selected independent variables. To ensure that the regression model does not have the multicollinearity problem, the variance inflation factor (VIF) was calculated following Chatterjee & Hadi (2006). The influence of selected independent variables on households' WTP for a safe water supply is presented in Table 4. According to Mitchell & Carson (1989), the simplest way to test the reliability of the amount of WTP is to obtain an acceptable R^2 value or goodness-of-fit value ($R^2 > 0.15$). Here the value of $R^2 = 0.34$ is reasonably good, and it means 34% of the total WTP can be explained by the explanatory variables, and the remaining values fall under error term. Therefore, the contingent valuation estimates of the present study can be considered reliable.

The result of the regression analysis (Table 4) shows that all the variables included in the model came out with the expected signs. The coefficients of the variables INCOME (household income) and DWEXP (monthly expenditure for drinking water) were statistically significant at 1% significance level. The coefficient of variable MEDEXP (monthly expenditure on medicine for waterborne diseases) was statistically significant at 5% significance level, and that of the variable EDUCATION (educational qualification of the respondent) was statistically significant at 10% significance level. Since the household income and expenditure on buying water was highly significant and positively influenced the WTP, it seems highly dependent on the economic condition of the household. This finding is in line with previous studies (Chowdhury 1999; Ifabiyi 2011; Polyzou *et al.* 2011; Sarker & Alam 2013; Khan *et al.* 2014; Vásquez & Espaillat 2016). Expenditure for medicine was found to be significantly positive with WTP, which indicates that the respondents who spend more on waterborne diseases are likely to pay more for improved drinking water. Education was found to positively influence the WTP, which could be anecdotally related to the influence of education on awareness of the respondents. Similar findings are also obtained in previous studies (Cho *et al.* 2005; Haq *et al.* 2007; Ifabiyi 2011; Polyzou *et al.* 2011; Sarker & Alam 2013; Khan *et al.* 2014; Vásquez & Espaillat 2016). Improving awareness about safe drinking water among the rural population in coastal areas of southwest Bangladesh is very essential for health safety (Islam *et al.* 2015), and is expected to increase WTP for improved drinking water supply. Therefore, emphasis on awareness building activity regarding the benefits of using improved drinking water is necessary in this area. The value of the constant was significant at 1% level of significance. AGE and HHSIZE (number of family

Table 4 | Estimates of the OLS regression model for the determinants of WTP

Independent variables	Coefficient	Standard error	t-statistic	$P > \|t\|$
AGE	−0.458	0.485	−0.95	0.346
HHSIZE	1.748	3.849	0.45	0.65
EDUCATION	10.167	5.501	1.85	0.066*
INCOME	0.007	0.002	2.85	0.005***
DWEXP	0.076	0.020	3.74	0.000***
MEDEXP	0.056	0.027	2.05	0.041**
Constant	75.845	25.526	2.97	0.003***

Note: Number of observation = 209; $R^2 = 0.34$, Adj. $R^2 = 0.32$; *significant at $p \leq 0.1$, **significant at $p \leq 0.05$, ***significant at $p \leq 0.01$.

members in the household) were not statistically significant, although they were correlated with WTP.

CONCLUSIONS

Scarcity of safe drinking water is an acute problem in southwest coastal Bangladesh, and is a major development concern because of its impacts on the health and livelihood of people. Averting measures adopted by the households imposes considerable costs, and cannot ensure a reliable source of drinking water. This study examined the WTP for an improved drinking water supply in rural areas of southwest coastal Bangladesh. Using a CVM, this study revealed that there is a demand for improved drinking water. Estimated mean WTP of BDT 193 (US$ 2.47) per household per month is about 3% of household income. The WTP increases with a household's monthly income, expenditure on buying drinking water and medicine for waterborne disease, and the respondent's level of education. Awareness raising activity on the benefits of safe drinking water could increase WTP for an improved drinking water supply, along with health benefits.

The WTP estimate was considerably lower than the average expenditure of households on buying drinking water. Typically, local people buy water during the time of shortage of water, especially in pre-monsoon season, which implies that they are bound to spend a higher amount because of the excessive shortage of drinking water. Although the WTP estimate was reasonable, the results of this study were derived from a relatively small sample size and cover only one union in the study area. Moreover, the study was based on a hypothetical improved drinking water service. A validity study is eventually essential to assess if the hypothetical WTP differs from the actual WTP for the improved drinking water service. Consequently, there is a need to examine the WTP in broader aspects and to apply alternative methods in future study. However, this study gives a better understanding of the demand for improved drinking water in the rural coastal community of southwest Bangladesh and is expected to help policy-makers to adopt more efficient strategies for improved drinking water supply in this area.

ACKNOWLEDGEMENTS

We express sincere gratitude to the respondents and relevant professionals who extended their cooperation during data collection.

REFERENCES

Ahmad, J., Goldar, B. & Misra, S. 2005 Value of arsenic-free drinking water to rural households in Bangladesh. *Journal of Environmental Management* **74** (2), 173–185.

Akter, S. 2008 Determinants of willingness to pay for safe drinking water: a case study in Bangladesh. *Asian Journal of Water, Environment and Pollution* **5** (3), 85–91.

Aziz, S. N., Boyle, K. J. & Crocker, T. 2015 Parental decisions, child health and valuation of avoiding arsenic in drinking water in rural Bangladesh. *Journal of Water and Health* **13** (1), 152–167.

Beaumais, O., Briand, A., Millock, K. & Nauges, C. 2014 *What are Households Willing to Pay for Better Tap Water Quality? A Cross-Country Valuation Study (March 12, 2014)*. FEEM Working Paper No. 24.2014.

Behailu, S., Kume, A. & Desalegn, B. 2012 Household's willingness to pay for improved water service: a case study in Shebedino District, Southern Ethiopia. *Water and Environment Journal* **26** (3), 429–434.

Briscoe, J., de Castro, P. F., Griffin, C., North, J. & Olsen, O. 1990 Toward equitable and sustainable rural water supplies: a contingent valuation study in Brazil. *The World Bank Economic Review* **4** (2), 115–134.

Chatterjee, S. & Hadi, A. S. 2006 Simple linear regression. *Regression Analysis by Example,* 4th edn. John Wiley & Sons, Hoboken, NJ, USA, pp. 21–51.

Cho, Y., Easter, K. W., McCann, L. M. & Homans, F. 2005 Are rural residents willing to pay enough to improve drinking water quality? *JAWRA Journal of the American Water Resources Association* **41** (3), 729–740.

Chowdhury, N. T. 1999 Willingness to pay for water in Dhaka slums: A Contingent Valuation Study. In: *Environmental Economics in Bangladesh* (Q. K. Ahmad, A. Nishat, Q. I. Chowdhury, A. K. E. Haque & A. Rahman, eds). IUCN, Dhaka, Bangladesh, pp. 105–116.

Frisbie, S. H., Ortega, R., Maynard, D. M. & Sarkar, B. 2002 The concentrations of arsenic and other toxic elements in Bangladesh's drinking water. *Environmental Health Perspectives* **110** (11), 1147. http://www.jstor.org/stable/3455440.

Gunatilake, H. & Tachiri, M. 2014 Willingness to pay and inclusive tariff designs for improved water supply services in urban Bangladesh. *Journal of Sustainable Development* **7** (5), 212.

Haq, M., Mustafa, U. & Ahmad, I. 2007 Household's willingness to pay for safe drinking water: a case study of Abbottabad district. *The Pakistan Development Review* **46** (4), 1137–1153. http://www.jstor.org/stable/41261218.

Hossain, M. F. 2006 Arsenic contamination in Bangladesh – an overview. *Agriculture, Ecosystems & Environment* **113** (1), 1–16.

Ifabiyi, I. P. 2011 Willingness to pay for water at household level in Ilorin, Kwara State, Nigeria. *Global Journal of Human-Social Science Research* **11** (2), 15–24.

Islam, M. A., Sakakibara, H., Karim, M. R., Sekine, M. & Mahmud, Z. H. 2011 Bacteriological assessment of drinking water supply options in coastal areas of Bangladesh. *Journal of Water and Health* **9** (2), 415–428.

Islam, M. A., Sakakibara, H., Karim, M. R. & Sekine, M. 2013 Potable water scarcity: options and issues in the coastal areas of Bangladesh. *Journal of Water and Health* **11** (3), 532–542.

Islam, M. A., Azad, A. K., Akber, M. A., Rahman, M. & Sadhu, I. 2015 Effectiveness of solar disinfection (SODIS) in rural coastal Bangladesh. *Journal of Water and Health* **13** (4), 1113–1122.

Islam, M. A., Akber, M. A. & Ghosh, P. K. 2017 Water quality of small-scale desalination plants in southwest coastal Bangladesh. *Water Science and Technology: Water Supply*.

Jalan, J., Somanathan, E. & Chaudhuri, S. 2009 Awareness and the demand for environmental quality: survey evidence on drinking water in urban India. *Environment and Development Economics* **14** (6), 665–692.

Jiang, Y., Jin, L. & Lin, T. 2011 Higher water tariffs for less river pollution – evidence from the Min River and Fuzhou City in China. *China Economic Review* **22** (2), 183–195.

Jianjun, J., Wenyu, W., Ying, F. & Xiaomin, W. 2016 Measuring the willingness to pay for drinking water quality improvements: results of a contingent valuation survey in Songzi, China. *Journal of Water and Health* **14** (3), 504–512.

Kabir, M. P., Islam, M. A., Akber, M. A. & Ahsan, M. S. 2016 Bacteriological assessment of aquifer storage and recovery (ASR) water in southwest coastal Bangladesh. *Journal of Water Sanitation and Hygiene for Development* **6** (2), 231–241.

Kaliba, A. R., Norman, D. W. & Chang, Y. M. 2003 Willingness to pay to improve domestic water supply in rural areas of Central Tanzania: implications for policy. *The International Journal of Sustainable Development & World Ecology* **10** (2), 119–132.

Karim, M. R. 2010 Assessment of rainwater harvesting for drinking water supply in Bangladesh. *Water Science and Technology: Water Supply* **10** (2), 243–249.

Khan, N. I., Brouwer, R. & Yang, H. 2014 Household's willingness to pay for arsenic safe drinking water in Bangladesh. *Journal of Environmental Management* **143**, 151–161.

Marques, R., Carvalho, P., Pires, J. & Fontainhas, A. 2016 Willingness to pay for the water supply service in Cape Verde–how far can it go? *Water Science and Technology: Water Supply* **16** (6), 1721–1734.

Mitchell, R. C. & Carson, R. T. 1989 *Using Surveys to Value Public Goods: the Contingent Valuation Method. Resources for the Future.* RFF Press, Washington, DC.

Polyzou, E., Jones, N., Evangelinos, K. I. & Halvadakis, C. P. 2011 Willingness to pay for drinking water quality improvement and the influence of social capital. *The Journal of Socio-Economics* **40** (1), 74–80.

Sarker, M. A. R. & Alam, K. 2013 Willingness to pay towards improved water supply service in Rajshahi City, Bangladesh. *Asian Journal of Water, Environment and Pollution* **10** (2), 41–49.

United Nations 2014 *Open Working Group Proposal for Sustainable Development Goals.* Tech. rep., United Nations, New York.

Van Houtven, G. L., Pattanayak, S. K., Usmani, F. & Yang, J. C. 2017 What are households willing to pay for improved water access? Results from a meta-analysis. *Ecological Economics* **136**, 126–135.

Vásquez, W. F. & Espaillat, R. 2016 Willingness to pay for reliable supplies of safe drinking water in Guatemala: a referendum contingent valuation study. *Urban Water Journal* **13** (3), 284–292.

Venkatachalam, L. 2015 Informal water markets and willingness to pay for water: a case study of the urban poor in Chennai City, India. *International Journal of Water Resources Development* **31** (1), 134145.

Wang, H., Xie, J. & Li, H. 2010 Water pricing with household surveys: a study of acceptability and willingness to pay in Chongqing, China. *China Economic Review* **21** (1), 136–149.

Whittington, D., Briscoe, J., Mu, X. & Barron, W. 1990 Estimating the willingness to pay for water services in developing countries: a case study of the use of contingent valuation surveys in southern Haiti. *Economic Development and Cultural Change* **38** (2), 293–311.

WHO/UNICEF 2015 *Progress on Sanitation and Drinking Water: 2015 Update and MDG Assessment*. WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation.

First received 25 August 2017; accepted in revised form 13 February 2018. Available online 23 February 2018