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Willingness to Pay for Improved Water Services in Rajshahi City, Bangladesh

Md Abdur Rashid Sarker[1]* and Khorshed Alam[2]
School of Accounting, Economics & Finance, Faculty of Business & Law
University of Southern Queensland, Toowoomba, QLD 4350, Australia
[1]Department of Economics, University of Rajshahi, Bangladesh
[2]Australian Centre for Sustainable Business & Development, University of Southern Queensland, Toowoomba, QLD 4350, Australia
✉ MdAbdurRashid.Sarker@usq.edu.au

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Abstract: This study uses contingent valuation (CV) method to elicit residential consumers' willingness to pay (WTP) for improved water supply services in Rajshahi city, Bangladesh. It identifies the factors affecting households' WTP through a multiple regression analysis. Accordingly, a sample of 150 households with piped water connection was chosen to be interviewed with the use of a face-to-face questioning technique. The results from this study show that households are willing to pay more for improved services which is important for the policy makers in devising appropriate water tariff. Among various indicators, households' income, education and type of housing have emerged as three most important factors in affecting consumers' WTP.

Key words: Contingent valuation, Rajshahi, water supply service, willingness to pay.

Introduction

Despite gradual increase in the provision of potable drinking water services, its safe and reliable supply remains a serious concern in many developing countries (Vásquez et al., 2009). About 1.2 billion people in developing countries still lack access to potable drinking water (UNDP, 2006). Bangladesh is not an exception in this regard. Urban water supply systems throughout the country are facing acute water supply and quality problems due to population growth, shortage of power, decreasing groundwater supply, increasing water treatment costs and so on (BBS, 2005). Moreover, existing systems are poorly maintained and extension of the service is rarely seen largely because of the financial constraints. To overcome these problems, it is very important to devise new financial arrangements and to meet not only the current and future demands but also to maintain the quality of services. Since the prime source of revenue generation is domestic water consumers, preferences of water users should receive special attention to understand whether they are willing to pay more to financially support the system as well as for improving the quality of services.

Urban water utilities in Bangladesh are facing a massive challenge in providing safe water supply services to the rapidly growing population in the cities. Millions of residents still lack access to adequate potable water supplies. Local government authorities are finding it hard to appropriately manage water resources owing to insufficient financial and technical resources. Water demand is growing in tandem with population growth and increase in economic activities. Supply constraints are also increasing due to power shortages and falling water tables. Most of the existing water supply services, thus, are not capable of meeting requirements from the city

*Corresponding Author

dwellers. It is estimated that in the urban areas, about 45 per cent of the population have access to reasonable safe water; however, remaining 55 per cent are to depend on contaminated traditional sources such as ponds, canals, ditches and dug-wells.

Water shortages result from the fact that water demand exceeds water supply. The situation is being exacerbated because of the inability of the water authority to provide regular operation and maintenance (O&M) services of the water supply systems (e.g. pipes, pumps and treatment plants). As a response to the current water deficits, an increase in the supply of potable water is essential. However, water supply authorities are largely dependent on central government's grants and subsidies. Therefore, cost recovery is being promoted as an option to generate fund for capital investments and/or O&M costs. International financial institutions such as the World Bank and Asian Development Bank are attaching a stint of conditions for water sector financing in that O&M costs should be self-financed through appropriate tariff system (ADB, 1999).

Water pricing is seen as a key step towards the implementation of an efficient tariff system. However, no explicit markets exist for potable drinking water in most developing countries. The concept of contingent valuation method (CVM) has been extensively used both in developed and developing countries to estimate the non-market benefits for water-related issues including safe water supply and water quality improvements. CVM is employed to elicit people's preference, expressed in terms of Willingness to Pay (WTP) or Willingness to Accept (WTA). Despite an array of validity and measurement issues and associated biases (Whittington, 2002; Carson et al., 2001), its application is growing in developing countries in a variety of settings. The concept of WTP has been used in developing countries to generate residential water users' WTP for higher water bills to ensure reliable and/or continuous flow of water (Genius and Tsagarakis, 2006). Most studies aimed to estimate participants' WTP for water and identify factors which can influence their WTP. However, policy-makers need to take into account the fact that these determinants are site-specific in nature (Venkatachalam, 2008). Therefore, country or site specific studies are required to assess the probability of WTP for more water or to identify the influence of key factors on the WTP.

The main objective of the study is to determine how much money households are willing to pay for an improvement in their water quality and quantity. This research uses a case study of Rajshahi city in Bangladesh. Current provision of tap water in Rajshahi is generally unreliable and often not safe for drinking purposes due to groundwater contamination. Seventy three per cent of the city area is covered by the supply network; however, none of its connections are metered and the network is able to supply water for an average of 7-8 hours per day in its service area. Residents generally treat water at home as well as purchase bottled water for drinking purposes. This study is therefore critical for producing quantitative economic information on domestic water uses and value that policy-makers may find useful in revising and implementing water tariff which is important for financial sustainability of the system and sustainability of the resource itself (i.e. environmental sustainability).

A Brief Overview of the Literature

There have been some reported studies on the WTP for water in a number of developing countries. Venkatachalam (2008) identified the determinants of household behaviour in relation to improved water supply services in a peri-urban context in Tamil Nadu, India. Consumers' belief in the management system and affordability towards increased water rates were appeared to be important determining factors in WTP. Haq et al. (2007) estimated the WTP and identified factors that might influence the WTP for improved services level and water quality improvements in Abbottabad, Pakistan. Their study found that household income had an insignificant effect on the WTP, however education level was found to have a direct bearing on the WTP for safe drinking water.

In a similar study, Raje et al. (2002) estimated residents' WTP more for water supply services and identified the factors affecting their WTP in Mumbai, one of the metro cities in India. The study revealed that in slums/chawls, on an average, residents were willing to pay 51 per cent more than what they were paying, while this increase was of the order of 36 per cent among people living in flats/bungalows. Households' WTP for safe and reliable drinking water has been investigated both in urban (Vasquez et al., 2009, Haq et al., 2007) and rural settings (Ahmad et al., 2005) in developing countries. These studies demonstrated that consumers were willing to spend extra amount over and above their current water bills to avert risks related to the quality and reliability of the existing water supply systems (Vasquez et al., 2009; Haq et al., 2007; Raje et al., 2002).

There have been very limited studies on the application of the CVM in Bangladesh. Using a CVM, Chowdhury (1999) estimated Dhaka slum-dwellers WTP for safe drinking water and found that slum-dwellers were willing to pay enough for water supply to cover costs of services, suggesting that higher water charges would be financially viable to generate funds for water system investment. Ahmad et al. (2005) estimated the economic value of arsenic-free drinking water in rural Bangladesh. Using a CVM approach, they estimated arsenic-affected rural households' WTP for piped water being more than 10 per cent of the capital costs and the whole O&M costs of piped water supply projects. In a similar study, Akter (2008) applied CVM to estimate the economic value of safe drinking water in highly arsenic-affected Bangladesh rural communities. The study estimated an average WTP of US$9 per year for safe drinking water. Stated WTP amounts were found to vary significantly with respondents' level of mass media exposure, standards of living (measured through the usages of latrine as a proxy), respondents' age, number of children in each household, levels of education and distance of arsenic-free drinking water sources. Alam (2008) used the CVM to elicit WTP values for the restoration of the Buriganga River in Bangladesh including its water quality improvements. Residents' mean WTP elicited in the form of money and time for such restoration were found to be Tk 51.91 and Tk 62.04 per month respectively. WTP estimates used within a cost-benefit approach demonstrated positive net social benefits of river restoration.

Studies show that increasing water tariff for improved services is economically feasible when the financially disadvantaged consumers are subsidized adequately. However, there have been limited studies regarding cost recovery of water supply in Bangladesh (Islam, 2001; Biswas and Adank, 2004). Islam (2001) analyzed the cost recovery from the perspective of private sector participation in billing and collection of water supply for Dhaka city, Bangladesh. He identified certain supply side factors to be responsible for poor cost recovery; however detailed analyses of these factors were not done. Moreover, whole demand side analyses remained absent in this research. Biswas and Adank (2004) explored the cost recovery and financing of water supply under the framework of National Water Policy. Issues of WTP for water service were not addressed in these studies. Hence there is an absence of academic study on the WTP for water services in Bangladesh. This study will, therefore, enrich the existing literatures, at least in the Bangladesh context.

Study Design

Study Site

Rajshahi city, one of the six divisional cities in Bangladesh, was selected as the study site for a few specific reasons. Firstly, the city is currently facing massive financial crisis in providing water services with government grants providing little aid in recovering service costs. Moreover, the current water supply system has limited coverage of the city's demand areas and supplies poor quality water to many areas. Typically, unaccounted for water, also referred to as non-revenue water, is found to be in the range between 15 and 30 per cent of total water production (Bridges, 1994); however, in Rajshahi, it stands at about 50 per cent. This higher water loss means greater revenue loss. Payment and water pricing have become problematic as well where the issue of current water tariff (water bill averages Tk 30 per month per connection) being too low to cover the O&M costs. This is exacerbated by a culture of non-payment and low willingness to pay in the first place. These issues are representative of both supply and demand problems of the water service management in Bangladesh.

Rajshahi City Corporation (RCC) (Figure 1), the local government authority responsible for bulk water supply in the city, is able to supply only about 50 per cent of the daily water requirement for the city's household consumption. There is a huge gap between daily water demand and supply indicating the deficiency of water resource in Rajshahi which can be seen in Table 1.

Table 1: State of water demand and supply (m^3/day)

Year	*Water demand*	*Water supply*	*Deficit*	*Supply as a percentage of demand*
1996	78,000	26,000	52,000	33.33
2002	103,000	47,000	56,000	45.63
2010 (projected)	160,000	130,000	30,000	81.25

Source: RCC, 2001.

It is clear from Table 1 that water demand is much higher than water supply. Only 33 per cent and 46 per cent of total demand had been met in 1996 and 2002 respectively. This means demand of large population remained unmet. This shows the vulnerable situation of the water supply services in RCC. Production per person in Rajshahi is only 0.14 (m^3/d/c) indicating a deficit of water resources, while in some Asian cities the average figure is 0.40. It is 0.22 even in Dhaka, the capital city of Bangladesh.

Power outages, voltage fluctuation and load shedding are regular phenomena which affect RCC's capacity to fulfill the water demands. Many shallow tube-wells in the city cannot function due to the falling water levels thought to be a manifestation of climate change. New

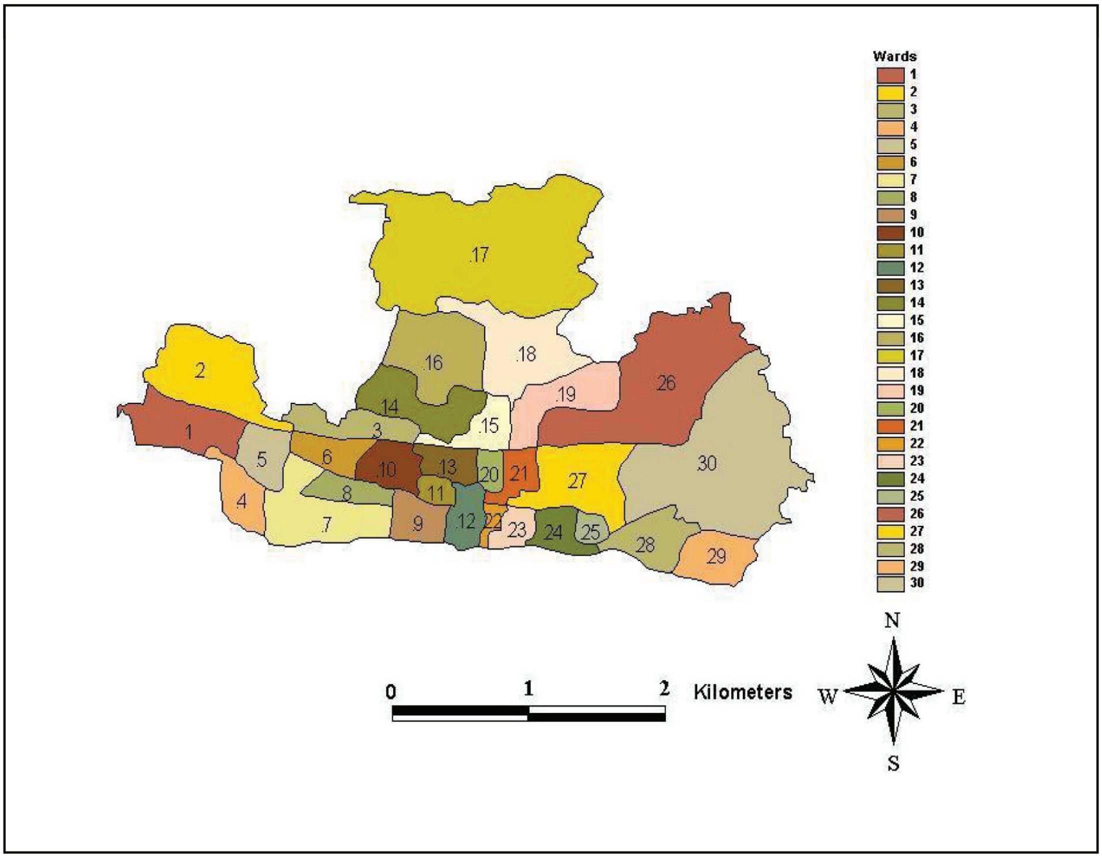

Figure 1: Map of Rajshahi City Corporation and the study area (Ward 15 and Ward 22).

pumps need to be installed and the old ones need to be repaired. The pipelines are old and damaged and need major replacement. However, the RCC is facing severe financial constraints in overcoming these obstacles to providing efficient water supply service.

RCC is unable to provide regular O&M service due to financial crisis. Moreover, the level of cost recovery is very poor at any rate. The percentage ranges from 10.89 to 15.28 over the period 1997-2002. After then, the rate got slightly increased which is near 30 per cent of the cost. On an average, the rate is almost 18 per cent during the period 1997-1998 to 2004-2005. This means a huge amount of cost remained un-recovered from year after year and it is almost 82 per cent of the cost. This might be because of the low water tariff as well as low collection rate.

Groundwater is an important source of domestic water in the RCC with approximately ninety per cent of the council's water being extracted from groundwater sources by tube wells (manual, shallow and deep tube wells). Ground water is supplied from 55 deep tube wells through pipe networks of 200 km reticulated over an area of 93.34 sq km. Provision of piped water has increased steadily since Bangladesh's independence in 1971, although only about one third of households are connected to the piped water supplies.

Groundwater pollution has become a critical problem for the RCC in providing quality water services due to high iron and manganese contents being found in groundwater sources. The level of iron and manganese are found to be in the range of 0.4-3.5 mg L^{-1} (compared to the national drinking water standard for iron of 0.3-1.0 mg L^{-1}) and 0.1-1.52 mg L^{-1} (compared to the national standard of 0.1 mg L^{-1}) (DRA, 2004). High level of arsenic contamination was also reported in many areas of the city (Rahman, 2005).

Sampling and Data Collection

The unit of analysis for this research is households. The method of data collection was face-to-face interviews conducted in October-November, 2005. Using a simple random sampling method, we selected 150 respondents with water supply connections in their homes, from two different areas of the city. The target population was the heads of household. The overall response rate was 100 per cent due to in-person interviews.

Contingent Valuation Method

CVM is a survey-based technique used to directly elicit participants' preferences for an environmental asset. The technique requires the construction of a hypothetical market through which respondents are asked to express their *ex ante* monetary values of a change in the provision of a good's quantity or quality (Mitchell and Carson, 1989).

As per the objective of this study, the CV method was used to estimate residents' WTP values for the increased supply of water or improved quality of piped water. Survey participants were offered a hypothetical market, in which they are asked to express their stated preference (i.e. WTP) for an improvement of the existing facilities as an amount over their existing payment.

In line with standard CV studies, the interview for this study included three types of questions: the respondent's socioeconomic information, questions relating to current water service quality and the WTP questions. The CV questions in this study begin with the description of two scenarios that directly ask respondents to state their maximum WTP for the particular use or non-use value of the water. The scenarios are described as follows:

Scenario 1: At present water supply is intermittent along with low pressure. Suppose water supply authority is going to provide a 24 hours continuous service or availability of water with good pressure.

Scenario 2: Currently piped water quality is too poor to drink directly (without further in home treatment such as boiling). Suppose water supply authority is going to improve the quality of water. i.e., bacteria-free and also in terms of colour, odour, hardness, iron so that water is safe to drink from the tap directly.

Households who are currently connected to the piped water network were asked to indicate the monetary value they would pay for these two hypothetical scenarios and the WTP questions consistent with these scenarios were as follows:

Question with scenario 1: In addition to your current water bills, how much would you be willing to pay per month to receive water in your house available for 24 hours rather than 7 to 8 hours a day as at present?

Question with scenario 2: In addition to your current water bills, how much would you be willing to pay for safe water that is directly drinkable from the tap?

Model Specification

Microeconomic theory suggests that WTP should change across individuals having various differing socio-demographic characteristics, residential characteristics and others (Casey et al., 2006). We, therefore, conduct a multivariate regression analysis which is almost similar in specification with that of Casey et al. (2006), Whittington et al. (2002) and Briscoe et al. (1990). The specification of the model is as follows:

$$WTP_j = \alpha_0 + \beta_i X_i + \varepsilon_j$$

where $i = 1 \ldots 9$ indicate nine different explanatory variables (such as gender, age, household size, housing type, years of education, income, connection size, supplying hours of water and food expenditure) and j represents continuous supply and quality of water. The variables selection is done mainly on the basis of previous studies. The estimation method of the model is ordinary least squares (OLS).

Empirical Results

Socio-economic Profile of the Respondents

Survey participants were the head of the households because of their decision making role in the households in a developing country context. Among the surveyed households, 89 per cent were male and 11 per cent were female, representing male dominated society. Apart from marital status, 97 per cent of the interviewees were married and the rest three per cent were single. Among the households, 39 per cent were government service holder and 37 per cent were business persons. The average age of the respondent was 49 years and the average household size was six. Mean year of education completed by the respondent was 13 and mean income was Tk[1] 11,343 per month. The respondents' other main demographic characteristics are listed in Table 2.

The Determinants of Willingness to Pay

The multivariate regression analysis provides us an insight into the relationship between the demographic, socioeconomic factors and WTP. An OLS method was used to comprehend households' decision on WTP for continuous water supply and improved water quality. The purpose of this analysis was to statistically determine how various households' demographic and socio-economic factors influenced their WTP decisions. Table 3 reports the factors that affect households' WTP for continuous water supply in their home where we can see that F = 6.07 and p = 0.000; this implies that the overall model appears to be statistically useful.

[1]TK (Taka) is Bangladesh currency and US$1 = Tk 69 as of March 2010.

Table 2: Descriptive statistics of the respondent's socio-economic profile

Variables	*Percentage*	*Mean*	*Std. Deviation*	*Minimum*	*Maximum*
Age (years)		49	12	24	95
Sex (%)	Male: 88.7				
	Female: 11.3				
Marital status (%)	Married: 96.7				
	Single: 3.3				
Major occupation (%)	Govt. service: 40				
	Business: 36.7				
	Others: 23.3				
Household size (no.)		6	2.23	2	14
Year of education (yrs)		13	4.14	0	16
Monthly income (Tk)		11,343	6316	3000	60,000
Monthly food expenditure (Tk)		5662	2316	2000	15,000
Monthly water expenditure (Tk)		113	54	30	340
Valid $N = 150$					

Table 3: Estimates of factors influencing WTP for continuous water supply

Model 1	*Un-standardized Coefficients*		*Standardized Coefficients*	*t*	*Sig. (P)*
	β	*Std. Error*	*Beta*		
Constant	-0.347	18.077		-0.019	0.985
Gender	0.478	6.123	0.006	0.078	0.938
Age	0.01715	0.154	0.008	0.112	0.911
Household size	0.349	0.860	0.031	0.406	0.685
Housing type	4.352	2.224	0.155	1.957	0.052
Years of education	0.864	0.524	0.143	1.648	0.102
Income	0.001140	0.000	0.289	2.569	0.011
Hours of supply	1.293	1.379	0.072	0.938	0.350
Food expenditure	0.001321	0.001	0.123	1.068	0.287
Connection size	7.210	10.361	0.053	0.696	0.488
Model Summary	$R^2 = 0.280$, $F = 6.067$; $P = 0.000$ (No. of Observation = 150)				

Dependent Variable: WTP for continuous water supply

In the model, only one factor, income, appears to be the most significant predictor at $\alpha = 0.05$ level because the *p*-value for income of 0.011 is less than 0.05. Other important predictors are housing type and education (significant at 10.2%). On the other hand, factors that influence households' WTP for the better quality of water is shown in Table 4 which shows the analysis between households' WTP for improved quality water and their various socioeconomic and demographic characteristics.

In Table 4, $F = 7.95$ with an associated *p*-value of 0.000; hence the overall model is a useful predictor of WTP for water quality. In the model, age, housing type and education appear to be the most important predictors. Education and housing type have become the most significant predictors at $\alpha = 0.05$. One important point to be made is that income appears to be no longer a significant factor for influencing WTP for improved water quality though theoretically it is important for influencing households' WTP. Akter (2008) also found no correlation between household income and participants' WTP for safe drinking water. However, income indirectly influences participants' WTP; housing type is found to have a significant impact on the WTP. Housing types represent socio-economic status of a household in developing countries like Bangladesh. In short, the above two models have produced very interesting results. Income is considered both theoretically and empirically a very important factor for affecting WTP and our results show that it is true for the hypothetical continuous water supply scenario. However, when WTP for improved water quality is the dependable variable, income is not

Table 4: Estimates of factors influencing WTP for quality of water

Model 2	*Un-standardized Coefficients*		*Standardized Coefficient*	*t*	*Sig. (P)*
	β	*Std. Error*	*Beta*		
Constant	9.051	21.931		0.413	0.680
Gender	8.707	7.428	0.089	1.172	0.243
Age	–0.349	0.186	–0.139	–1.871	0.063
Household size	1.496	1.043	0.108	1.434	0.154
Housing type	9.571	2.698	0.274	3.548	0.051
Years of education	1.289	0.636	0.171	2.027	0.045
Income	0.00008014	0.001	0.163	1.489	0.139
Hours of supply	2.046	1.673	0.092	1.223	0.223
Food expenditure	0.0002126	0.002	0.159	1.417	0.159
Connection size	10.916	12.571	0.064	0.868	0.387
Model Summary	$R^2 = 0.315$, $F = 7.949$; $P = 0.000$ (No. of observations = 150)				

Dependent Variable: WTP for quality of water

seen as the main determining factor among others. For WTP for improved water quality, level of education of the participants has emerged as the most influential factor.

The Estimation of WTP

Whilst the city authority is maintaining its policy of providing water at nominal tariff for all domestic users where the country's national policy for water supply calls to cover the O&M cost through monthly water tariff at the very least, the water supply service in Rajshahi city is not satisfactory. This study was not intended to develop a water tariff structure for the city. Nonetheless, the potential for increased revenue collection is being made on the basis of mean WTP of households. The flat rate of Tk 30, although being criticized by many quarters, is used in the RCC for the convenience of implementation (RCC, 2001). On the contrary, the households who are consuming more water should pay more. Moreover, apart from raising enough funds and sustainability of the resource itself, it is an urgent issue to control water use, conserve water resources, and limit wasteful use of water. A cost reflecting pricing mechanism linked to the volume of water consumption will help to achieve this demand management and water conservation strategies.

According to the study, the mean values for WTP are Tk 59 and Tk 83 per month for ensuring continuous water supply and improved quality of water respectively as shown in Table 5 where we see that the number of connected households is 14,812 and the monthly flat rate is equivalent to the mean WTP. This indicates that consumers' WTP is comparable to what they are currently paying for their water supplies. If we multiply the number of household by the monthly mean WTP, we get the monthly revenue potential. Annual revenue potential thus is Tk. 10.4 million and Tk. 14.7 million for continuous supply and improved quality water respectively. The money households are ready to pay for the improved quality of water can cover 71 per cent of the O&M cost of Tk 35.32 million per annum.

Concluding Comments

Analyses reveal that households' WTP vary according to various socioeconomic and demographic characteristics. Usually, households' WTP for current service is low; however, they are willing to pay a considerable amount of money for the continuous supply and improved quality of

Table 5: Revenue potential based on WTP estimates

Scenarios	*Number of households connected*	*Mean WTP (Tk/ monthly)*	*Potential monthly revenue (Million Tk)*	*Potential annual revenue (Million Tk)*
WTP for continuous supply of water	14,812	59	0.87	10.4
WTP for quality water	14,812	83	1.2	14.7

Source: Authors' own calculation

water. The mean WTP is Tk 59 for the continuous supply of water and Tk 83 for the improved quality of water. These amounts are respectively 97 and 177 per cent above the existing average household water tariff of Tk 30 in 2005. Under a range of assumptions about uncertainty, Vásquez et al. (2009) found households' median WTP for safe and reliable drinking water between 45.6 per cent and 77.28 per cent above their current water bills. Soto Montes de Oca and Bateman (2006) found a WTP for an improved water supply system ranges between 50 and 340 per cent of the existing water bills. Therefore, the WTP amounts generated by this study are consistent with others. Consumers are willing to pay a bit more than what they are currently paying for the monthly charges. Potential revenue yield, based on WTP analysis, is thus about Tk 10.5 million for the continuous supply of water and about Tk 15 million for improved quality of water. There is, therefore, a potential to raise enough funds from water users which at least can cover annual O&M costs. The regression analyses showed that household income is the most powerful determining factor for WTP for continuous supply of water. The most important finding is that the level of education of the head of the households is the most significant factor in determining WTP for improved water quality. Government policy therefore needs to facilitate awareness programmes to educate residents about the importance of improved water quality.

Water security is a critical factor in economic, environmental and social systems and for life itself. Due to the reduction of surface water sources, potable freshwater stress owing to increasing population and urbanization, water use will increase significantly in future. Adding to this problem, impact of climate variability and change is adversely affecting freshwater scarcity in the northern Bangladesh including Rajshahi. Sustainable provision of potable water supplies requires substantial investment in water supply systems including its regular O&M. Residents' WTP for water prior to the implementation of any water sector improvement project is a useful piece of information in planning and designing process. The findings of this study have particular significance in the context of the Government's move towards the introduction of user's fee for generating revenue to meet the costs of maintaining water infrastructure and treat water for drinking purposes. The National Water Management Plan also emphasized on the introduction of the increasing block tariff structure in the urban areas with an expansion of metered supplies (GoB, 2001). Low levels of tariffs make it hard to influence consumers' demand, i.e. no possibility of achieving a price elasticity of demand. This study reinforces that the existing water tariff system can be restructured through applying principles of cost recovery and increased WTP for better services.

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